Mobilising climate finance through carbon removal: the case of Namibian bush biomass and biochar

Final report

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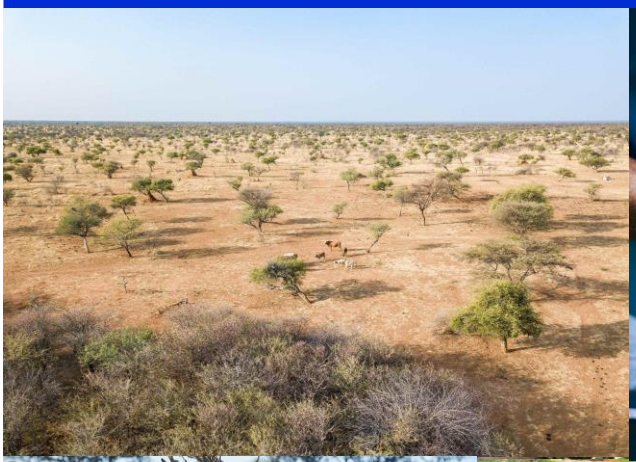

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Acronyms and abbreviations

°C	Degrees Celsius
ABU	Australian Biodiversity Unit
AFD	French Development Agency (Agence Française de Développement)
AFOLU	Agriculture, Forestry, and Other Land Uses
BCBU	Bush Control and Biomass Utilisation
BCR	Biochar Carbon Removal
BioBanking	Biodiversity Offsets and Banking Scheme
BIOFUND	Foundation for the Conservation of Biodiversity
BOS	Biodiversity Offsets Scheme
CA	Corresponding Adjustment
CAM	Carbon Asset Manager
CAoN	Charcoal Association of Namibia
CSI	Carbon Standards International
CBNRM	Community-Based Natural Resource Management
CCB	Climate Community and Biodiversity
CCF	Cheetah Conservation Fund
CO_2	Carbon Dioxide
COP	Conference of the Parties
CORCs	CO2 Removal Certificates
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
DRFN	Desert Research Foundation of Namibia
EBC	European Biochar Certificate
EBI	European Biochar Initiative
EIF	Environmental Investment Fund
EPMAPS	Municipal Sewer and Potable Water Company of Quito
ESS	Ecosystem Services Standard

ETS	Emissions trading scheme
FM	Forest Management
FONAG	Fund for the Protection of Water
FSC	Forest Stewardship Council
GBF	Global Biodiversity Framework
GEF	Green Environment Facility
GHG	Greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
ha	Hectare
HSF	Hanns Seidel Foundation
ICAP	International Carbon Action Partnership
ICROA	International Carbon Reduction & Offset Alliance
IETA	International Emissions Trading Association
IPCC	Intergovernmental Panel on Climate Change
ITMO	Internationally Transferred Mitigation Outcomes
MAWLR	Ministry of Agriculture, Water and Land Reform
MEFT	Ministry of Environment, Forestry and Tourism
MME	Ministry of Mines and Energy
MRV	Monitoring, Reporting, and Verification
N-BiG	Namibia Biomass Industry Group
NDC	Nationally Determined Contribution
NNF	Namibia Nature Foundation
NSW	New South Wales
NUST	Namibia University of Science and Technology
PDD	Project Design Document
PES	Payment for Ecosystem Services
PMR	Partnership for Market Readiness
PV Nature	Plan Vivo Biodiversity Standard

REDD+	Reducing Emissions from Deforestation and Forest Degradation
ROI	Return on Investment
SBTi	Science-based Targets Initiative
SD VISta	Verra Sustainable Development Verified Impact Standard
SOC	Soil Organic Carbon
SSI	Sustainable Sugarcane Initiative
tCO_2e	Tonne of Carbon Dioxide Equivalent
UNAM	University of Namibia
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
USBI	US Biochar Initiative
USD	US dollar
VCM	Voluntary Carbon Market
VCMI	Voluntary Carbon Markets Integrity Initiative
VCS	Verified Carbon Standard
VRC	Vulnerability Reduction Credit™
VVB	Validation/Verification Bodies
WWF	World Wide Fund for Nature

Executive summary

Namibia faces the problem of bush encroachment, a process in which woody plant species become the dominant component of an area's vegetation. It is assumed that 30% of the country's farmland is affected. As a result, the carrying capacity of the land is reduced, threatening the livelihoods of farmers. The issue of bush encroachment can also be understood through the concept of ecosystem services. Ecosystem services play a central role to human wellbeing and economic progress, as they represent the benefits society derives from the functioning of ecosystem services. In the Namibian context, the relevant ecosystem services include: groundwater recharge; carbon sequestration; recreational and tourism services; biodiversity; and soil conservation.

Ecosystem services are often undervalued in economic terms, resulting ultimately in their underprovision. A solution to this problem is offered by the concept of payment for ecosystem services (PES), where those benefitting from a particular service provide financial or other incentives to the individuals or entities providing that service. For instance, a landowner practising sustainable forest management to maintain watershed services might receive payments from downstream users, such as water utility companies. PES schemes can be categorised into different mechanisms: i) payments for implementing sustainable practices, often funded publicly; ii) voluntary markets where ecosystem services are commoditised and can be purchased by private or public entities; and iii) user charges and compliance markets.

Namibia's constrained financial resources make it challenging to implement publicly financed PES mechanisms in the short term. A user-charge approach, based on compliance obligations, is also difficult, due to the unclear identification of all beneficiaries of ecosystem services from sustainable bush management. However, a promising alternative lies in adopting a voluntary market-based approach, which could offer a cost-effective solution for the Namibian state. Among the ways to commodify the ecosystem services in market-based approaches are carbon credits and biodiversity credits. On one hand, there are carbon credits, which can be divided into two broad categories: avoidance credits and removal credits. An avoidance credit, generated by projects that prevent GHG emissions that otherwise would have taken place, represents 1 tonne of CO_2e whose release into the atmosphere has been avoided. A removal credit represents 1 tonne of CO_2e that has been removed from the atmosphere. On the other hand are biodiversity credits, which involve payments for the protection, restoration or management of biodiversity. While the market for carbon credits is well established, biodiversity credits have only slowly been gaining traction, and it is unlikely that they can be commercialised at a scale comparable to carbon credits in the near future.

Within the voluntary carbon market, biochar manufacturing is considered the most developed technology that may generate significant revenues. Multiple studies have been undertaken to research biochar's positive properties on soil quality, as well as its carbon sequestration potential. According to the latest report of the Intergovernmental Panel on Climate Change (IPCC), biochar is one of the safest, most durable and fastest ways to draw down carbon today. Beyond its potential as a tool for climate mitigation, biochar is also widely known for its use as a soil enhancer that can be used in agriculture and horticulture. Other uses of biochar may be found in soil decontamination, wastewater treatment and as a material that can be used in the building sector. The biochar market is experiencing rapid growth, attracting various stakeholders, including project developers, marketplaces, associations and technology providers.

Several private sector companies in Namibia are currently experimenting with biochar-based business models. Among them, PyroNam stands out as the only operational facility in the country, with ambitious plans for rapid expansion. Prime Biochar is another active player in Namibia's biochar production landscape. Additionally, there is Planboo, a startup dedicated to carbon removal through biochar projects in tropical regions, which, in addition, provides a specialised technology, combining both hardware and software for measurement, reporting, and verification. Simultaneously, Namibia is witnessing various biochar trials, including the NUST BUSH project (2018-2021) and the African Wilddog Biomass Hub Project as well as ongoing scientific trials led by the Perivoli Rangeland Institute, among others.

A number of gaps and barriers need to be addressed in order to create an enabling environment that leads to the scaling of biochar carbon removal in Namibia. On a regulatory level, addressing the issue of land ownership is paramount. While biomass can be commercially harvested on privately owned land, existing laws prohibit this on communal lands, except for personal use. Additionally, regulatory clarity is needed and is currently being pursued through the development of a carbon market framework. Crucially, the lack of demand for biochar as a material product poses a significant challenge. Due to the absence of demonstrated impacts of biochar on soil productivity, farmers show limited interest in using biochar as a soil enhancer or as a replacement for conventional chemical fertilisers. Furthermore, there is a general lack of awareness regarding the potential applications of biochar. Developing these value chains will require a substantial amount of time and concerted efforts in education and awareness-building initiatives.

The primary conclusion drawn from the study is that for biochar production to be financially sustainable, it must diversify its revenue streams. Relying solely on income from carbon credits is insufficient to establish a viable business model. There are two prominent biochar production models, each aligned with specific technologies. One model involves high-tech facilities utilising semi-continuous production processes with advanced mechanisation. The contrasting model employs Kon-Tiki kilns, which operate in a decentralised manner. Achieving the necessary production scale for a viable biochar carbon removal (BCR) project with Kon-Tiki kilns requires multiple kiln operators. Unlike high-tech facilities, Kon-Tiki kilns promote a distributed operational approach, emphasising the involvement of local operators working collectively to meet the required production scale.

A business case tool has been developed in the form of an Excel-based workbook. This tool enables biochar producers to simulate results for different project design options. This allows to biochar producers to recognize the contribution that carbon market may bring for their projects, but also what their limitations are. In this sense, the business case tool serves to illustrate the study's main finding that biochar production needs diversified revenue streams to be financially sustainable. Moreover, it allows biochar producers to see at what carbon credit prices they need to launch their production, as well as to calculate the costs associated with the carbon project development process.

As the biochar industry is at the very beginning of its development in Namibia, the analysis has shown that many of the key actions are likely to benefit if supported by an industry group, i.e. a coordinating and governing body. To advance the development of the biochar sector and address the identified gaps and barriers, it is essential to establish an organisation tasked with coordinating, supporting and fostering the sector's growth, as well as overseeing sector-wide governance. Alternatively, existing organisations could be entrusted with this mandate. The responsibilities of

this governing body would encompass: coordinating the implementation of biochar pilot projects in Namibia; bolstering technical expertise and awareness; and facilitating organised and coordinated efforts among stakeholders involved in biochar initiatives. After conducting research and consulting with stakeholders, it becomes evident that organisations like Namibia Biomass Industry Group (N-BIG) and Charcoal Association of Namibia (CAoN), either individually or as a joint governing body, are well suited for this role. This governing body, or its constituent organisations, could serve as the central hub for engaging with other industry stakeholders and the national government. They could lead the charge in crafting a national biochar strategy and explore avenues to involve relevant government bodies in establishing biochar operations on communal lands capable of attracting carbon finance. Given the strength and diverse capabilities of Namibia's biomass sector, there exists a significant opportunity to contribute to a carbon dioxide removal economy, provided that the necessary institutional frameworks are put in place.

This report was concluded in November 2023 and includes relevant developments in Namibia up to that date.

1 Introduction

Namibia is currently facing a significant challenge with bush encroachment. Bush encroachment is the process by which woody plant species proliferate and become the dominant component of an area's vegetation. This phenomenon has affected around 30% of the country's farmland, leading to a reduction in the carrying capacity and productivity of these lands for cattle and game. Consequently, the livelihoods of game and livestock farmers are under threat. Additionally, bush encroachment has had a severe impact on the ecosystem services provided by these areas, such as: groundwater recharge; carbon sequestration; recreational and tourism services; biodiversity; and soil conservation. Bush encroachment can be addressed through various measures of bush control, including: preventive measures; active rehabilitation measures; and follow-up measures (Birch et al., 2016). However, these approaches are labour and cost intensive.

The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) has tasked South Pole and VO Consulting to assess additional sources that may finance measures to address the bush encroachment problem and restore the ecosystem services provided by the savannah bushland, and to develop an action plan. The study aimed to understand the landscape of environmental and climate financing related to bush biomass value chains. An analysis of Namibia's current bush biomass value chain was conducted, highlighting existing gaps and barriers. Based on these findings, an action plan was developed, outlining responsibilities for stakeholders. Additionally, a practical business model tool was created to assist potential biochar producers in evaluating the cost-effectiveness of addressing bush encroachment.

The following chapters present the research findings, structured based on the specific work packages that were completed. Chapter 2 describes the concept of ecosystem services, introduces and reviews different payment for PES schemes and analyses which are most promising for Namibia, based on a review of selected case studies. In addition, the chapter introduces carbon credits, including a brief overview on Article 6-regulated markets and the voluntary carbon market (VCM), before presenting the available standards and methodologies to generate carbon credits from biochar production. Chapter 3 provides an overview of Namibia's biomass value chain, detailing: key stakeholders; current uses of bush biomass; and the country's readiness for various PES schemes. In Chapter 4, the study delves into the gaps and barriers analyses, outlining the areas requiring attention to establish an enabling environment for biochar production with carbon credit sales as a revenue source. The chapter also outlines specific actions to create this enabling environment. Chapter 5 introduces the business model tool, which is an Excel spreadsheet designed to conduct a cost-benefit analysis. Additionally, this chapter offers instructions on establishing a biochar-based carbon project. Further supporting materials can be found in the annexes.

2 Landscape mapping

2.1 Ecosystem services and bush encroachment in Namibia

Ecosystem services are essential to human wellbeing and economic development. The term 'ecosystem services' describes the benefits provided by natural capital and ecosystems, representing the dynamic interaction between plants, animals, microorganisms and the non-living environment and human society. The most widespread classification of ecosystem services is the one proposed by the Millennium Ecosystem Assessment (2005). It classified ecosystem services into provisioning services such as: food, fresh water or raw materials; regulating services including carbon sequestration and storage, flood and diseases control or pollination; supporting services, such as habitats for species and maintenance of genetic diversity; and cultural services, such as tourism, spiritual activities, recreation and mental and physical health. Although alternative classifications exist, all classifications aim to quantify the contribution of nature to human wellbeing and are used to justify and/or raise investment and financing of natural protection and rehabilitation, such as savannah restoration through bush thinning.

Bush encroachment poses a threat to ecosystem function and reduces the ability of savannah and grasslands to provide vital services that support economic activity in Namibia. Bush encroachment refers to the invasion and thickening of undesirable woody species, resulting in changes to the grass-to-bush ratio, a decrease in biodiversity and a reduction in the carrying capacity of the land, transforming former grass and savannah lands into an imbalanced rangeland ecosystem. This has led to severe economic losses in Namibian farming areas, including lower grazing potential and a steep decline in agricultural production (Stafford et al., 2017). In addition, bush encroachment has negative environmental impacts, such as the reduction of groundwater recharge and loss of mammal habitat (e.g. cheetahs). It also affects tourism by decreasing the probability of spotting wildlife, reducing species diversity and impacting the iconic, open landscapes that are the competitive advantage of Namibia's tourism industry.

Efforts to address and reverse bush encroachment through bush control measures have the potential to generate significant economic value by restoring important ecosystem services. For instance, these measures can help increase groundwater recharge, which is particularly important in an arid or semi-arid country such as Namibia. Additionally, bush control measures can enhance the grazing capacity of Namibian lands and provide wood products for fuel and electricity production. Bush thinning can also restore the visual appeal of landscapes, promoting recreational and tourism-related activities such as hunting and wildlife photography. Furthermore, the use of appropriate bush-thinning techniques can foster biodiversity, enhancing the overall resilience of the ecosystem. Where the removed encroacher biomass is utilised as a feedstock for biochar, further benefits can be achieved: the application of biochar from woody biomass provides for stable carbon storage, while potentially improving soil quality and acting as a fertiliser. The summary of the key ecosystem services which can be supported by bush thinning and which will be considered in this assessment are summarised in Table 1: Overview of ecosystem services affected by bush thinning

Table 1: Overview of ecosystem services affected by bush thinning

Ecosystem service	Description
Groundwater recharge	Bush encroachment in Namibia can have a significant impact on the process of groundwater recharge. When the natural vegetation is replaced by dense bush cover, it can significantly reduce the amount of rainfall that is able to penetrate the soil and recharge the groundwater aquifers below. Furthermore, the deep root systems of the encroacher bush can deplete the water resources in the soil, leading to a decline in groundwater recharge rates. This can result in a reduction of the available water supply for both human and animal consumption and other uses.
Carbon sequestration	Bushes naturally absorb and sequester carbon dioxide (CO2) from the atmosphere, making them a carbon sink. Therefore, activities such as bush thinning can reduce the amount of carbon that is sequestered in these plants. However, the main carbon sequestration potential is linked to the potential use of bush biomass, which can be used for electricity generation or transformed into biochar for permanent carbon storage. The net benefit in terms of carbon sequestration therefore depends on subsequent land use (e.g. more cattle farming will increase emissions) and on how the biomass is utilised.
Recreational and tourism services	It is generally accepted that ecosystem services include cultural services such as recreation, education and aesthetic values. Namibia's tourism industry depends on the unique features of its landscape, which are threatened by bush encroachment. Effective bush control measures can restore the ecosystem services that support the industry.
Biodiversity and soil conservation	Biodiversity is not explicitly recognised as an ecosystem service. However, the concept of biodiversity captures the potential value of ecosystem services that result from the interaction of species, habitats and processes. Bush encroachment is understood to have a negative impact on biodiversity, as bush disturbs the optimal mix of vegetation and alters the natural balance of wildlife. Measures addressing bush encroachment are hence assumed to positively impact biodiversity.
Adaptation	Adaptation services refer to natural processes or ecosystem services that help humans cope with environmental changes including climate change. Bush control restores the overall ecosystem state and functionality by enhancing the individual ecosystem services mentioned above, specifically water availability and grassland productivity, thereby rendering the country more resilient to climatic changes.

(Source: South Pole, based on Birch et al., 2016; Laborel et al., 2020; Lavorel et al., 2014)

2.2 Environmental and climate financing and its mechanisms

2.2.1 The concept of PES within the broader realm of environmental funding

Ecosystem services are often undervalued in economic terms, resulting in their benefits being inadequately considered during decision making. This market failure leads to short-term decisions that prioritise unsustainable resource use over long-term ecological health. One solution to this issue is the concept of PES, defined as 'a contractual transaction between a buyer and a seller for an ecosystem service, or a land use/management practice likely to secure that service' (United Nations Economic Commission for Europe [UNECE], 2007). In general terms, PES is a scheme in which the beneficiaries of a service provide financial or other incentives to the providers of that service. For example, a landowner who engages in sustainable forest management, ensuring the watershed services of a forest, receives payments from downstream users of the water e.g. water utility companies. By making the costs and benefits of ecosystem services explicit to both beneficiaries and providers, PES incentivises sustainable practices that ensure the continued provision of ecosystem services over the long term.

PES schemes are characterised by two key features: conditionality and additionality. Conditionality means that payments are contingent upon the provision of a specific ecosystem service or the implementation of land management practices that result in the provision of an environmental service. This requires that the services delivered can be distinguished from the provision of mandatory services and that they can be measured. The second feature of PES schemes, **additionality**, requires that the scheme goes above and beyond what is required by regulatory compliance. This means that the scheme must quantify the additional value of ecosystem services delivered under the scheme compared to what would have been delivered in the absence of such a scheme. Therefore, PES schemes should not be introduced for activities that would be adopted in any case or for interventions already mandated by law. Moreover, interventions should ensure their permanence and avoid leakage (Fripp, 2014).

The concept of PES itself originated in the late 1990s as a response to the lack of funding for conservation and sustainable management of natural resources. The aim was to create a mechanism that would provide the necessary financing to preserve ecosystems by enabling the beneficiaries of ecosystem services to compensate the providers for maintaining and enhancing those services. Various mechanisms, including market-based, government-led and other hybrid approaches, led to the significant diversity of PES schemes at the local, regional and national levels, with more than 550 active programmes worldwide and an estimated value of USD 36-42 billion in transactions in 2018 (Salzman et al., 2018). Watershed PES schemes are the most well established, while carbon-based PES schemes have gained more attention due to the increased significance of climate change policy. The varying success rates of these mechanisms, which depend on their ability to provide clarity on service provider and beneficiary, as well as to establish a reliable mechanism for exchanging and collecting funds, emphasise the crucial role of the design of the PES mechanism.

2.2.2 Review of PES types and mechanisms

PES is a relatively new environmental policy tool that has been implemented in various forms across local, regional, and national levels. Its application to different environments and sectors such as watersheds, forests, and biodiversity has resulted in a multitude of configurations regarding financing arrangements and stakeholder involvement. This heterogeneity poses a significant challenge in consistently classifying existing PES schemes. Consequently, most PES schemes, including those discussed in this report, adopt a hybrid approach. Despite the challenges in classification, the diversity of PES approaches and contexts offers opportunities to tailor the scheme to the local context, giving it potential to become an effective tool for environmental management.

Due to their diversity, PES mechanisms can be categorised in various ways. These include sectoral classifications by: type of PES mechanism; main funder; and flexibility of the scheme. These are presented further in this section.

Classification based on mechanism applied. PES can be classified based on the broader mechanism or approach towards the ecosystem services (Namirembe et al., 2014) and how finance is directed to support them**.** These include:

- **'commoditisation' of environmental services**, which entails recurrent payments for the delivered environmental services and involves a form of certificates tradable on the market. This category will include generation of carbon credits or other tradable certificates, such as emerging solutions such as biodiversity credits and Certified Adaptation Benefits.[1]
- **'compensation' for opportunities skipped**, which will involve payments for missing a certain commercial opportunity or fulfilment of certain conditions in the applied ecosystem management approaches. In the context of bush value chains, this could involve payments for opting for sustainable bush-harvesting approaches and/or biomass utilisation techniques.
- **'co-investment' in stewardship**, which includes non-market commercial rewards for entrusting the ecosystem management with local communities. These are based on either delivering certain ecosystem services or the use of certain best-practice approaches. Examples include watershed services, forest conservation and ecotourism.

Classification based on finance provider. Another classification of ecosystem services focuses on the finance provider and the flexibility of the mechanism to differentiate PES mechanisms (Salzman et al., 2018). It defines the following categories of PES mechanisms:

- **user-financed PES:** individuals, companies, NGOs and public actors who benefit from ecosystem services agree to pay landholders for activities that maintain or improve these services.
- **government-financed PES:** third parties, for example governments, compensate landholders for maintaining or improving ecosystem services, on behalf of buyers who do not directly use these services. Examples include government programmes in Costa Rica

1 Certified Adaptation Benefits are a mechanism under development by the African Development Bank. The mechanism is still in a conceptual phase.

and China that pay landholders for reducing deforestation or promoting afforestation to protect food, water and other ecosystem services.

- **compliance PES:** parties facing regulations compensate others for maintaining or improving similar ecosystem services or goods, in exchange for standardised credits that meet their mitigation requirements. This includes: water quality trading; wetlands mitigation banking; and the European Union's emissions trading scheme for greenhouse gases (GHGs).

Based on the above PES types, three key PES mechanisms can be derived (see Table 2). They include: i) **payment for application of sustainable practices**, which typically relies on public funding; ii) **voluntary markets**, where ecosystem services are commoditised and can be acquired by private, and sometimes public actors, on a voluntary basis; and iii) **user charges and compliance markets**, where private sector actors are required to purchase commoditised units of delivered ecosystem services. These three types of PES will be analysed further in this report to understand which of them can be most successful in supporting the sustainable management of the Namibian bush sector.

Table 2: Review of PES mechanisms

PES mechanism	Type of mechanism	Financing type	Source of financing
Payments for application of sustainable practices	Compensation/co-investment	Public	Tax revenues/other charges Philanthropy/development funding
Voluntary markets	Commoditisation	Private, public	(International) private companies governments, development and climate finance providers
User charges/compliance markets		Private	National companies (or those operating in the country)

(Source: South Pole, 2023)

2.2.3 Review of the effectiveness of PES mechanisms

2.2.3.1 Main conditions for effective PES application

Evaluating the effectiveness of PES schemes can be challenging due to the complexity and diversity of ecosystem services, as well as the absence of clear indicators and baselines for comparison. Research on the effectiveness of PES has produced mixed results, which can be attributed to a lack of baseline data, control areas or randomised design (Salzman et al., 2018). The research on PES in general is lacking in quality, given the lack of data and the absence of a centralised PES database, rendering the extrapolation of findings of limited value (Mongabay, 2017). In addition, multiple factors contribute to the success of PES programmes, including: socioeconomic and environmental factors; programme costs; direct and indirect programme impacts; and spillover effects, which often complicate the comparison. When evaluating the

effectiveness of PES programmes, it is important to consider potential trade-offs and synergies between environmental and welfare-related outcomes. It has been noted that trade-offs between effectiveness and equity are rarely explored in a quantitative manner (Börner et al., 2017).

The success or failure of PES schemes is heavily influenced by contextual factors in their design and implementation, such as institutional arrangements and data collection. While PES programmes have shown positive effects such as increased conservation and improved ecosystem services, negative effects such as leakage, crowding-out of conservation efforts and reduced equity have also been observed (Börner et al., 2017). Researchers have identified that inclusive land access relations, suitable land use options, and long-term commitment by implementers are key enabling conditions for successful PES implementation, but have found that many PES programmes suffer from inadequate institutional settings and a lack of ecological systems thinking and data collection (Börner et al., 2017). A key bottleneck in PES design is often the lack of data and information related to climate and water behaviour at the local level (Mongabay, 2017). Moreover, many programmes rely on proxies (e.g. forest cover), because the specific output of ecosystem services is difficult to measure. Choosing the correct proxies requires a good understanding of the functioning of an ecosystem, hence the effectiveness and long-term viability of a PES programme depends on the ability to accurately estimate the ecosystem services from easily observable properties (Kelsey Jack et al., 2008). PES programmes have the potential to be an effective policy tool for promoting conservation and reducing poverty, but their success depends on various factors, including programme design and implementation context.

Research findings suggest that the success of PES programmes depends on the presence of clearly defined buyers and sellers and a reliable mechanism for exchanging and collecting funds (Salzman et al., 2018). Once you move away from a system with clearly attributable and localised benefits or when the public at large is a direct beneficiary of a service, it becomes unclear who should be charged, posing significant challenges to implementing a PES scheme. This finding, however, would be more applicable to mandatory/compliance PES rather than voluntary PES mechanisms whereby buyers can choose to participate in transactions without direct connection but primarily for the purpose of supporting ecosystem services. Wealth and ecological differences are also important factors that enable successful PES projects (Wang & Wolf, 2019). Box 1 summarises key enabling conditions, barriers and the implications of both for PES implementation.

Box 1: Key enabling conditions, barriers and implications for PES implementation

Key enabling conditions

- Defining clear and measurable ecosystem service benefits
- Involvement and participation of local communities
- Fair and equitable benefit-sharing mechanisms
- Adequate financial and institutional support
- Strong monitoring and evaluation systems

Barriers

- Difficulty in establishing clear property rights and land tenure
- Challenges in ensuring long-term sustainability and scalability
- Insufficient funding and limited access to financing

- Limited capacity for effective monitoring and evaluation

Implications for PES implementation

- Proper understanding and definition of ecosystem services is crucial for effective implementation
- Local communities should be involved and their needs and perspectives considered
- Land tenure and property rights should be addressed to ensure secure and sustainable management of ecosystem services
- Effective monitoring and evaluation systems are essential for ensuring the long-term effectiveness and sustainability of PES schemes

(Source: South Pole, 2023)

2.2.3.2 Review of effective PES mechanisms

While academic literature provides a good foundation to delineate PES mechanisms, the identification of appropriate PES mechanisms with the highest potential to succeed in the Namibian context must be based on lessons learned from practical examples. In order to evaluate the effectiveness of various types of PES mechanisms, a comprehensive analysis of PES applications in different countries has been conducted. This involved a literature review and analysis of several case studies. The findings of these case studies are summarised in Table 3: Review of PES application experiences (below); additional details on each case study can be found in Annex I.

Table 3: Review of PES application experiences

PES mechanism	Case study
Payments for application of sustainable practices	National PES, Costa Rica
	Fund for the Protection of Water (FONAG), Ecuador
	Mainstreaming Incentives for biodiversity Conservation in the Climate Resilient Green Economy Strategy, Ethiopia
	Foundation for the Conservation of Biodiversity (BIOFUND), Mozambique
	Community-Based Natural Resource Management (CBNRM), Namibia
	Forest Stewardship Council (FSC) Certification
Voluntary markets	EcoAustralia, Australia
	Sustainable Sugarcane Initiative (SSI), India
	Vulnerability Reduction Credit™ (VRC), global

PES mechanism	Case study
	Sustainable development units programme, New Zealand
	VCMs, global
User charges/compliance markets	Biodiversity Offsets and Banking Scheme (BioBanking), Australia
	Carbon tax allowing offsets, Colombia

(Source: South Pole, 2023)

While application of reviewed PES mechanisms highlighted the importance of specific national conditions, the analysis also revealed that certain types of PES mechanisms have proven to be more successful in providing finance to ecosystem services than others. The specific findings for each type of PES mechanism are presented in more detail below, providing insight into their relative effectiveness and the key factors that contribute to their success.

Payments for application of sustainable practices

Payments for the application of sustainable practices can include either compensation for opportunities skipped or co-investment, and typically rely on public funding. To be sustainable, such schemes need to have a stable revenue collection by the government or a fund providing the payments, and typically rely on tax revenues or other charges. The national PES scheme in Costa Rica presents an example of such a scheme. Widely credited for reversing deforestation and increasing the country's forest cover to 52% (up from 20% in 1987), the programme provides payments for landowners for the environmental services produced by their lands when adopting sustainable land use and forest management techniques. Funding for Costa Rica's PES comes from the government through water and fuel taxes (Porras et al., 2013). Another example is FONAG in Ecuador, which relies on a 1% surcharge on monthly water bills and financial support from a local electrical utility and beer company, large consumers of water.

While such programmes may not be overly complex, the financial burden on the public budget can be significant. They typically require the implementation of new taxes and charges, particularly in the environmental domain. In some cases, such schemes can be complemented by funding from international development institutions. However, these forms of financing are typically timebound, which threatens the sustainability of the PES mechanism in the long term. This may also require the PES mechanism administrator to search for additional forms of funding during a period of shortage of international financial support. For example, Mozambique's BIOFUND which started considering implementation of biodiversity offsets to complement its funding received support from the African Development Bank and other donors.

Case studies in this category demonstrated a reasonably high level of success, with those focusing on sustainable projects typically achieving a higher level of success than those focusing on sustainable practices. In this way, Mozambique's BIOFUND and Ecuador's FONAG, which fund specific projects protecting ecosystems, have demonstrated significant positive results. At the same time, other case studies, such as Costa Rica's national PES, Namibia's CBNRM and FSC certification, which mostly pay farmers and communities for the application of specific practices, achieved less. This can be due to the complexity of developing a simple streamlined certification

system for ecosystem services, which can be hard to quantify on a small scale, such as in the case of FSC.

With regard to the FSC certification, however, the Namibia-specific context is important. With the introduction of Namibia-specific FSC certification in 2020, a payments for application of sustainable practices scheme is already present. FSC-certified farmland has grown rapidly and stood at 1.6 million hectares (ha) in 2020 (FSC, 2020). This growth is mainly driven by an increased demand for FSC-certified charcoal in the European market. Furthermore, Namibia is the first country in Africa to obtain an FSC group chain of custody certificate, which allows local processors in the industry to join the FSC value chain at an affordable cost.

Box 2: FSC certification and FSC ecosystem services procedure

FSC certification

The FSC offers voluntary accreditation and third-party certification for environmentally appropriate, socially beneficial and economically viable forest management, which allows certificate holders to market their products as FSC certified. Based on a set of principles and criteria, the FSC provides a system tailored to the national context that certifies environmentally and socially sustainable forest management practices, such as: training requirements for workers; health and safety measures; minimum housing requirements; and other elements of forest management plans. In practice, adherence to these management practices, both with respect to the environment and workers engaged in harvesting and production, allows the marketing of products such as charcoal as FSC certified.

FSC Ecosystem Services Procedure

The Ecosystem Services Procedure is a process that allows for the verification of positive impacts resulting from forestry activities on various ecosystem services such as: biodiversity conservation; carbon sequestration and storage; watershed services; soil conservation; and recreational services. The use of FSC trademarks is permitted to promote verified impacts and may lead to rewards from: customers; investors; financial sponsors; users; and other interested parties. The Ecosystem Services Procedure can provide benefits to buyers of ecosystem services; these include certified impact, which can be used for marketing purposes or audited data that can be used in a company's own sustainability reporting.

(Source: South Pole, 2023)

The FSC Ecosystem Services Procedure currently has limited applicability to Namibia's bush-encroached areas. Of the five ecosystem services that the procedure currently certifies, only two – biodiversity and recreational services – may be applied to the Namibian context according to FSC guidance. Under biodiversity, the conservation and restoration of species diversity may be demonstrated using the procedure. With respect to recreational services, the protection of areas of importance for recreation or tourism and of populations of species of interest for nature-based tourism may be demonstrated (FSC, 2018). Both cases require the development of theory of change and the selection of outcome indicators and methodology. Payment for the implementation of the procedure could be a grant, a financial investment, a premium price, or financial sponsorship. For instance, charcoal-producing entities could implement the procedure to secure a premium on their produced charcoal, provided that FSC conditions are met and corporate buyers demand higher levels of sustainability certification.

The PES mechanisms relying on communities' management of natural resources, such as Namibia's CBNRM, represent an important example of restoring justice and empowering local communities, yet PES mechanisms can face a number of barriers affecting their efficiency. For example, local communities often lack capacity and technical skills for appropriate ecosystem management. This suggests that provision of technical training and support for communities would be important. There are also wider regulatory and institutional barriers to such schemes that cannot be addressed within the community, necessitating a holistic policy approach. This would be true for all considered PES mechanisms.

Voluntary markets

Voluntary markets rely on the commoditisation of ecosystem services, requiring the development of a methodology to allow the quantification of units of ecosystem services, which can then be sold to private companies. The technical complexity of such an approach is typically high during the methodology development but, once it is developed, it can be considered moderate, given that users of the PES need only to apply the developed rules. Recently, such methodologies have been developed for carbon markets (in the case of carbon sequestration) while other certifiable schemes are currently undergoing development (such as biodiversity credits). Private sector participation and the commodification of ecosystem services demonstrated potential for: quicker implementation; testing; scalability; adaptability to local needs and sectors; and flexibility to adjust the scheme to emerging needs or challenges through trial-and-error approaches.

One of the main advantages of voluntary markets is that they help attract private finance, reducing pressure on the public budget. Moreover, they also help attract finance from outside Namibia, due to the global interest and commitment of private-sector players to reducing their impact and supporting ecosystems around the world. The voluntary market operates as a self-regulating mechanism, in which companies communicate their sustainability initiatives, including their efforts to achieve carbon neutrality. This communication fosters visibility and serves as an example to other private sector entities by demonstrating the viability of the voluntary market as a means to channel finance to communities. These systems are flexible and allow financing to be obtained from governments and development finance providers.

In parallel, innovative voluntary-market approaches are being developed, which include biodiversity credits, water benefit credits and vulnerability reduction credits. These represent promising examples and are gaining momentum; however, demand for them on voluntary markets can remain lower since they do not allow companies to offset their impact the way carbon credits do. While this situation may be supported by the compliance market, as discussed further below, innovative solutions are being developed to stimulate demand for such credits. For example, EcoAustralia credits are tradable units where carbon credits are paired up with biodiversity credits, which allows taking advantage of the existing demand for carbon credits while attaching the extra cost to recognise biodiversity and habitat protection benefits. While this mechanism is new, it represents a promising example of going beyond carbon credits and recognising wider ecosystem services.

User charges/compliance markets

User charges or compliance schemes can involve public or private companies or individuals, which are required to purchase ecosystem service units to compensate for the impact of their actions. Under such mechanisms, the direct users of an ecosystem pay an economic actor for maintaining or enhancing the services provided by their land or activities. The main benefit of this scheme is a predictable and regulatable demand for ecosystem service units, which is imposed through the necessary regulatory measures. It also allows the distribution of the cost of ecosystem services among the relevant actors, typically benefactors of the ecosystem services or companies producing negative environmental impacts.

The user charge systems can be straightforward in cases where users are easily identifiable. A common example of such a mechanism would be charges imposed on water users, which then finance the mechanism for water cleaning, as, for example, in the case of Ecuador's FONAG. However, this approach might be more difficult to implement in case of ecosystem services such as biodiversity and carbon sequestration, where the direct beneficiary is hard to identify. In these cases, wider compliance markets can be implemented.

The design of a compliance market, however, can be complex, as it would require detailed analysis of the economic consequences of implementation and evaluation of provisions ensuring market equilibrium. Typically, it would require the introduction of a carbon tax allowing the use of carbon offsets towards a tax liability or an emission trading system in case of carbon. Such mechanisms can also be implemented in other areas, requiring industrial companies to acquire biodiversity, vulnerability reduction or water benefit credits where their activities have significant impact on these areas.

Allowing the use of carbon credits towards a tax liability in Colombia has proven to be largely successful in directing financial resources toward mitigation efforts, particularly within the forestry sector. This approach has also resulted in an increase in tax revenues that can be earmarked for further environmental protection initiatives. However, it is essential to acknowledge a potential drawback associated with this mechanism: a reduction in public revenue derived from the carbon tax as a result of allowing the use of credits for tax compliance purposes. Therefore, it is advisable to incorporate the use of offsets into the initial tax design, as was the case in Colombia. Here, the strategic decision to augment the carbon tax rate was deliberate, aimed at stimulating demand for carbon credits.

Australia's BioBanking represents an interesting mechanism requiring participating property developers to acquire biodiversity units to compensate for the negative impact of their developments. While the mechanism is voluntary in nature, once a developer commits to participate it can be penalised for not compensating its biodiversity impact (UNECE, 2007). This mechanism is an example of the requirement for economic actors to acquire ecosystem units for the impact that they produce in the area beyond carbon emissions.

A summary of the assessment of key characteristics is presented in Table 4 (overleaf).

Table 4: Assessment of PES mechanisms

PES mechanism	Success in attracting finance to support ecosystem services	Technical complexity	Burden on the public budget
Payments for application of sustainable practices	• Where programmes had a stable revenue income which could finance the mechanisms (e.g. environmental tax) and the scheme was long lasting, the mechanism is relatively successful. • More successful in project-based rather than practice-based approaches	• Relatively simple to implement • Require establishment of applicability conditions and monitoring, reporting and verification (MRV) approaches	• Need to be funded from the public budget • Even if a dedicated revenue stream is chosen/introduced, it will take public finance from other purposes or create a new charge for national businesses. • International financing must typically be secured from development institutions, yet it is usually fixed term, limiting the duration of the system.
Voluntary markets	• Help mobilise private capital • If globally applicable, help attract foreign finance • Have proven to be successful, yet the level of maturity and private sector interest varies by type of commodity	• Require certification methodologies and overseeing bodies • Require MRV infrastructure • Require technical preparedness from market participants	• Do not require public financing
User charges/ compliance markets	• Depending on the design, can be successful in attracting private finance	• Hard to impose in those areas where the benefitting entity is difficult to identify. • Establishment of compliance markets typically requires macroeconomic modelling to	• May have economic impact on the affected users, reducing their economic performance and, hence, public revenue • If PESs are offered as an alternative to a national pricing mechanism,

PES mechanism	Success in attracting finance to support ecosystem services	Technical complexity	Burden on the public budget
		understand the impact on the affected sectors. • Compliance markets typically require elaborated rules for balanced functioning. However, simpler mechanisms can be implemented.	opting for the PES scheme would drive finance away from the public budget.

(Source: South Pole, 2023)

The undertaken analysis demonstrated that different PES mechanisms have varying levels of success and should be chosen with the consideration of the national economic situation, public financing ability and technical capacity of the government or other potential PES implementers. Mechanisms that are simpler and manage to attract high levels of private capital tend to be more successful, as is the case with voluntary markets. However, other forms of PES mechanisms can also be successful; therefore, their joint implementation, either in the short or longer term, can be considered. Hybrid solutions, which are becoming increasingly popular and allow various sources of PES finance streams to be combined, should be considered.

2.2.4 Application of PES to the Namibian bush sector

The choice of the appropriate PES scheme must take into consideration the unique challenges posed by the problem of bush encroachment, Namibia's economic and regulatory situation and the financial sustainability of a scheme.

Due to constrained public finances in Namibia, the implementation of publicly financed PES mechanisms, such as payments for sustainable practices, may be challenging, at least in the short term. In practice, this would involve the government subsidising landowners to clear bush lands in exchange for the restoration of ecosystem services, which would be associated with a considerable increase of public expenses. To ensure the continuous implementation of this PES mechanism, a stable dedicated revenue source such as a carbon tax would be necessary, which is currently absent in Namibia. Moreover, for a more complex economic policy such as a carbon tax, extensive preparation and policy development would be needed. While this solution may be challenging in the short term, it can be considered in the medium to long term.

An ecosystem services mechanism based on a user-charge approach arising out of compliance obligations may also be challenging since not all beneficiaries of ecosystem services produced by sustainable bush management may be clearly identified. The problem of bush encroachment is geographically dispersed and affects the public at large, making it difficult to determine who should pay and how much. Additionally, it is technically difficult to measure and quantify the services accurately. Water companies, for example, are direct beneficiaries of increased groundwater recharge, as they are relieved of the need to invest in water infrastructure when recharge is improved. Ideally, for water companies to be charged, the link between improved groundwater recharge and decreased need to invest in infrastructure must be demonstrated and quantifiable. However, in reality, a simpler solution such as a charge on water supplies (e.g. 1%) can be established to collect funds for ecosystem services. In any case, it carries the risk that ultimately the end user will have to pay via higher charges.

At the same time, a voluntary, markets-based approach could present a cost-effective solution for the Namibian state. One of its benefits is that it does not require direct beneficiaries to be identified and ensures that funds are released only upon the delivery of results. Moreover, this approach can have positive impacts on employment and communities, while keeping demands on public resources to a minimum.

For voluntary markets, the technical complexity of the approach depends on the specific ecosystem service being certified. While there is no available standard for recreational and tourism-related services, carbon sequestration services benefit from high demand and several standard-setting organisations, whereas biodiversity, water benefit and adaptation reduction represent emerging solutions which can support the commoditisation of the ecosystem services of restored bush control. These are summarised in Table 5 and described in more detail below.

Table 5: Suitability of the current systems to support the commoditisation of ecosystem services restored by bush control

Ecosystem services in the bush sector	Potential market standard	Potential unit	Applicability	Readiness
Biodiversity and soil conservation	Plan Vivo Biodiversity Standard (PV Nature)	1 credit = 1% increase in median value of a basket of metrics	Applicable	In progress: public consultation phase
	Verra Sustainable Development Verified Impact Standard (SD VISta)	Unknown	Applicable	Early stage: under development
Groundwater recharge	Gold Standard Water Benefit Standard	1 Water Benefit Certificate = 1 cubic metre of water supplied, purified, or conserved	Not applicable	Ready
Carbon sequestration	Verified Carbon Standard (VCS) Puro Standard European Biochar Certificate (EBC) C-Sink	1 credit = 1 tonne of carbon dioxide equivalent (tCO_2e) reduced or removed[2]	Applicable	Ready
Vulnerability reduction (adaptation)	VRC Framework	1 credit = cost of the estimated impact of climate change avoided	Applicable	Early stage: under development
Recreational and tourism services	None	Not applicable	Not applicable	Not applicable

(Source: South Pole, 2023)

[2] See Box 5 for further information on the distinction between avoidance and removal credits.

Biodiversity and soil conservation

Biodiversity credits are gaining attention as a new concept, and various methodologies are currently being developed. However, creating these credits is more challenging than their carbon market counterparts due to the need to demonstrate their additionality and permanence while also ensuring their commercial viability by turning them into fungible tokens that can be compared across projects.

The Plan Vivo Foundation has been working on developing a biodiversity standard called PV Nature since 2022. This standard employs a biodiversity credit methodology that can be applied to all ecoregions and habitats. To determine the credits for biodiversity, a minimum of five measures are used that align with the conservation goals for the relevant ecoregion and application area. Each biodiversity credit represents a 1% increase or avoidance of loss in the median value of the selected metrics per hectare. The credits will be issued by Plan Vivo, and the standard is currently undergoing public consultation.

Verra also announced the development of a biodiversity methodology in November 2022. However, based on recent announcements, this methodology is not yet ready for application in the Namibian biomass sector.

Biodiversity considerations may be included with standards on top of existing carbon credit certifications. Examples include Verra's Climate, Community and Biodiversity (CCB) Standard and SD VISta, as well as the framework of the Gold Standard, which includes biodiversity as a co-benefit.

Groundwater recharge

The Water Benefit Standard by Gold Standard was launched in 2014 as the first globally consistent standard that certifies the positive water and socioeconomic impacts of water projects. The standard's Water Benefit Certificates represent a specific volume of water that has been sustainably supplied, purified, and/or conserved by a project over a specific time period. For projects to meet the Gold Standard WBS requirements, they must involve water supply, purification or conservation, as well as utilise an approved methodology to measure project outcomes.

The Gold Standard's registry does not display the available number of certificates, which could suggest either low supply or low demand for these credits. Additionally, it is possible that eligible methodologies do not currently account for groundwater recharge (Gold Standard, n.d.). This standard is hence ready for application but its applicability to the Namibian biomass sector is limited.

Carbon sequestration

There are established standards to measure and monetise the carbon sequestration from converting biomass to biochar. Puro.earth released the first carbon removal methodology for biochar in 2019, and Verra followed in 2022 with a methodology for Biochar Utilisation in Soil and Non-soil Applications. Although biochar credits not endorsed under the International Carbon Reduction & Offset Alliance (ICROA) have only been sold through Puro.earth (prior to ICROA endorsement) and Carbonfuture marketplace in limited quantities over the past two years, with prices in the range of EUR 100-150 per credit (Puro.earth, n.d.-a), the carbon sequestration service of bush control is now ready for commercialisation. With the endorsement of Puro.earth under ICROA in 2023, a stronger market demand for credits from officially accredited standards will emerge in subsequent years.

Vulnerability reduction

Efforts to monetise vulnerability reductions have been explored, but remain largely at a conceptual stage. The Higher Ground Foundation has developed VRCs, aiming to monetise the estimated costs of climate change impacts. VRCs are standardised and adjusted for the income level of the community, and may be sold to parties interested in funding adaptation activities. Although the concept was developed in 2018, it has not gained enough momentum, perhaps due to a lack of demand and the absence of a robust market for adaptation solutions.

Recreational and tourism services

There are currently no standards or methodologies that could attest to the recreational and tourism-related services provided by bush control. Therefore, for these types of ecosystem services, other PES schemes can be considered, such as for community-based land management, which is already being implemented in Namibia.

Box 3: PES review summary

While currently only carbon sequestration benefits are poised for commercialisation, there is potential to incorporate additional ecosystem services, such as biodiversity, into existing carbon standards as certified co-benefits. Verra has developed the CCB Standard that offers credits in addition to carbon credits for projects that meet the standard. While the CCB Standard currently applies only to agriculture, forestry and other land use (AFOLU) projects, there is potential to expand it to include technology-based methodologies such as biochar in the future. However, this decision ultimately rests with the standard-setting organisation.

An alternative solution can be the pairing of carbon credits with other ecosystem-based credits, without the joined certification. This would allow them to take advantage of the existing demand for carbon credits and help generate payments for other ecosystem services relevant to sustainable bush management and benefit local communities.

(Source: South Pole, 2023)

2.3 Commoditisation approaches: landscape review

Given that the assessment of PES relevant to the Namibian bush biomass sector has demonstrated that commoditisation approaches are likely to be the most suitable mechanisms supporting debushing, this section of the report presents an overview of their main characteristics and stakeholders. Given that carbon markets are more developed, the review will primarily focus on their functioning, while biodiversity markets, which represent a less immediate opportunity, will also be considered.

2.3.1 Carbon markets

There are two main types of markets in the realm of carbon trading: compliance or regulated markets, and voluntary markets. Compliance markets emerge due to policy or regulatory mandates at the national, regional or international level. In the context of carbon, compliance markets require regulated entities to purchase and retire emissions allowances or carbon credits to meet regulatory targets. Carbon markets subject to Article 6 of the Paris Agreement refer to regulated markets, where countries can transfer emission reductions that they have earned from reducing their GHG emissions to other countries in the form of credits, assisting them in meeting their climate objectives. Voluntary markets, on the other hand, describe the issuance, sale and purchase of carbon or other types of credits by individuals or companies with corporate sustainability goals. The two markets differ in terms of the source of demand, pricing and regulatory oversight.

This section of the report will begin with an introduction to compliance and Article 6-regulated markets. Subsequently, the report will shift the focus to voluntary markets, including carbon and biodiversity credits. The discussion will include relevant market developments, as well as an overview of the key schemes and stakeholders involved in these markets.

2.3.1.1 Compliance and Article 6-regulated markets

Compliance markets

Compliance markets are established in response to regulatory requirements and national or international reduction policies. These markets are created using different types of carbon instruments, including emissions trading schemes (ETSs) and carbon taxes. Under an ETS, a regulator sets a cap on GHG emissions and assigns emission allowances to entities within the ETS. At the end of the compliance period, entities must surrender allowances. Entities with surplus allowances may sell these, which creates an incentive to reduce their emissions (International Carbon Action Partnership [ICAP], n.d.). In contrast, a carbon tax establishes a cost for carbon by specifying a tax rate on GHG emissions or fossil fuels' carbon content. A carbon tax is not a market as such but may interact with market mechanisms if the tax allows the use of carbon offsets towards a tax liability, as in the case of carbon taxes in South Africa, Colombia or Singapore. With carbon taxes, the level of the tax rate will, in many ways, define which carbon emissions are being incentivised. For example, the South African carbon tax currently at around USD 8/tCO_2[3] targets emission reductions with the abatement value below that level, which may be suitable for lower-cost, emission-reduction projects, but would not create demand for offsets from more expensive projects. Both ETS and carbon taxes assign a value and cost to carbon, creating an incentive for emissions reductions.

Another growing international compliance carbon market is that of the international aviation sector. Regulated under the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), it is a compliance scheme aimed at reducing international aviation emissions. Its credits have been trading for a little over USD 2 as of April 2023 (Carbon Credits, 2023).

The development and implementation of carbon pricing instruments such as an ETS take several years of preparatory activities. The deployment of an ETS necessitates significant planning and involves making numerous decisions about timing and processes. Among issues to be defined is the scope, i.e. what sectors are to be included and which emissions sources or GHGs are to be covered. In addition, emissions data must be collected, the cap level and long-term trajectory determined and MRV processes developed, alongside a range of other design features to ensure the functioning of the system. As a result, policymakers may begin with a trial or pilot phase to test and assess the suitability of some of these decisions to the local context. For some jurisdictions, 5–10 years of active involvement and training on climate change market mechanisms were needed before they were able to make informed and widely accepted policy decisions regarding an ETS ([PMR] and ICAP, 2016). The implementation of an ETS can be a complex process that requires significant time and effort to set up. On the other hand, a carbon tax and offset mechanism is comparatively simpler to implement, but still requires an economic assessment to determine the appropriate level of tax and whether the use of offsets is desirable to achieve the desired emission reduction targets. A capacity-gaps-and-support needs assessment conducted for United Nations Development Programme (UNDP) Namibia showed that the country is not yet ready to implement an ETS or a carbon tax.

3 The rate will be augmented every year by at least USD 1 until it reaches USD 20. Starting in 2026, the government intends to accelerate the growth of the carbon price each year to achieve at least USD 30 by 2030 and USD 120 beyond 2050 (The Conversation, 2022).

Article 6-regulated markets

The Paris Agreement emphasised the need for global cooperation and action to reduce GHG emissions and transition towards sustainable development. In its aim to limit the increase in global temperature to well below 2°C above pre-industrial levels while pursuing efforts to limit such increase to 1.5°C, the Paris Agreement provided for voluntary cooperation and market mechanisms to achieve emission reductions through Article 6. It establishes three mechanisms to support countries in the achievement of their mitigation targets and to foster sustainable development. These include:

- cooperative approaches using Internationally Transferred Mitigation Outcomes (ITMOs) (Article 6.2);
- a new crediting mechanism (Article 6.4); and
- a framework for non-market approaches (Article 6.8).

Article 6 of the Paris Agreement creates regulated markets that allow a country (or countries) to transfer their GHG emission reductions[4] to other countries in the form of credits. There are two methods for trading mitigation outcomes under the Article 6 framework: direct trading between countries (Article 6.2) or centralised trading under the supervision of the Conference of Parties (Article 6.4). Mitigation outcomes transferred under Article 6 are referred to as ITMOs**.** To prevent double counting, ITMO transfers necessitate corresponding adjustments (CAs), requiring the country transferring the credits to 'add back' to its GHG inventory the emissions reductions that were transferred to the acquiring country for nationally determined contribution (NDC) compliance reporting purposes.

GHG mitigation efforts within the scope of Article 6 should ensure environmental integrity, transparency and strong accounting practices. These should ensure that emissions reductions are authentic, quantifiable, verifiable and consistent with the enhanced transparency framework outlined in Article 13 of the Paris Agreement. It is therefore essential that a country understands and meets these preconditions to ultimately participate in cooperative approaches and the new crediting mechanism under the Paris Agreement. This requires a country to set up the governance frameworks that allow them to fulfil accounting and reporting requirements, as regulatory, institutional and financial challenges might act as barriers to fully comply with these requirements and hinder participation in international carbon markets.

While significant uncertainty surrounding Article 6 prevailed after the adoption of the Agreement in 2015, Conference of the Parties (COP) 26 in Glasgow brought the adoption of the Article 6 rulebook. The rulebook contains the guidelines and procedures for the implementation of cooperative approaches in support of fulfilling country NDCs. In the wake of the adoption of this rulebook, countries are now increasingly embarking bilaterally in the development of mitigation activities within the context of Article 6. The first transfer of emission reductions under the umbrella of Article 6.2 took place in February 2023 between Thailand and Switzerland (Klik Foundation, 2023).

UNDP Namibia has supported the Ministry of Environment, Forestry and Tourism (MEFT) in the development of a framework for engagement in carbon markets. Key findings from a capacity gaps and needs assessment that has been conducted with support from UNDP is summarised in Box 4: Findings from a feasibility study on the development of Namibia's carbon crediting framework.

[4] Or other forms of mitigation outcomes measures in non-GHG metrics in line with countries' NDC targets

Box 4: Findings from a feasibility study on the development of Namibia's carbon crediting framework

The objective of the study was to evaluate the policy and institutional frameworks in place to net-enable the implementation of Article 6.2 and carbon credit market (A6.4M/VCM) in Namibia. The study found that Namibia is not currently equipped to implement an ETS, a carbon tax or a domestic crediting scheme. While the country has established a national GHG inventory system and has published GHG inventory in various reports, the reporting of information to track progress towards its NDC related to mitigation needs improvement. In addition, there is a lack of measurable indicators and tools for collecting data. Namibia also lacks a clear strategy for implementing key elements of Article 6.2 and has no formal governance structure for developing, planning and accounting for its NDC and mitigation activities. The study recommends that Namibia develop the capacity of key stakeholders to participate in Article 6 transactions and the VCM.

(Source: UNDP, 2023)

Namibia is in the process of setting up the governance frameworks to participate in international carbon markets. The Namibian government has not yet provided specific steps to implement its involvement in the global carbon market. However, this work is currently underway through activities that are supported by UNDP Namibia, such as the above-mentioned capacity gaps and needs assessment, alongside further work on national guidelines for Namibia's participation in international carbon markets. If established in the near future, such a framework could help Namibia become one of the first movers in this space, gaining the attention of buyers looking for Article 6-regulated credits. While MEFT and Namibia are working towards readiness for participation in Article 6 regulated markets, efforts should also be pursued in parallel to promote the participation in VCM.

2.3.1.2 Voluntary carbon market

A VCM is a platform where individuals and companies can trade environmental commodities, such as carbon credits, without being subject to regulations. Unlike the compliance carbon market, which is driven by national decarbonisation strategies, the voluntary market is fuelled by the corporate social responsibility strategies of non-governmental actors who seek to reduce their carbon footprint. In this market, participants have the flexibility to purchase various types of credits that align with their sustainability objectives, allowing them to make credible claims about the environmental impact of their products and operations, including net zero claims. As a result of the sale of carbon credits, private sector funding is channelled towards climate projects that contribute to the mitigation of climate change, while also contributing to various other co-benefits, such as biodiversity, community livelihoods or others depending on the different project types.

The voluntary market is significantly smaller than compliance markets. However, the market has rapidly been growing in size. Since 2019, the market has grown by 600% reaching a total market value of USD 1.98 billion in 2021 (Ecosystem Marketplace, 2021). This growth has been driven by a combination of factors, including increasing public awareness of environmental issues and the rise of sustainability as a key business concern. The growing number of net zero pledges and commitments from the private sector to reduce their environmental footprint are further driving demand. As a result, the VCM has become a widespread tool for companies to reduce their carbon footprint and contribute to the fight against climate change, while also demonstrating their commitment to sustainability and responsible business practices. Market studies are predicting the voluntary market will grow by five times by 2030 compared to 2021 (Reuters, 2023). Despite

macroeconomic challenges in 2022, the VCM has remained resilient. Demand increased by 3.4% in 2021 compared to the previous year, and December 2022 was the month with the highest volume of issuances on.

Carbon credits can be divided into two broad categories: avoidance credits and removal credits. While avoidance projects prevent the release of GHG emissions, removal projects remove GHG directly from the atmosphere. Box 5: Avoidance carbon credits versus removal carbon credits highlights the characteristics of each type of credit. While avoidance and removal are complementary strategies that are necessary to mitigate the impacts of climate change, carbon removals tend to trade at a premium. That is due to their essential role in achieving climate neutrality, as recognised by the IPCC, which highlights that anthropogenic emissions will have to be balanced out by removals. Furthermore, under the guidance of the Science-Based Targets initiative (SBTi), companies may only use removals to neutralise their residual emissions and to claim net zero (SBTi, 2021). Also, recent controversies surrounding the additionality and over-crediting of avoidance credits, such as those from Reducing Emissions from Deforestation and Forest Degradation (REDD+) or cookstove projects, have increased the relative value of removal compared to avoidance credits. In the context of Namibia's encroacher bush, the utilisation of biomass to produce biochar sequesters carbon and is hence counted as a removal technology and credit.

Box 5: Avoidance carbon credits versus removal carbon credits

Avoidance credits

An avoidance credit represents 1 tonne of CO_2e whose release into the atmosphere has been avoided. This type of credit is generated by projects that prevent GHG emissions that otherwise would have taken place. Project types of the avoidance type include, for example: renewable energy projects; energy efficiency projects; cookstove projects; and forestry projects. Credits generated by REDD+ projects, i.e. projects that prevent deforestation and land degradation, are also considered avoidance credits.

Removal credits

A removal credit represents 1 tonne of CO_2e that has been removed from the atmosphere. Approaches to achieve emission removals include nature-based solutions such as reforestation or afforestation, employing direct air capture to extract CO_2 from the air and store it underground, generating energy from biomass and capturing the resulting emissions, called 'bioenergy with carbon capture and storage', and different biochar applications.

(Source: South Pole, 2023)

It is conceivable that carbon credits could be generated through the avoidance of GHG emissions through biogenic energy production. Biomass-based energy production has the potential to replace fossil fuel-based energy production, which, in turn, can help to reduce GHG emissions. One such approach is the use of biochar methodologies, which use a removal calculation. The pyrolysis process of producing biochar generates excess heat that can be utilised as zero-carbon, biogenic energy to prepare feedstocks and replace fossil fuels. However, this approach requires a separate project to be operated in conjunction with the biochar removal project. It is important to note that the potential for emission reduction, depending on factors such as: the baseline configuration of the energy production; initial energy carrier; efficiency; and emission control systems, as well as the operating time. Energy replacement projects are more suitable in contexts with centralised energy demands (e.g. for cement) and less so for rural settings. For example, in the case of cement, it may be more

feasible. Additionally, there is a high risk of overlaps with NDCs and subsequent double claims, which would prohibit the issuance of credits for the VCM.

Given that the costs of grid-connected, renewable energy projects have gone down considerably, leading voluntary market standards have imposed restrictions on such projects. In particular, with Verra or the Gold Standard, it is not possible to generate carbon credits from a biomass-based energy production plant located in a non-least developed country. However, other standards which represent a smaller share of the carbon market activities still allow for such projects to be registered.

2.3.1.3 Biochar-based credits

The PES assessment undertaken presented earlier identified that voluntary markets for ecosystem services represent a promising opportunity to attract finance for sustainable bush management. Within the voluntary market, biochar manufacturing is considered the most developed technology that may generate significant finance revenues. The following subsection will focus on biochar and related stakeholders and developments.

Standards and certifications schemes are central stakeholders in carbon markets. By following a set of robust methodologies and requirements for each type of carbon project, independent standards certify that a project has achieved its stated objectives and the corresponding volume of emissions. In addition, they ensure that core principles of the market are upheld such as additionality and permanence. In the context of value chains for Namibia's encroacher bush, the production of biochar can be cross financed by the generation and selling of credits on the voluntary market. Table 6 shows the carbon certification schemes relevant to biochar project development.

Table 6: Carbon certification schemes relevant to biochar project development

Carbon certification scheme	Geography	Relevance to biochar/biomass value chain	ICROA approved	Readiness of biochar methodology	Applicability to Namibia
VCS	Global	'VM0044 Methodology for Biochar Utilisation in Soil and Non-soil Applications' (see Box 6: Verra and Puro.earth biochar methodologies)	Yes	Yes	Applicable
Gold Standard	Global	Currently developing a biochar methodology	Yes	No (expected in mid-2024)[5]	Incomplete methodology
Climate Action Reserve	North America	Currently developing a biochar methodology (South Pole serving as an advisory organisation)	Yes	No (expected mid-2024)	Geographic limitation
American	North	Inactive methodology	Yes	No	Geographic

[5] Shared with South Pole through email correspondence. No further details on content and applicability of the standard was known as at September 2023.

Carbon certification scheme	Geography	Relevance to biochar/biomass value chain	ICROA approved	Readiness of biochar methodology	Applicability to Namibia
Carbon Registry	America	for biochar projects			limitation
Puro.earth	Global	Biochar methodology	Yes	Yes	Applicable
C-Sink (operated by CSI)	Global	Based on the operationalising the guidelines of the EBC, including two methodologies: 1) EBC C-Sink; and 2) Global Artisan C-Sink.	No	Yes	Applicable
C-Capsule	Global	Methodology for Distributed Biochar	No	Yes	Applicable

(Source: South Pole, 2023)

The biochar market is experiencing rapid growth and attracting various stakeholders, including project developers, marketplaces, associations and technology providers. The demand for certification and verification of biochar products and projects is increasing, resulting in several emerging certification schemes and verification providers working to meet this demand. As can be seen in Box 6: Verra and Puro.earth biochar methodologies (below), Verra and Puro.earth, two standard-setting organisations, have methodologies for biochar that are endorsed by ICROA.[6] With expected maturity of biochar carbon markets, ICROA endorsement is considered as a key requirement to ensure demand from buyers that aim to achieve credible climate neutrality.

Box 6: Verra and Puro.earth biochar methodologies

Verra biochar carbon crediting methodology

Verra released in August 2022 the 'VM0044 Methodology for Biochar Utilisation in Soil and Non-soil Applications', which is the first globally approved biochar methodology under the ICROA and CORSIA-approved VCS Standard. The methodology is globally applicable and provides a framework for the quantification of climate impacts associated with the production (i.e. thermochemical processes) and application of biochar made from waste biomass (Verra, n.d., a).

Puro.earth biochar methodology

Puro.earth is a platform that provides a certification standard and registry for biochar-based carbon offsets. Puro.earth released a methodology for Puro.earth CO_2 Removal Certificates

[6] ICROA is an international non-profit industry association housed within the International Emissions Trading Association (IETA). ICROA operates a code of best practices for offsetting standards and ensures quality of carbon credits. Its members are established carbon and offset providers. These organisations engage with governments and international organisations to support the development of the VCM.

(CORCs) in December 2019 and published a revision in 2022. One of the key advancements in the methodology is the quantification of biochar permanence in soils for a minimum of 100 years. CORCs are ICORA-approved (Puro.earth, n.d.,b).

(Source: South Pole, 2023)

At the same time, Verra and Puro.earth methodologies are mostly applicable to larger biochar-producing installations with advanced technical characteristics, which do not cover more artisanal methods such as those that could be applied to biochar production in Namibia. In particular, these methodologies exclude Kon-Tiki kilns, which are currently used widely for charcoal production and which can be converted to biochar production (Box 7: Kon-Tiki kilns). However, while they are easily available to the wider Namibian population, these kilns produce increased methane emissions, resulting in reduced emission removals.

Box 7: Kon-Tiki kilns

'Kon-Tiki kiln' is an umbrella term referring to artisanal methods of biochar production that utilise a flame curtain as a protective barrier, preventing combustion and safeguarding the pyrolysis zone. This term does not dictate the specific shape of the kilns or whether they can be made of metal, but represents a methodology rather than a distinct technology (European Biochar Certificate, 2022).

Kon-Tiki kilns have been extensively field tested in Namibia and have proven to be effective. According to a study conducted in the context of the GIZ Bush Control and Biomass Utilisation (BCBU) project, this technology is highly scalable, allowing for the production of both small and large kilns based on demand, and multiple manufacturers are involved in the production of these kilns in Namibia. Larger variants of the Kon-Tiki kiln have a capacity to carry up to three cubic metres of biomass. Testing facilitated by N-BiG suggests that biochar derived from Namibian encroacher bush and produced using a Kon-Tiki kiln meets the stringent international standards set by the EBC for feed char (BCBU, 2020). Kon-Tiki kilns are currently employed extensively in charcoal production and may be repurposed for biochar production. However, it should be noted that their utilisation is associated with increased methane emissions, which in turn would result in lower emission reductions per unit of biochar produced.

(Source: South Pole, 2023)

Out of all available standards, the C-Sink certificate developed under the EBC is the only one that can be applied to biochar production in Kon-Tiki kilns (see Box 8: EBC C-Sink credits). While this standard is currently not approved by ICROA and therefore cannot be used for CORSIA compliance purposes, its credits can be traded on VCMs for contribution claims.

Box 8: EBC C-Sink credits

Developed by the Ithaka Institute, the EBC provides a material standard for biochar as a product to ensure quality characteristics. The EBC collaborates with and provides support to established biochar methodologies. Puro.earth's mandates EBC certification for biochar suppliers and the guidelines of Verra's methodology list the EBC production guidelines as potential eligibility criterion.

Further, the EBC has developed the C-Sink certificate, a voluntary industry scheme that issues so-called 'C-Sink Credits'. The C-Sink certification process consists of two essential steps. Firstly, the EBC assesses the carbon removal potential of the biochar at the biochar producer's location. This assessment takes into account various factors, including: biomass production; chipping; storing; drying; and emissions from the pyrolysis plant. In a second step, the biochar is monitored throughout its journey to the final sink and its ultimate use. This monitoring involves measuring carbon expenditures and GHG emissions that occur during transportation, milling and processing. Once the biochar is incorporated into agricultural substrates or transformed into a durable material, its C-Sink potential is converted into tradable C-Sink certificates. To certify and issue a C-Sink in the registry, which is operated by Carbon Standards International (CSI), an initial on-site assessment is conducted, followed by subsequent certifications for each batch. The cost of the initial on-site certification is approximately USD 1,077 (excluding travel expenses), although this amount can vary depending on specific circumstances (BCBU, 2020).

The EBC offers two methodologies: EBC C-Sink[7] and Global Artisanal C-Sink. The latter is particularly relevant in the Namibian context as it is designed for biochar produced using artisanal, non-industrial methods such as Kon-Tiki kilns. This methodology is limited to countries according to the World Bank's classification. It is important to note that C-Sink credits provided by the EBC are not currently approved by ICROA and, therefore, do not qualify for use under CORSIA. ICROA members who are project developers cannot sell offset credits that are not ICROA approved for offsetting claims, but they may still be sold for contribution claims.

(Source: South Pole, 2023)

A stakeholder mapping exercise was conducted for the carbon market to support discussions on international, biochar carbon-market opportunities. The mapping includes significant international stakeholders such as: project/methodology developers; verification providers; associations; and technology providers. Table 7 provides an overview of some of the key stakeholders that are relevant in the biochar project development space.

Table 7: Stakeholders relevant to biochar project development

Stakeholder type	Description	Sample list of actors (non-exhaustive)
Project developer/ methodology developer	Project developers develop and implement projects that reduce GHG emissions. The reductions can be turned into credits and sold on the carbon market. Project developers typically: identify potential emission reductions projects; assess their feasibility; navigate regulatory frameworks; and take care of the certification and verification of third	Project and methodology developers include: Planboo (present in Namibia); PyroNam (present in Namibia); anew, Bluesource; 3degrees; C-Quest Capital; Carbon Capital; South Pole; Delaney Forestry Services; and Forliance, among many others.

[7] At the time of publication of this report, PyroNam has successfully generated carbon credits under the EBC C-Sink standard. It holds the distinction of being the first African project to produce EBC C-Sink carbon credits.

Stakeholder type	Description	Sample list of actors (non-exhaustive)
	parties. Project developers may also develop their own methodologies for emission reduction projects.	
Verification provider	MRV is a crucial element of project development. In the MRV process, verification providers are typically engaged to conduct independent assessments and verification of project outcomes.	Verification providers include: Bureau Veritas; TUV Nord; TUV Sud; Aenor Internacional; ERM Certification; and Verification Service.[8] TUV Nord verified Verra's Biochar Carbon Crediting Methodology, for example.
Association	Biochar-focused associations promote the use of biochar as a sustainable means of mitigating climate change, improving soil health and providing other benefits. These organisations collaborate on scientific research, promote best practices for biochar production and use, and facilitate knowledge sharing among stakeholders in the biochar community.	International Biochar Initiative, African Biochar Partnership, European Biochar Industry Consortium, US Biochar Initiative (USBI), Australia New Zealand Biochar Industry Group
Technology provider	There are a wide range of providers of biochar systems and equipment. These provide, for example: portable kiln systems; small-scale biochar and heating systems; mobile carbonisers; and small-, medium- and large-scale pyrolysis and gasification equipment (USBI, n.d.).	Portable kiln systems: Wilson Biochar Small-, medium- and large-scale pyrolysis and gasification: Pyreg GmbH; NetZero; Pyrocal Pty Ltd.; Earthcare LLC; Bio-Techfar; Pyrovac Mobile carbonisers: Air Burners Inc.

(Source: South Pole, 2023)

Recently, carbon removal prices have been rising due to limited supply and increasing demand. It is worth taking into consideration that no credits from ICROA-endorsed standards (Verra and Puro.earth) have been issued so far. In the past two years, a limited quantity of non-ICROA-endorsed biochar credits has been sold through Puro.earth and Carbonfuture marketplace, with prices ranging from EUR 100–15.

[8] Available at: https://verra.org/validation-verification/ and https://globalgoals.goldstandard.org/verification-validation-bodies/

Abatement cost estimates for biochar projects vary significantly. Some authors suggest that CO_2 prices in the range of USD 30 to 50/tCO_2 are sufficient for economically viable biochar application (Lomax et al., 2015; Roberts et al., 2010), while others anticipate these ranges to be higher, at between USD 60 and USD 120/tCO_2 (Shackley et al., 2011; McGlashan et al., 2012; Smith, 2016). According to a recent paper by the Tuck School of Business, the prices of high-quality certifiable biochar today are the upper bound of most empirical literature, at around USD 120/tCO_2 (Kalra et al., 2022). South Pole expects these prices to decrease to around USD 85/tCO_2 in 2030 due to advances in kiln technology and increased biomass feedstock availability. The further development of the voluntary market with respect to biochar will be influenced by a number of market and policy developments, which are outlined below in Box 9: Biochar-relevant market developments. It is also important to note that in the short term, Verified Carbon Units (issued under the ICROA-endorsed standard Verra) or CORCs (CO_2 Removal Certificates from Puro.earth) from biochar projects are expected to be traded at higher prices due to the scarcity of volume and the anticipated premium price compared to non-ICROA biochar credits.

Box 9: Biochar-relevant market developments

Definition of carbon removals under Article 6.4 of the Paris Agreement

There are currently no criteria for carbon removal certificates under Article 6.4 of the Paris Agreement. Such a definition, however, is crucial for their future eligibility as credits under 6.4, which will have an impact on the role carbon removals such as biochar can play in NDCs. At COP27, the adoption of such criteria was postponed due to criticism from delegations targeting the ambiguity of the proposed definitions. The discussion will be resumed at COP28 in 2023.

Voluntary Carbon Markets Integrity Initiative (VCMI)

The VCMI aims to enhance the credibility of carbon offsets and provide guidance to buyers on the claims they can make, potentially affecting the demand for carbon credits. The initiative released a draft code of practice on claims on 7 June 2022. While there are differing views on whether and when carbon credits used for voluntary purposes should be subject to corresponding host country adjustments in national GHG accounting, the VCMI did not make a judgement on the issue at the time of the release of the new draft code of practice on claims. The VCMI's provisional stance is that carbon credits, with or without a CA, can be used to support the various categories of claims as defined by the VCMI. However, companies must transparently disclose whether the credits they use to achieve their climate neutrality goals have been accompanied by the execution of a CA.

Removals under the SBTi

SBTi's Net-Zero Standard emphasises that removals and beyond-value-chain mitigation are important in achieving net zero emissions, but they should come after reducing emissions within a company's value chain. However, there is currently no detailed guidance on removals and 'neutralisation'. SBTi intends to provide more detailed guidance on these topics and more information will be released in the course of 2023.

From net zero claims to contribution claims

Amid heightened scrutiny of the voluntary carbon market and critical media investigations, there is a notable resistance emerging not only towards terms like 'carbon neutral' but also towards

product labels certifying carbon neutrality. Within this shifting landscape, the market is increasingly gravitating toward claims centred on mitigation contributions. Within this framework, South Pole has introduced a 'Funding Climate Action' label. The key advantage of a contribution claim lies in its potential to clarify the role of the voluntary carbon market in relation to national-level initiatives, while mitigating the risk of double claiming.

(Source: South Pole, 2023)

2.3.2 Market for biodiversity credits

Biodiversity credits are another way to commoditise ecosystem services, which involves payments for the protection, restoration or management of biodiversity. Biodiversity credits are relevant to the Namibian bush biomass sector, as bush control measures not only promote the restoration of original savannah grasslands but also encourage a return to a natural balance of wildlife, ultimately leading to positive impacts on biodiversity if practised sustainably (Birch, 2016). Tools and approaches to facilitate payments to the benefit of biodiversity include: biodiversity offsets; conservation easements; certified biodiversity-friendly products and services; bioprospecting; payments for biodiversity management; hunting permits; and ecotourism. These markets are structured around the 'mitigation hierarchy', which prioritises avoiding, minimising and then mitigating negative impacts to biodiversity (Ecosystem Marketplace, n.d.). While biodiversity offsets are used to compensate for residual negative impacts on biodiversity after taking prevention and mitigation measures, biodiversity credits are an economic instrument used to finance actions resulting in measurable positive outcomes for biodiversity.

Biodiversity is becoming an increasingly important issue in the policy arena, as shown by the adoption of the Global Biodiversity Framework (GBF) in December 2022. More than 100 countries support Target 3 of the GBF, which calls to protect 30% of the planet's land and oceans by 2030 (known as the 30x30 target). In addition, Target 14 encourages large companies and financial institutions to disclose risks, dependencies and impacts on biodiversity, and Target 19 calls for significant increases in public and private funding for biodiversity through innovative schemes such as biodiversity offsets and credits. The release of guidance from the Taskforce on Nature-related Financial Disclosures, similar to the Taskforce for Climate-Related Financial Disclosure, is expected to drive companies' awareness of their reliance on nature and biodiversity. Furthermore, the Africa Carbon Markets Initiative, launched at COP27, announced 13 action programmes in the run-up to COP28, including the development of biodiversity credits (Climate Champions, 2023).

Biodiversity credits are gaining interest from companies and investors, with new schemes and standards being developed. A 2023 global climate survey from the Dutch asset management firm Robeco demonstrated that investors are gaining awareness of biodiversity as part of the struggle against climate change, with 41% of surveyed investors indicating that they were actively seeking investments that made a positive contribution to biodiversity (Carbon Pulse, 2023). In light of these targets, actors are gearing up to create the necessary infrastructure that could support a market that channels private capital into nature-positive initiatives. One such initiative is the Nature Framework Development Group, which brings together: Blue Nature Alliance (with support from McKinsey & Company); Conservation Finance Alliance; Conservation International; the Great Barrier Reef Foundation; International Union for Conservation of Nature; The Biodiversity Consultancy; and Verra. Together they are working on a nature crediting framework to channel finance into biodiversity restoration and conservation activities (Verra, n.d.-b). Another example is the Financing for Nature initiative of the World Economic Forum, which aims to explore the potential of biodiversity credits markets to unlock financing for nature-positive outcomes. The initiative has three key objectives:

building awareness of supply and demand dynamics; developing core integrity and governance principles; and learning from early-stage pilot transactions (World Economic Forum, 2022). Of the standards that currently exist or that are under development, the most relevant are listed in Table 8.

Table 8: Emerging biodiversity standards

	Description
Plan Vivo's PV Nature	Plan Vivo is a non-profit organisation that provides certification for community-based sustainability projects. The organisation is developing a biodiversity standard, PV Nature, which aims to positively incentivise landowners and communities to conserve and restore important habitats for biodiversity and people. PV Nature will be based on a peer-reviewed methodology, centred on biodiversity quantification, and will be tested against seven pilot projects to ensure its accessibility for high-quality projects. The standard has completed the public consultation phase (Plan Vivo, 2022). The standard is currently in the public consultation phase.
Verra's Nature Crediting and Biodiversity Methodology (under SD VISta)	Verra's announced biodiversity methodology will enable project developers to measure the biodiversity benefits of their conservation and restoration activities. Once verified, companies can purchase biodiversity credits to invest in biodiversity and meet their nature-positive commitments. However, based on recent announcements, no methodology for biochar is available or envisioned. Verra uses the term 'nature credit' rather than 'biodiversity credit' because biodiversity is just one component of nature and the framework will not exclusively focus on biodiversity. The methodology is expected to be published by the end of 2023.
Verra's CCB Standard	The CCB Standard can be applied to any land management project and require project leaders to incorporate principles such as: obtaining free, prior and informed consent, as well as identifying and maintaining high conservation values. The standards are used in conjunction with VCS certification and can help projects scale up their impact by creating a price premium. Over 120 projects have been validated to CCB Standards, with over 100 having verified benefits in more than 48 countries (Verra, n.d.-c). It is not possible to use the CCB Standard to quantify co-benefits and achieve a higher carbon credit value for biochar projects.[9]
FSC Ecosystem Services Procedure	The FSC's Ecosystem Services Procedure certifies the positive impact of responsible forest management on ecosystem services. Forest managers can make credible claims on how their activities contribute to maintaining and enhancing ecosystem services, including biodiversity. The ESS procedures assure investors and sponsors that products preserve ecosystem services. While the certification does not lead to the generation of tradable credits, it could generate revenue through a grant, a financial investment, a premium price, or financial sponsorship (FSC, n.d.).

[9] Shared with South Pole through e-mail correspondence.

(Source: South Pole, 2023)

While the idea of biodiversity credits has been gaining momentum, the reality is that such credits are in their infancy and are unlikely to be commercialised at a scale comparable to carbon credits in the near future. The key differentiating feature between a market for biodiversity credits and the carbon market is the unit of measurement. In the carbon market, a credit represents a tonne of CO_2 equivalent, whereas a similar measure does not exist for biodiversity. A biodiversity credit from Namibia is not directly comparable to a biodiversity credit from India, for example. As a consequence, biodiversity credits are unlikely to be traded at the same scale as carbon credits. This is not to suggest that biodiversity cannot be commoditised and sold on voluntary markets, but demand for such credits will be significantly smaller in magnitude. Instead of being sold on global commodity markets, specific corporations may be interested in specific projects or regions, depending on their marketing strategies and customer base.

There are nevertheless various possible approaches to generating revenue for biodiversity outcomes. Biodiversity can be certified as a specific co-benefit on top of carbon credit certification. During interviews conducted for this project, the interviewees recommended that adding ecosystem services, such as biodiversity, into carbon certification could be the best way to make credits stand out in the market. However, it is currently not feasible to certify biodiversity co-benefits under Verra's CCB Standard due to the lack of recognition of biochar under AFOLU. Moreover, certifying biodiversity outcomes under SD VISta would require the development of a new methodology, which is a time-consuming and expensive process that can take up to one-two years. Another option that has proven economically viable in other contexts is the coupling of carbon with biodiversity credits. In Australia, this has been developed with EcoAustralia™ credits, which combine one carbon credit (issued by internationally recognised standards such as Gold Standard or Verra) with one Australian biodiversity unit (ABU) issued under the state-level biodiversity compliance scheme. For Namibia, biochar credits could be combined with biodiversity credits that quantify the amount of savannah grasslands restored.

Box 10: Summary of commoditisation approaches

In the short term, VCMs show promise as a solution, while in the medium to longer term, Article 6 or other compliance markets can be developed. It is noted that Namibian authorities are already working on the governance frameworks necessary for participation in Article 6 regulated markets. Biochar technology is a promising solution for carbon crediting, with a strong economic case due to its removal capacity. As a result, biochar projects are expected to generate high prices on the compliance markets. In Namibia, several biochar projects are already underway. In addition to biochar, biodiversity credits represent a promising solution, especially if they can be linked to carbon crediting. However, developing this linkage will require more time.

(Source: South Pole, 2023)

2.4 Landscape mapping: conclusions

Ecosystem services produced by sustainable bush management in Namibia, while crucial, are currently undervalued. It is important to attract finance through PES to enable consistent application of sustainable practices and support local communities. PES mechanisms can

represent an important opportunity to financially support them. However, for this policy to achieve success, a suitable PES mechanism(s) should be designed, alongside wider technical and regulatory support.

For the implementation of any selected PES mechanism, it will be important undertake a number of steps. These will include clearly quantifying delivered ecosystem services and their monitoring, identifying service provider and beneficiary, involving communities in the design of the scheme, and analysing and ensuring suitability of the national and local regulatory framework.

PES mechanisms relying on public funding, such as payments for application of sustainable practices, may be challenging to implement in Namibia in the short to medium term due to constrained public resources. To make this mechanism successful, a stable stream of public revenue should be allocated or generated through, for example, an introduction of a carbon tax or a charge made to companies benefitting from the provided ecosystem services, with collected revenue directed to a government-managed PES fund. While it is hard to define clear beneficiaries of the provided ecosystem services, which in turn complicates implementation of the user charge-based PES, a lower charge on the wider number of users can be considered.

Establishment of the user charge or a compliance market may not be suitable in the short to medium term, given that it is more complex and will require an extensive analysis prior to implementation. However, a dedicated charge on users of ecosystem services, such as water providers or large water consumers, may be considered. This could feed into a government-funded PES mechanism mentioned above.

Commoditisation of ecosystem services, which enables trade of ecosystem service 'units', appears to represent the most promising opportunity for sustainable bush biomass harvesting. This approach does not place a burden on the public budget and allows international private finance to be obtained. Out of the relevant ecosystem services, carbon sequestration in the form of biochar manufacturing is the most developed technology allowing short-term actions. Other forms of commoditisation of ecosystem services, such as biodiversity credits, are also gaining attention. However, due to their novel character, these are likely to become a financing solution in the medium to long term. At the same time, a carbon crediting approach would still produce positive co-benefits for biodiversity.

Therefore, given the specific situation of the Namibian bush biomass sector, a carbon credit-based approach has the strongest potential to respond to the need of securing short-term finance for sustainable bush harvesting and support the much-needed ecosystem restoration. It is therefore recommended to consider business models that can enable its implementation in Namibia and to assess different business approaches and revenue streams investigated in early biochar pilots in Namibia.

3 Status quo assessment

This chapter presents the findings of an assessment of the status quo of Namibia's bush biomass value chains. The assessment provides an overview of the stakeholders involved, outlining their roles and capacities. It also explores the existing bush biomass value chains, highlighting the different uses of biochar and private-sector initiatives. The chapter also assesses Namibia's readiness in comparison to the PES schemes identified in the previous chapter. These findings form the basis for the subsequent gap analysis and action plan discussed in Chapter 2. The goal is to use this assessment to attract more financial support to the growing bush biomass sector.

Biomass from Namibia's encroacher bush has multiple uses. It is mainly used as firewood for: local consumption; the production of charcoal for export; as an input to animal feeds; to produce biochar; and for various types of compressed wood products, both for local use and export. While bush biomass is often viewed as a nuisance, especially by livestock farmers, Namibia's emerging bush biomass sector wishes to capitalise on the sheer magnitude of the biomass resource, which is estimated to far exceed 450 million tonnes. Developing bush resources may expand and create opportunities for new jobs and add economic value (the Southern African Institute for Environmental Assessment [SAIEA], 2015).

The development of the bush biomass sector remains constrained, except for the charcoal sub-sector. In part, this is due to a lack of large anchor clients, sizeable biomass offtake agreements and limited revenue opportunities. Moreover, the diversity of bush biomass uses and products, especially those that have high value, remains limited. Given the abundance of the resource and unused opportunities for other uses of biomass from encroacher bush, further diversification and significant upscaling across the bush biomass value chain are possible. However, such initiatives depend on developing business models that create sustainable financial returns.

To support the sector's development and national efforts to restore ecosystem services through labour-intensive bush thinning and use, additional revenue opportunities are needed. Among others, these could include the creation of new revenue streams connected to the ecosystem services supported by bush thinning, such as: groundwater recharge; carbon sequestration; recreational and tourism services; biodiversity and soil conservation; and adaptation. Funding for these services could to an extent come from the private sector, specifically from impact-driven finance including but not limited to carbon credits, and diversification towards higher-margin biomass products.

Being a net carbon sink and having multiple opportunities for carbon sequestration, Namibia has potential to leverage participation in international carbon markets. It could help unlock new financing opportunities for its ambitious nationally determined contribution targets, as well as the development of the bush biomass value chain MEFT (2021). One promising approach is the monetisation of ecosystem services through the establishment of appropriate payment schemes. An example is the trade of carbon credits generated by the restoration of natural rangelands and the production of biochar, which may attract carbon finance. By exploring these and other opportunities in the international carbon markets, Namibia may secure additional funding to achieve its climate targets while simultaneously addressing the encroacher bush problem.

3.1 Local biomass stakeholder landscape

Given the growing importance of the biomass sector in Namibia, its stakeholder landscape includes multiple organisations with significant expertise related to biomass value chains. The main groups of stakeholders include public and private organisations, as shown in Figure 1 below. The figure shows only the main stakeholder relationships relevant for the undertaken assessment.

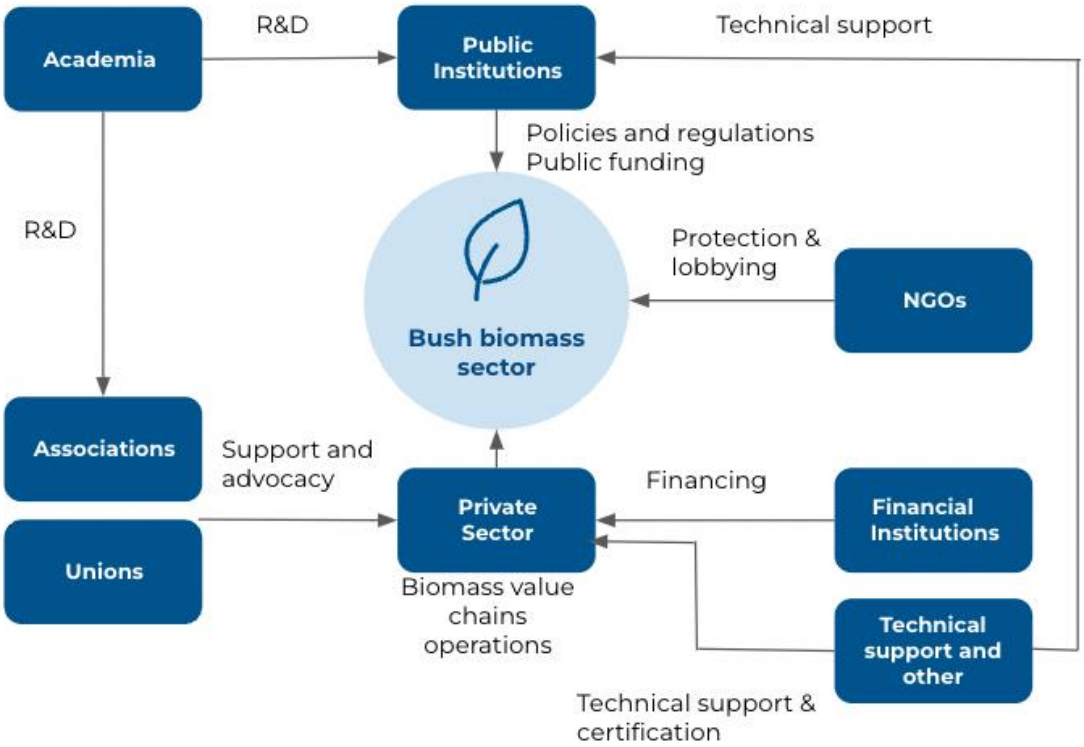


Figure 1: Key stakeholders in the Namibian bush biomass sector

(Source: South Pole, 2023)

For the undertaken assessment, stakeholders in each category have been. A review of the key institutions and their role in the operation of bush biomass value chains is presented further in this section.

The following **public institutions** have a stake in the country's biomass sector:

- MEFT; and
- The Ministry of Mines and Energy (MME).

MEFT oversees environmental activities in Namibia, primarily through the Office of the Environmental Commissioner, which is responsible for issuing environmental clearance certificates when necessary. Furthermore, MEFT's Directorate of Forestry is responsible for granting permits for bush biomass harvesting activities. Currently, the MEFT is receiving support from the UNDP to establish an inclusive carbon market framework (UNDP, 2022). Moving forward, the MEFT's

Designated National Authority office will become increasingly important in terms of the national recognition, monitoring, and verification of carbon credits for the compliance market.

MME plays a role in terms of the biomass use in the energy sector. It is worth noting that wood biomass remains widely used as thermal fuel, particularly in rural Namibia.

Various **non-governmental organisations** (NGOs) have an interest in biomass uses:

- Cheetah Conservation Fund (**CCF**);
- Desert Research Foundation of Namibia (**DRFN**);
- Namibia Nature Foundation (**NNF**); and the
- Hanns Seidel Foundation (**HSF**); and others.

The NGOs mentioned above have initiated and executed various projects in the bush biomass sector, subject to the availability of funding. The **CCF** has important links with international funders and has been addressing the threat posed by encroacher bush to Namibia's grasslands, which are essential habitats for cheetahs. The organisation has supported studies examining the impact of bush thinning on wildlife (Nghikembua et al., 2020). Additionally, the CCF operates CCF Bush Pty Ltd, which manufactures wood fuel briquettes from encroacher bush, and is involved in the **SteamBioAfrica** project, supported by the European Commission's Horizon 2020 Programme, aimed at producing biochemicals and solid biofuel from bush biomass. One of the project's work packages focuses on examining the impact of biomass harvesting on soil organic content.

The **DRFN** is an environmental NGO with activities in forest management and community-based integrated farming management, among others. The **NNF** is a conservation NGO, and has been investigating the impact of encroacher bush on ecosystem services, soil carbon content and the effect of biochar on soils. The **HSF** is a German-based political foundation that promotes environmental awareness in Namibia and other countries.

The bush biomass sector is home to **private sector organisations and entities**, including:

- the Namibia Biomass Industry Group (**N-BiG**);
- the Charcoal Association of Namibia (**CAoN**);
- various private biomass harvesters, including those producing charcoal, firewood, animal fodder, biochar, wood chips and pellets;
- technology providers for bush harvesting and processing equipment, charcoal kilns and biochar retorts, and others, supplying end users active in the sector;
- producers of charcoal, animal fodder, biochar, and bush biomass derivatives; and
- off-takers and users of processed bush biomass, e.g. Ohorongo Cement and Namibia Breweries, and others who use such products as a fuel.

N-BiG is a non-profit and donor-funded association of companies and organisations involved in the Namibian biomass industry. It promotes the sustainable use of biomass resources, creating economic opportunities and looking for markets for the output of biomass value chains. Its objectives include policy advocacy, support for members, research and development (R&D), and promotion of biomass products. **CAoN** is a non-profit association of the Namibian charcoal industry. It assists its stakeholders in contributing to the responsible economic growth of the charcoal industry by taking into account environmental, economic and social factors.

The sector is supported by numerous environmental practitioners, who undertake Environmental Impact Assessments for individual projects and initiatives for which the issuance of an Environmental Clearance Certificate is required under Namibia's Environmental Management Act.

The main agricultural unions in Namibia, namely, the **Namibia Agricultural Union**, the **Namibia National Farmers Union**, and the **Namibia Emerging Commercial Farmers' Union**, are actively involved in the country's bush biomass sector. Their activities include: bush thinning; charcoal and firewood production; and animal fodder production, as well as the production of wood chips, wood pellets and other biomass-related products.

Namibia's state-owned electricity utility **NamPower** is assessing the viability of a 40 MW electricity generation plant using bush biomass near the northern town of Tsumeb. NamPower's project team is assessing the possibility to use a type of PES mechanism as a benefit-sharing arrangement with farmers, which would also support bush-harvesting aftercare activities.[10]

The **Renewable Energy Industry Association of Namibia**, is an umbrella organisation of commercial entities active in the renewable energy sector, including the country's bush biomass sector. Its members include entities active in the charcoal industry and bush biomass processors as well as carbon finance organisations.

The Namibia University of Science and Technology (**NUST**) is engaged in activities to assess and evaluate the potential of biochar and has been active in the quantification of the national bush biomass resource. The University of Namibia (**UNAM**) has in the past participated in select bush biomass initiatives and may broaden its engagement in future.

The subregional office for Southern Africa of the FSC is involved in the certification of select bush biomass harvesting areas. The area of farmland certified by FSC has experienced significant growth, reaching 1.6 million hectares (ha) in 2020. This growth is attributed to a rise in demand for FSC-certified charcoal in the European market. Moreover, FSC offers a certification specific for ecosystem services through its Ecosystem Services Standard (ESS) procedure.

Development agencies involved in Namibia's bush biomass sector include the German development agency **GIZ**, which is active in the field through its Bush Control and Biomass Utilisation Project, along with various other initiatives. **UNDP** is currently working with the MEFT to prepare a national framework for Namibia to participate in regulated international carbon markets.

The Namibia Chamber of Environment is an environmental umbrella organisation that provides a broad forum for entities active in the environment sector.

Various **financing and funding entities** also have projects/initiatives in the sector:

- **Development Bank of Namibia** provides financial services and products that support activities in the energy, agriculture, and bush biomass sector;
- **Agribank** provides funding for projects in the agricultural sector, including for the processing and value addition of bush biomass;
- Environmental Investment Fund of Namibia (**EIF**) supports sustainable economic development through investments in and the promotion of activities and projects that protect and maintain Namibia's natural and environmental resources;
- all main commercial banks provide loans for biomass-related ventures; and
- financial consulting and advisory firms (e.g. **Cirrus Capital, Business Financial Solutions and Triple Capital**) are involved in funding bush-related initiatives.

[10] Shared with South Pole during an interview held on 18 April 2023.

Local funding capacities are mainly available in the form of loans by commercial banks and private equity capital. However, other sources exist. For example, there are a variety of forms of grant funding to trial bush processing technologies. In most instances, these sources of finance enable biomass producers to invest in plant and equipment required to produce and process biomass feedstock. Almost all interviewed stakeholders suggested that sourcing capital for their biomass-related project was not the most pressing challenge.

3.2 Value chains using Namibian bush biomass feedstock

Bush biomass has a variety of uses and is employed in multiple industries in Namibia as well as exported abroad. Some of the uses dominate the biomass application while others are only gaining traction.

More than half of households in Namibia continue to use wood for cooking and heating. Firewood is mainly collected from communal and commercial farms and public lands and sold in both informal and formal markets. Wood harvesting in informal urban areas is causing a steady depletion of biomass resources. The everyday use of firewood for cooking and heating is mostly unregulated, with an estimated consumption of around two million tonnes per year. Furthermore, not all firewood used in formal markets is derived from encroacher bush. Firewood is also exported, mostly to South Africa. Currently, an estimated 0.6 million tonnes of bush is harvested annually for use as firewood.

Namibia's charcoal industry is mostly active in the north-central parts of the country. The main production areas are north of Otjiwarongo, up to and around Grootfontein, Outjo and Tsumeb, with most of the production exported as barbeque charcoal due to low local demand. In 2021, almost 1,500 members of the Charcoal Association of Namibia produced about 0.16 Mt, some of which were FSC certified. Fencing material requires an estimated 0.3 Mt of bush biomass annually, while wood chips are produced using some 20,000 tonnes of bush biomass. Small amounts of bush biomass were also used to produce torrefied biomass pellets and briquettes. Official statistics on biochar and wood vinegar production, and the amount of bush biomass lost to fires, are unavailable.

Bush biomass is also used for electricity and heat generation. The state utility NamPower plans to build the 40 MW Otjikoto power plant near Tsumeb, which will consume around 0.2 Mt/a of bush biomass when in full production, necessitating multiple supply agreements with nearby farmers (N-BiG, n.d.). The availability of additional sources of finance, such as climate finance, is being assessed to ensure the project's economic feasibility.[11] Ohorongo Cement has successfully trialled the replacement of coal by bush biomass in its clinker production, while Namibia Breweries has replaced some of its fossil-fuelled burners with those fed by bush biomass.

Box 11: NamPower's Otjikoto Biomass Power Station

NamPower is currently planning the construction of a 40 MW biomass power plant, the Otjikoto Biomass Power Station near Tsumeb. The plant's location in the Oshikoto region was principally motivated by the availability of encroacher bush as a fuel resource in the surrounding area, and the benefit of a dispatchable baseload power station in the country's electricity mix. The plant is to be fully owned and operated by NamPower, and will be financed in part through a loan agreement with the French Development Agency. Wood chips, sourced from encroacher bush from the surrounding areas, will be used as fuel, aligning it with the national development goals outlined in the National

[11] Shared with South Pole during an interview held on 18 April 2023

Integrated Resource Plan and the 5th National Development Plan, which prioritise electricity generation from renewable sources.

Realisation of the plant has faced financing challenges, due to the high upfront capital expenditure requirements, as well as ongoing operation costs associated with the procurement of harvested bush biomass chips. Various comprehensive studies have been conducted to evaluate the feasibility and potential impact of the Otjikoto Biomass Power Station. The European Investment Bank financed a soil impact study, and NamPower, MEFT and GIZ jointly commissioned a micro- and macroeconomic impact analysis. The latter study highlighted the substantial positive impact of Namibia's balance of payments due to the import-substitution effect of electricity that would result in an annual reduction of some USD 16.5 million leaving Namibia. Furthermore, the NNF, supported by GIZ, conducted an in-depth aftercare cost-benefit assessment.

To facilitate the detailed preparation phase, NamPower has secured USD 26.9 million in financing from the Nationally Appropriate Mitigation Action Facility for a duration of up to 15 months. Additionally, a carbon pre-feasibility study indicated that the Otjikoto Biomass Power Station project may be eligible for carbon financing and certification under the Global Carbon Council and the United Nations Framework Convention on Climate Change methodology ACM00018, which applies to electricity generation from biomass. However, due to Namibia's classification as an upper-middle-income country, the project might be eligible for negligible carbon financing from the Gold Standard or Verra. South Pole and NamPower are currently reviewing options to access climate finance through the VCM.

(Source: NamPower staff, 2023)

Most bush biomass providers use mechanical equipment for harvesting operations. However, some operations, such as in the charcoal sector, still rely in part on manual labour, with over 10,000 people currently employed in the sector. FSC certification is available to some harvesters, including Namibia-specific FSC standards launched in April 2020, of relevance to encroacher bush biomass. The FSC certifies forest management practices that are environmentally and socially sustainable, including worker training, health and safety protocols, minimum housing standards, and other forest management plan components that are tailored to meet the country's specific needs and regulations. The size of FSC-certified farmland grew rapidly, standing at 1.5 million ha in 2022, driven by increased demand for FSC-certified charcoal in the European market.

Table 9: Summary of estimated bush biomass use in Namibia

Biomass use	Consumption per year (Mt/a)
Cooking and heating	2
Charcoal industry	1
Export	0.6
Fencing material	0.3
Wood chips	0.02

Biomass use	Consumption per year (Mt/a)
Power generation	0.2[12]
Biochar	TBC
Wood vinegar	TBC
Use in industry (e.g. cement, brewing)	TBC
Total used	**3.22**
Approximate available biomass	**> 450 Mt**

(Source: South Pole, based on N-BiG [2020])

While most of the above-mentioned figures on bush biomass usage are estimates, it is clear that the supply of biomass is significantly larger than the current demand, with the availability of bush biomass exceeding 450 million tonnes. This indicates that there is strong potential for further value addition through expanded and new uses of bush biomass and without the risk of competition for available resources, which can support expansion of the mature and emerging value chains.

Box 12: Stakeholder interview results – emerging biomass value chains

According to some stakeholders interviewed in this project, there are potential additional value chains related to biomass. They suggested that energy products derived from biomass, requiring minimal processing and enjoying stable demand, could be further explored. Moreover, the stakeholders emphasised the importance of creating high-value products, such as incorporating biochar into cement for the production of low-carbon building materials, or using wood in the manufacturing of wood composites. It was also pointed out that biochar can be created using parts of the wood that may not be appropriate for traditional charcoal production. For example, offcuts from stems can be utilised to generate biochar, which makes it possible to integrate the production of biochar into existing charcoal production processes.[13]

(Source: South Pole, 2023)

3.3 Biochar applications and uses in Namibia

Biochar, a biomass product that is gaining significant attention, has multiple benefits. These benefits include enhancing depleted soils, and use as a supplement in animal feeds and as an additive for horticultural production. Inoculated biochar is used to address mineral deficiencies in soils, and to promote water retention in arid regions.

[12] Estimated value once NamPower's Otjikoto power plant is operational
[13] Information gathered during various interviews that took place between 23 March and 18 April 2023.

Box 13: Biochar

Biochar is a carbon-rich solid material formed by the thermochemical processing of biomass in an oxygen-limited environment. These processes can be classified as either pyrolysis (in which oxidants are excluded) or gasification (in which oxidant concentrations are low enough to generate syngas). Biochar is considered a carbon sink when its soil applications (e.g. soil amendment in agricultural lands) or non-soil applications (e.g. cement, asphalt) can prove carbon stability over time.

(Source: Verra, 2021)

3.3.1 Biochar application and scientific evidence

Multiple studies have been undertaken to research biochar's positive properties on soil quality as well as its carbon sequestration potential. These have demonstrated that biochar increases soil resilience to droughts and increases water and nutrient content in soil which can be accessed by plants, thereby increasing crop yields (Edeh, et al. 2020). In addition, biochar also increases soil organic carbon (SOC) and reduces soil GHG emissions, serving as a carbon sink (Huang et al., 2023). According to the latest report of the IPCC, biochar is one of the safest, most durable and fastest ways to draw down carbon today. Biochar's stable structure makes it possible to store it for a long period of time, resulting in long-term carbon sequestration, as well as a host of other climate benefits (IPCC, 2022).

Biochar trials in Namibia have also been carried out; however, their results remain limited. While NUST has undertaken various trials with biochar in Namibia, no clear results have been produced so far. The aim was to assess the impact on horticultural yields at full and half irrigation, with and without the application of biochar. The analysis of the field data has not yet been completed, while preliminary findings indicate that the addition of biochar to soils does not lead to a significant difference in the yields of produce (more information on the findings of the study is shown in Appendix II). As suggested in the interviews undertaken in the scope of this project, this may be due to the small number of separate trials that have been undertaken to date. At the same time, it was reported in project interviews that some of the CAoN members have produced encouraging results from biochar applied to dryland farming. It is also reported that their trials on wood vinegar have had encouraging results, enabling farmers to reduce the use of chemical pesticides.

Interest in biochar is expected to lead to further trails in the near future. For example, the Perivoli Climate Trust is currently conducting a rangeland trial at Farm Krumhuk. However, the design of the trial and application across heterogeneous rangelands render it improbable that scientific evidence pointing to specific benefits through biochar will be identified, except possibly those of relevance to soils and farming practices at Farm Krumhuk.

The interviewed stakeholders have suggested that the lack of evidence to validate the benefits of biochar application has hindered the development of the biochar market. To establish the positive co-benefits of biochar, comprehensive studies are required to compare the existing local evidence with international findings. Therefore, it is necessary to conduct further research and collect more data to determine the efficacy of biochar, including the application on Namibian drylands.

3.3.2 Industrial applications of biochar

While biochar is widely known for its use as a soil fertiliser, it has a wide range of applications beyond agriculture, horticulture or animal farming. It is used in soil decontamination, wastewater treatment, and biogas production leading to increased gas yields, as well as in the building sector. The composition of biochar (which consists of carbon; volatile matter; mineral matter; and moisture) determines its properties as a product and the resulting use cases. Various factors such as pyrolysis type, biomass type, residence (pyrolysis time), and the pre-treatment of the biomass influence the characteristics of biochar (Armah et al., 2022). Especially for soil applications, but also other application types, further processing steps, such as composting, might be necessary. It is therefore vital to ensure that the biochar characteristics are aligned with the respective end use.

The construction sector stands out as a significant application area for biochar; this also ensures a permanent end-use location, which is vital to ensure the carbon dioxide removal. Biochar has been employed in road construction and as an additive to concrete. Biochar has proven beneficial for cement hydration, although it has been observed that the presence of particles may lead to microcracks and strength degradation. Additionally, wood-derived biochar shows promise for cement-based recycling processes involving highly contaminated waste. With respect to the use of biochar in the building construction sector, the low thermal-conductivity and high water-absorption capacity of biochar make it advantageous for insulating buildings and regulating humidity in the construction industry (Schmidt, Wilson, n.d.). The utilisation of biochar in construction materials offers potential for trapping atmospheric carbon dioxide within buildings, thus contributing to the reduction of GHGs. Besides valorisation through VCM, stakeholders in the construction industry look at biochar as a carbon negative material to reduce the footprint of their operations.

While biochar shows promise in various applications such as water treatment, energy production and agriculture, further scientific research is necessary to determine its full potential and optimal use cases. The effectiveness of biochar can vary depending on its specific application, as biochar used in water treatment may differ from that used in energy or agriculture. The chemical behaviour of biochar with heavy metal ions has also shown inconsistency (Armah et al., 2022). Continued efforts in research and development to understand the chemical and physical properties of biochar and its use in various applications is needed before these can be integrated in a potential biochar-based biomass value chain in Namibia. As of now, soil application seems to be the most relevant application type for the Namibian context due to the vast land area as well as limited observable initiatives to utilise biochar in construction or other use cases.

3.3.4 Private sector engagement in biochar

A number of private sector entities are piloting biochar-based business models in Namibia. They are briefly introduced in this subsection.

PyroCCS views itself as a business incubator for biochar projects. The company operates in Namibia through its subsidiary PyroNam. The company's self-stated vision is to provide farmers with an alternative to using bush biomass for charcoal through biochar. If there is enough biomass available for the construction of a pyrolysis plant in a given area, PyroNam plans to partner with FSC-certified farmers and signs offtake contracts. As reported, plant construction is done at PyroNam's own risk, and the company pays the farmers based on weight delivered. PyroNam takes care of certification and generation of C-Sink certificates, which provide the exclusive source of revenue in PyroNam's business model. The produced biochar is returned to the farmers free of charge.

With currently just one operational facility in Namibia, PyroNam has plans to grow quickly. As reported in a project interview, PyroNam aims to construct six biochar plants in 2024, each with a production capacity of 2,500 tonnes of biochar. The company plans to expand its operations gradually, provided that the current business model is successful, and construct up to 1,000 plants by 2035. PyroNam calculates that this could result in the sequestration of 2.5 million tCO_2e per year.

Founded in 2020, Prime Biochar is another biochar producer in Namibia. Having initially encountered challenges due to the lack of awareness about biochar, they invested in research and development and prioritised production for research purposes. By 2021, the company's efforts started to show promising results, and the potential of biochar gained recognition. The EIF provided some financial support to the company, enabling them to continue their operations. Prime Biochar has partnered with PyroNam, but, in contrast to PyroNam, it sells the biochar to the farmers at a highly subsidised cost.

Planboo is a startup focused on carbon removal through biochar projects in the tropics. The company provides an MRV technology that employs both hardware and software, which is distributed to individual biochar producers (Planboo, n.d.). Although the company does not currently operate in Namibia, it is seeking funding to conduct a pilot test of the application of biochar in Namibia's dryland conditions. According to the interview, the main challenges to implementation are the high operating costs, which make biochar an economically unfeasible carbon credit, and the lack of a use case for biochar in Namibia. Planboo suggests that biochar could be mixed into concrete or used in co-composting solutions, but the market needs to be created, and the utility of biochar to farmers needs to be demonstrated for this to be realised.

3.4 Readiness for PES implementation

3.4.1 PES overview

While there are multiple public and private organisations that are closely involved in the bush biomass value chain in Namibia, it is important to understand their level of readiness for PES implementation. PES schemes are designed to address the issue of undervaluation of ecosystem services, which leads to short-term decisions that prioritise unsustainable resource use over long-term ecological health. In PES schemes, beneficiaries of a service provide financial or other incentives to the providers of that service, incentivising sustainable practices that ensure the continued provision of ecosystem services over the long term. The success of PES schemes depends on their ability to clearly identify service provider and beneficiary, as well as to establish a reliable mechanism for exchanging and collecting funds.

Table 10: Review and classification of PES mechanisms

PES mechanism	Type of mechanism	Financing type	Source of financing
Payments for application of sustainable practices	Compensation/co-investment	Public	Tax revenues/other charges Philanthropy/development funding
Voluntary markets	Commoditisation	Private, Public	(International) private companies governments, development and climate finance providers
User charges/ compliance markets		Private	National companies (or those operating in the country)

(Source: South Pole, 2023)

PES is a relatively new environmental policy tool that has been piloted and implemented in a diverse set of contexts. Nevertheless, any PES scheme must be tailored to the specific local context. It has been concluded during the interview phase of the present project that stakeholders have limited familiarity with PES schemes. More information on the origins of PES, different classifications of PES schemes and their applicability to the Namibian context are reported in Chapter 2.2.4 Application of PES to the Namibian bush sector.

3.4.2 Readiness in Namibia

3.4.2.1 Commoditisation of environmental services

Regarding the commoditisation mechanism, two aspects are of particular interest to Namibia, namely, the use of carbon markets and biodiversity certificates. These are explored in the following section.

Carbon credits

Stakeholders in Namibia have identified carbon credits as a promising revenue stream for financing debushing activities, which can in turn enhance carbon sequestration. In this regard, the methodologies that quantify the carbon sequestration potential of biochar are particularly significant. Verra's Biochar Carbon Crediting Methodology and Puro.earth's Biochar Methodology are both endorsed by the ICROA and are the only ones with such recognition. Although there may be other methodologies and practices related to the production of biochar, ICROA-endorsed methods hold greater potential for commercialisation due to their reliability and credibility.

Namibia started looking to engage with VCMs over a decade ago, but with no success. In 2012, two Clean Development Mechanism projects[14] were registered in the country, yet they never reached the stage of credit issuance (UNEPCCC, n.d.). Verra's project registry also lists four renewable energy projects and a clean cookstoves project that is currently under validation (Verra, n.d.). Stakeholders interviewed for this project identified certain challenges to the development of carbon projects in Namibia, such as the lack of expertise in the country. The absence of baselines for carbon accounting is a concern, as carbon has not been given the necessary consideration in the past. However, the sector has brought forth some promising developments. PyroNam has set up the first biochar project in Africa that is generating carbon credits under the EBC C-Sink standard.[15]

As for the compliance carbon markets, the country has expressed interest in participating in regulated international carbon markets, such as those under Article 6 of the Paris Agreement. However, to participate in such markets, regulatory frameworks must be established. MEFT, the government ministry responsible for the development of regulatory frameworks, is currently undertaking efforts in this direction through an initiative on the 'Development of Namibia's Carbon Markets Framework', implemented with support from UNDP Namibia and the Government of Japan. In the context of this initiative, a feasibility assessment of a potential Emission Trading Scheme and other carbon pricing instruments, such as a carbon tax, has been conducted. The preliminary findings suggest that Namibia is not currently equipped to implement an emissions trading system, a carbon tax, or a domestic crediting scheme.

The UNDP assessment recommended that Namibia develop the capacity of key stakeholders to participate in Article 6 transactions and the VCM. A date for when such a framework will be approved and finalised, and will be ready for operationalisation, has not yet been published; however, it is expected that such a framework would be published shortly. This framework should establish the necessary governance structures needed for Namibia to engage in Article 6 transactions (e.g. authorisation of transfers of mitigation outcomes) and provide clarity to potential project proponents as to the types of projects which would be eligible for Article 6 cooperation, among other things. Once the framework is in place, it should help Namibia become an early mover in the Article 6 cooperation space, since many seller countries are yet to implement the necessary policy-related and legal arrangements, which in turn slows down the development of an Article 6 market.

Apart from the policy regulations, an important consideration for potential carbon project developers will be the form of land ownership for areas where biomass is collected or used. Given the two types of land tenure in Namibia (see 4.2.1.1 Land ownership in communal areas), commercially owned lands can offer opportunities for project developers to gain ownership of the generated carbon assets. This, in turn, may exclude local communities from participating in biomass value chains, benefitting from bush encroachment clearance, or gaining access to potential benefits of biochar application.

Box 14: Namibia's land tenure systems and the implications for biomass use

Namibia's land tenure systems consist of communal and commercial systems, each having its own set of characteristics, rights and management practices. While both systems play a vital role in the country's land governance, they differ significantly in terms of ownership, use and administration.

[14] Project types: landfill gas and avoided methane
[15] Carbon Pulse (2023), Standard sees first biochar carbon credits awarded to an African project (paywall).

The inherent differences between the country's land tenure systems have important repercussions for the large-scale harvesting and use of biomass resources.

The commercial land tenure system in Namibia is based on private ownership and follows (mostly) market-oriented principles. Under this system, land is owned by individuals, corporations or the state. Under the auspices of the government, commercial land tenure allows for the buying, selling and leasing of land, thereby enabling commercial activities, such as agriculture, tourism and others. The system follows a formal legal framework, with clearly defined property rights and regulations enforced by the government. It encourages investment and economic growth by providing a secure and predictable environment for business activities.

In regard to the biomass resources on commercial land, these can be utilised by the owner, subject to the relevant laws and regulations governing the harvesting, processing, use and export, as may be relevant. The significant increase in charcoal production in recent years, and other uses of the biomass resources, are testimony of a matured legal and regulatory framework, offering clarity regarding the ownership of the biomass resource on commercial land.

The other form of land ownership in Namibia, the communal land tenure system, is characterised by the collective use of land, which formally remains state owned. Communities have customary rights to the land, and decisions regarding the use of land and/or its allocation are often made collectively, including with the involvement of traditional authorities.

Communal land is primarily used for subsistence farming and livestock rearing. Investments in infrastructure additions or upgrades depend – to a significant degree – on the availability of government allocations. Incentives for private investments, for example by land users and related beneficiaries, are limited, and communal land cannot be used as collateral. While communal land often includes common grazing areas, making provision for access to water and vegetation, including biomass resources, such uses are for own use only. This has important implications for larger-scale bush biomass projects that could potentially be undertaken on bush-encroached communal land, in that the harvesting of such biomass for purposes other than private use is currently not allowed.

(Source: South Pole, 2023)

Biodiversity credits

Although there is growing interest in funding nature-positive outcomes, the development of biodiversity credits is still at an early stage on a global level, compared to carbon credits. Bush control has the potential to be of benefit to biodiversity. Stakeholders interviewed for this project emphasised the need for better understanding of the specific ways in which biodiversity is affected and for tangible evidence to be provided to demonstrate these outcomes. The presence of the FSC in Namibia should be noted as a positive indicator of institutional readiness to certify biodiversity outcomes in the future. As mentioned, FSC manages the ESS, which can be used to certify ecosystem services, including biodiversity, on top of existing FSC certification. While this does not yet equal the same degree of commodification as biodiversity credits, it serves as an existing framework on which the concept of such credits in Namibia can be built.

With respect to biodiversity, the challenge is less the institutional readiness than the novel character of biodiversity credits, whose demand over the longer term and commercial viability has yet to be proved internationally. Nevertheless, the growing interest in this area and its rapid development demonstrates the need for continuous monitoring to understand how Namibia can benefit from preserving its biodiversity.

3.4.2.2 Compensation for skipped opportunities

As of early 2023, there are no local frameworks in place to compensate landholders who choose to forgo development on their land or to comply with a set of predetermined conditions as part of their land management approach. If such an approach were to be implemented, however, it could be applied for the following practices with positive outcomes in terms of environmental sustainability:

- bush thinning as opposed to bush clearing practices;
- the application of specific aftercare approaches following bush thinning; or
- specifications in terms of heavy harvesting equipment, for example in terms of the maximum vehicle footprint, maximum degree of soil compaction during harvesting and processing, and maximum GHG emissions, may warrant further consideration.

The successful implementation of sustainable practices requires adequate financing, which, in turn, necessitates identifying a buyer willing to provide the necessary funds. Given the difficulties associated with provision of public financing for such services or with imposing charges on Namibian companies, as discussed in Chapter 2, implementation of such an approach would be challenging in the short to medium term without implementation of a supporting financing mechanism, such as an environmental or carbon tax.

3.4.2.3 Co-investment in stewardship

Co-investment in stewardship, which includes non-market commercial rewards for entrusting the ecosystem management to local communities, is being practised in Namibia. Namibia's Community-based Natural Resource Management aims to create a platform whereby people in communal areas manage the ecosystems under their custodianship. This enables communities to generate revenues from tourism, wildlife use and the harvesting of natural products within the boundaries of formally registered conservancies. Such benefits, in turn, are to incentivise residents of conservancies to protect and safeguard the environment and associated ecosystem services.

In early 2023, almost 90 conservancies, one association and 32 community forests are registered and documented, and benefit about 230,000 rural residents. While the framework for such benefits exists, there are also additional opportunities. These include protecting biodiversity hotspots, which is particularly relevant in south-western Namibia, and further incentivising and expanding ecotourism enterprises, especially in rural Namibia.

In the context of enhancing bush value chains, community-centred initiatives in rural Namibia could be envisioned for further development, for example, to foster:

- biodiversity conservation;
- protection of river and waterway ecosystems;
- ecotourism developments; and
- developments of local medicinal plant and bioproduct materials.

While incorporation of such initiatives would be highly beneficial, it faces the same challenge of the need for additional financing as the compensation for unused opportunities. These might be sought through increased tourism or hunting charges. Elasticity of demand may result in reduced revenue for the communities and would need to be studied further, but does not fall within the scope of this study.

3.5 Status quo assessment: conclusions

Despite the undesirable features and impacts due to bush encroachment, Namibia's biomass resource has a multitude of uses, creating jobs and economic value. Among the largest subsectors in the bush use sector is the production and export of charcoal. Other bush biomass uses include: the production and sale of firewood; as an industrial and commercial fuel; for animal feeds; in the form of biochar and compressed wood products; as well as in the form of wood vinegar and other derivative products. Namibia's encroacher bush resource is substantial, both in scale and its coverage across the country. Given new and innovative financing approaches, such as PES, the use and beneficiation of bush biomass could – under certain circumstances – be further enhanced.

The bush biomass sector in Namibia is very dynamic with multiple private and public organisations operating in this space. In particular, there are businesses working on expanding the existing and exploring new uses of biomass application, including biochar and use of bush biomass for heat and electricity generation. There are industry bodies supporting private businesses and access to capital remains possible. The sector is also supported by academia working on related research, and by international development partners supporting the technical capacity of both the private sector and the Namibian government, helping them take advantage of relevant opportunities.

With regard to the biochar sector development, there is already growing interest and a number of businesses are starting to work in this space in Namibia. Their business models vary from selling biochar at subsidised prices to fully relying on carbon credits as their main source of revenue. Nevertheless, it appears that lack of understanding of biochar benefits and the lack of scientific evidence produced in Namibia remains the largest challenge to the development of the sector.

As for the readiness to participate in the carbon markets, which represents an interesting opportunity, more work would need to be undertaken by Namibian stakeholders. While engagement with VCMs to date has not been successful, there are no barriers to such involvement. Moreover, the government is interested in engaging with Article 6 compliance markets and, with support from UNDP, is currently working on the national Article 6 framework. Should such a strategy be established in the short term, it could help Namibia join the ranks of the first movers on the international Article 6 markets.

Apart from carbon markets, there are also other PES instruments which deserve attention. These include biodiversity certificate trading, which could help reflect the value of savanna restoration through sustainable encroacher bush harvesting. Nevertheless, the relatively early development stage of the biodiversity certificate market represents a greater barrier than national readiness. This opportunity is therefore likely to be more promising in the medium than short term.

4 Gaps and barriers analysis

This chapter presents the results of the gaps and barriers analysis and is accompanied by an action plan. The analysis of gaps and barriers applies to the facilitation of a biochar production value chain in Namibia, with a specific focus on selling the resulting carbon credits on the VCM. Moreover, the chapter includes an action plan designed to address these gaps with concrete actions to be implemented by identified actors, each with their distinct responsibilities. As such, this chapter builds on the analysis of carbon market potential to support sustainable bush thinning in Namibia (section 2.3.1 Carbon markets) and the assessment of the status quo in Namibia (refer to Chapter 3 above). The findings of gaps and barriers analysis and the action plan provide the foundation for an enabling environment for project operators, also providing an overview of applicable standards.

The aim of this chapter is to support farmers, landowners and other interested individuals who wish to engage in biochar production with the assistance of carbon finance. For this purpose, this chapter provides an overview of actors involved in the creation of a BCR project, presents the key gaps and barriers, and proposes how these may be addressed before outlining potential business models, also introducing the business model tool developed as part of this project that allows to perform a cost-benefit analysis of a project.

4.1 Roles and responsibilities

The creation of a BCR project is a collaborative process, which involves multiple actors and stakeholders with distinct capacities and responsibilities. While the establishment of such a collaboration is initially challenging, a respective cooperation structure will ultimately ensure that a BCR project, as well as the consecutive value chains, can function effectively and guarantee the continuation of such projects.

The following section provides a high-level description of potential roles and outlines the respective responsibilities and capacities of the actors. While these are models, describing what a particular actor would typically do, it is also possible that one organisation or actor takes up multiple roles. This happens, for example, if an actor is already engaged in similar activities in the biomass sector, or if an actor has a particular well-suited network that can be leveraged to reduce costs and demand on resources.

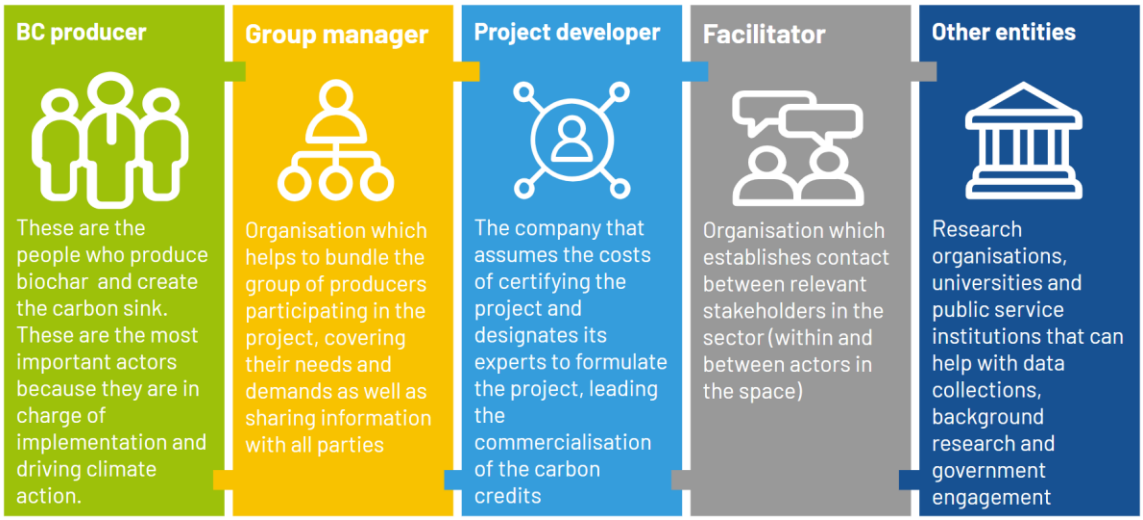


Figure 2: Roles

Source: South Pole (2023)

Biochar producer

The role of biochar producer can be taken up by a variety of different actors, including subsistence farmers, small-scale kiln operators serving as service providers, commercial farmers, or centralised BCR entities, with a dedicated focus on biochar production.

The primary responsibility of the biochar producer lies in the operation of the production facility, while adhering to social and environmental safeguards, in alignment with approved carbon accounting methodologies, and compliance with material quality requirements and guidelines of the carbon standards. Such compliance ensures the integrity of the biochar production process.

Biochar producers are assumed to be rational economic agents who conduct a cost-benefit analysis before engaging in an economic activity. In this capacity, they reap the economic benefits of the Namibian BCR potential provided by the abundance of biomass while also facing the entrepreneurial risk for their activity and investment. The biochar producer is likely to require specialised training on biochar production, including on the properties of biochar and the impact of different production methods (e.g. the control of the biochar production temperature). Such training serves to equip the biochar producer with the necessary skills and knowledge to operate a production facility in alignment with the available standards.

Main requirement: ability to operate the pyrolysis equipment in accordance with relevant carbon standards

Group manager/aggregator

The group manager, or aggregator, acts as the implementation entity and spokesperson in the case of BCR projects that involve several smaller producers. The group manager assumes a key position in facilitating communication between several biochar producers on one side and the project developer or financing institution on the other.

The presence of a group manager in a BCR project is not obligatory as potential biochar producers can choose to establish their own operations. However, the feasibility and viability of such an

undertaking relies heavily on the volume of credits that an operation can generate over its years of activity. These credits must cover the costs of certification and the transaction expenses for the project developer. For example, if a project developer collaborates with just one producer generating a low quantity of removal credits, it might be challenging to recover costs solely through the margin from credit sales. In this sense, collaborating with a group manager offers several advantages, resembling the chain of custody group scheme of the FSC, as is already known and applied in Namibia. This optimises the process, ensuring efficient communication channels and enabling project developers to work as a cohesive unit, rather than duplicating efforts across multiple individual producers.
Where multiple producers collaborate under the guidance of a group manager, it falls upon the latter to orchestrate and oversee the seamless implementation of the carbon project under their management. As such, the group manager may also serve as the legal entity accountable for the execution of the projects.

The overarching responsibility of the group manager encompasses the following key aspects.

- **Monitoring and reporting:** monitoring project activities and compiling comprehensive reports that align with the data requirements stipulated by carbon standards and methodologies
- **Benefit-sharing agreements:** implementing benefit-sharing agreements with the biochar producers; These agreements are designed to ensure equitable distribution of revenues generated by the project among all stakeholders.
- **Training and guidance:** the group manager also takes on the role of educator and adviser to biochar producers. This involves the development and implementation of training programmes that equip producers with the necessary skills and knowledge to adhere to project guidelines.

It is worth noting that some of the above-mentioned services (e.g. monitoring and reporting) can be outsourced to external service providers who can act as subcontractors or partners with the group manager, if the group manager lacks the capacity to provide these services in house. However, the group manager is accountable to the carbon project developer.

Main requirements: ability to connect to local producers through existing networks; capacity to develop and implement training; as well as to establish monitoring and enforce legal agreements with producers

Project developer/carbon asset developer

The role of the project developer, sometimes also referred to as the carbon asset developer, is to connect the group manager, working on behalf of biochar producers, with international carbon markets.

Key responsibilities of the project developer include:

- **project registration:** the project developer registers the project in accordance with the relevant carbon standards. This involves navigating (the often complex) procedures underlying the relevant standards, to obtain validation and verification that are required for the issuance of carbon credits.

- **market commercialisation:** an important aspect of the developer's role is to bridge the gap between the project and potential buyers within the voluntary carbon market. To achieve this, they engage in the commercialisation of BCR. This process involves the development of marketing materials and the strategic integration of the project into a sales portfolio. The project developer may also establish commercial agreements (e.g. Carbon Dioxide Removal Purchase Agreement, CDRPA) with group managers/aggregators, either under a purchase agreement, offtake guarantee or pre-purchase commitment. See chapter 4.3.1 for more information on typical commercialisation options.

Facilitator

The role of the facilitator involves supporting the expansion of the biochar market, including the various value chains and off-takers that may exist beyond carbon-related matters. They are responsible for raising awareness about biochar and building demand for its use in soils, as well as for other applications. This involves more than just guiding biochar production, as the facilitator must provide extensive support, such as capacity building and information dissemination, including on production technologies and material, and connecting different stakeholders like industry groups and farmer's unions. Prominent organisations like EBI, USBI, and ANZBIG can serve as international models for an equivalent Namibian organisation that may be formed in future. Given Namibia's constraints in supporting emerging sector organisations, such an entity could be initiated by a single organisation or a consortium of organisations.

The two entities that are best placed to play the role of a facilitator are N-BIG and CAoN. Both of these nonprofit organisations do already play a key role in developing the Namibian biomass industry. N-BIG focuses on the sustainable use of biomass and market development, emphasising advocacy and the promotion of sustainable harvesting and production methods of biomass. CAoN, on the other hand, represents the Namibian charcoal industry, and works closely with farmers to address bush encroachment by way of charcoal production, thereby creating additional economic opportunities for farmers.

N-BIG strengths lie in exploring diverse use cases, while CAoN's hands-on connection to producers renders it well to facilitate the shift to biochar production among local stakeholders. It is essential for both organisations to actively participate in discussions regarding the establishment of a biochar facilitating body, even if only one eventually assumes the role.

Main requirements: the capability to explore and establish domestic value chains and national/international markets for biochar-related products by engaging with industry; industry liaison and networking for and on behalf of the sector players; as well as developing and mainstreaming biochar product guidelines.

Other potential actors and entities

Additional entities that play integral roles in the to-be-established Namibian biochar ecosystem encompass the scientific community, government bodies, as well as downstream industries across the entire biochar value chain.

- **Government:** government agencies are tasked with creating an enabling environment for biochar projects, mainly through regulatory frameworks on international carbon markets in regard to the implementation of Paris Agreement Article 6. Government's responsibilities also relate to the establishment of specific material requirements, and essential standards and regulations to ensure the quality and safety of biochar products. Additionally, the government may advocate for the adoption of biochar within the local industries, such as incorporating biochar into national road networks, and for similar applications that may become viable in future.

- **Academic community:** the academic community takes the role of providing evidence and data regarding the impact of biochar products, e.g. on the impact and longevity of biochar applied to soils or in other media. Academic institutions, such as UNAM and NUST, should also be involved in the development of trials and pilot projects designed to test the scientific assumptions and validate the efficacy of biochar in various applications. Their research contributes essential insights viewed as necessary to create strong market demand for biochar as a material product.

- **Laboratories:** laboratories analyse and certify biochar samples in accordance with recognised standards, such as IBI or EBC. This certification procedure is essential to ensure that the material meets the quality requirements necessary for the successful commercialisation of biochar as a marketable product.

- **MRV service providers:** MRV service providers may be hired to conduct monitoring and reporting activities on behalf of biochar producers or group managers, particularly in instances where these entities lack the necessary capacity to comply with carbon standard requirements on their own.

  Downstream actors and industries (value chain): downstream actors and industries operating within the biochar value chain play a vital role in transforming biochar into practical, scalable products. As an example, the cement industry may consider incorporating biochar into their production processes.

4.2 Gaps and barriers and recommended actions

There are a number of gaps and barriers that could affect the development of the bush biomass and biochar industry, as well as the Namibian carbon market in general. Each gap or barrier was classified based on two main factors:

- **potential impact**: the significance of an obstacle for the development of the biochar sector; and
- **ease of addressing**: how much effort, time and/or investment is needed to address it.

These two factors were assessed as high, medium or low, in line with the approach shown in Table 11 (below).

Table 11: Classification of identified barriers and gaps

Barrier/gap	High (red)	Medium (amber)	Low (green)
Potential impact	The gap/barrier, if unaddressed, can prevent the growth of carbon credit-based biochar business models.	The gap/barrier, if unaddressed, can limit the development of carbon credit-based biochar business models.	The gap/barrier, if unaddressed, will not affect its overall development.
Ease of addressing	Addressing the gap/barrier requires significant investment and/or legislative changes and requires an extended period of time.	Addressing the gap/barrier will require investments and can be carried out in the medium term.	Addressing the gap/barrier can be addressed in the short term and does not require major investments.

Source: South Pole (2023)

For each identified gap or barrier, one or more recommended actions to address the issue are provided. These recommendations also specify the most suitable actor to take on the task and resolve the situation. The identified gaps and barriers are broken down into categories and presented further below.

4.2.1 Regulatory

4.2.1.1 Land ownership in communal areas

Potential impact: Ease of addressing:

Any project that operates under VCM standards, such as Verra or Gold Standard, needs to thoroughly demonstrate integrity and a fair involvement of stakeholders, as well as equitable distribution of benefits. Consequently, clearly defined **land ownership titles are of critical importance for Namibian VCM projects involving land-based activities**. For biochar projects, this includes the following two specific aspects:

- access to land resources, and the rights to utilise and source biomass from the land; and
- ownership rights to own and sell land-based assets, which includes the rights to sell the claims for BCR that are stored in the soil, when biochar is applied as part of a biochar project.

The Namibian land ownership rules include two principal types of property, namely, communal and commercial ownership (i.e. freehold), which has impacts on the potential scale and scope to develop biochar carbon projects on those lands. Almost 48% (39.7 million ha) of land is under commercial ownership[16], while 35% (28.7 million ha) is classified as communal land, and thereby belongs to the state. The remaining 17% (13.9 million ha) is other state land, such as national parks. Both commercial and communal lands are affected by bush encroachment. On commercial land, bush encroachment is particularly dense in the north-central parts of the country. Bush encroachment decreases in

[16] Thereof, 5,491,110 ha are owned by the state.

commercial areas in southern Namibia. Communal areas particularly affected by bush encroachment are the Kunene and Erongo regions in north-western Namibia. Northern regions, such as Omusati, Oshana, Oshikoto, Ohangwena, Kavango West and Kavango East, are less affected. Figure 3 (below) shows the different land allocations between commercial, communal and other state land. Figure 4 shows the overall distribution of bush encroachment in Namibia.

Biomass can be commercially harvested on privately owned land, but existing laws prohibit this on communal lands, except for personal use. Commercial biomass collection and use in privately owned (commercial) land is regulated under the 'Forest Act' and associated regulations, where the owner of the land is also the owner of the biomass. In these commercial settings, biochar applications and carbon assets generated by way of biochar use accrue to the owner of the land. In contrast, the implementation of carbon projects in the communal areas is more challenging, due to the legal status of communal lands, which prohibits the commercial utilisation of biomass resources. Their legal status implies that carbon credits from the application of biochar becomes the property of the Government of Namibia as the legal custodian of communal lands**.** As a result, bush biomass harvesting in communal lands (see 1. above) is not possible for commercial purposes.

In communal land areas, the issue of ownership of carbon rights (see 4.2.2.1 above) therefore effectively limits the development of BCR projects. However, recent government announcements indicate that this might change in the future. The exclusion of communal land in the commercial utilisation of bush biomass is currently under revision by MEFT, meaning that commercial use might be possible for selected value chains in the future. Communities on communal land may manage the land and benefit from select ecosystem services, including wood, fruit or meat, but not engage in commercial activities involving the sale of assets that accrue from land uses, such as biomass or carbon credits, as such ownership remains vested with the Government of Namibia. This ownership arrangement poses a severe barrier to the commercialisation of BCR resulting from carbon storage on communal land through private markets. While this issue could – in principle – be addressed, this would involve multiple government ministries, including the Ministry of Agriculture, Water and Land Reform (MAWLR), Environment, Forestry and Tourism (MEFT), as well as Urban and Rural Development (MURD). Some of these issues are already being addressed; for example, the MEFT is in the process of developing a communal governance framework and Forest Management Plan, which addresses commercial bush use in communal areas and which may improve the integration of communal communities in biochar-related value chains.[17] Under these circumstances, private project developers may only develop biochar projects, including the commercial sourcing of biomass and commercial biochar applications, in privately owned areas, thus excluding communal lands from the benefits of bush thinning or the opportunities arising from generating carbon credits. In the absence of a change in legislation or legal changes that provide certainty to biochar producers and carbon asset developers, commercial BCR projects will be limited to freehold land.

[17] Information provided by a representative from the Ministry of Environment, Forestry and Tourism (MEFT) during the Standard Bank Biomass Fair on September 8, 2023.

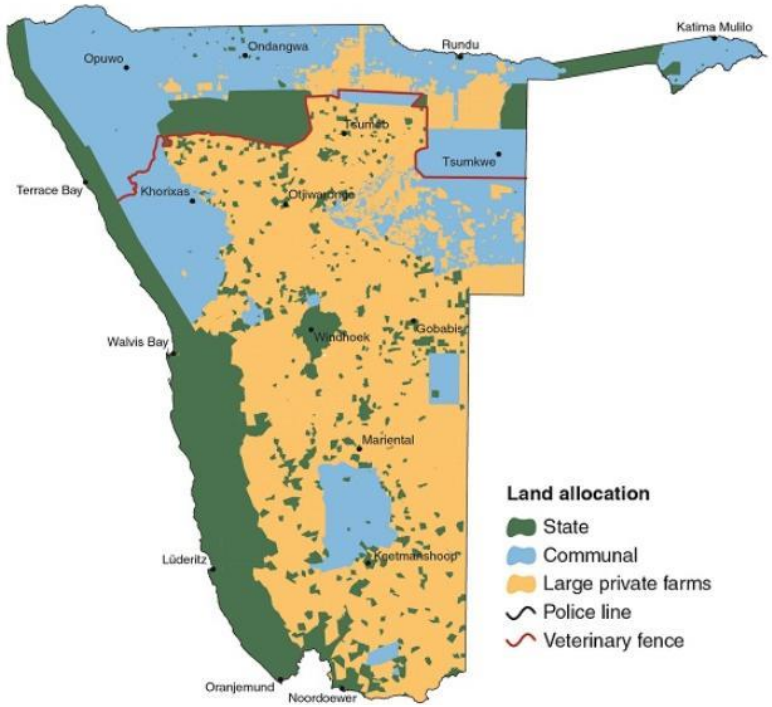


Figure 3: Map showing Land Allocation in Namibia in 2020

Source: Atlas of Namibia, Chapter 8: Land rights and management, A portrait of the land and its people (Atlas of Namibia Team, 2022)

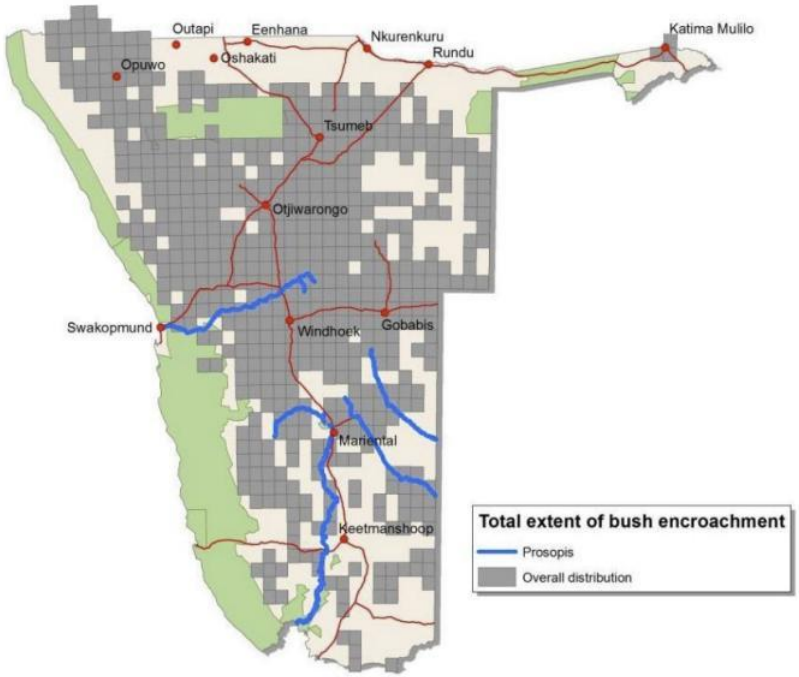


Figure 4: Map showing total extent of bush encroachment

Source: Strategic environmental assessment of large-scale bush thinning and value addition activities in Namibia (SAIEA, 2015)

Recommended actions

1 Conduct legal review

Verify and confirm the identified barriers to engage in BCR projects related to the ownership of land with a focus on communal lands, by conducting a legal review of the issue.

Table 12: Actors and responsibilities – legal

Actors	Responsibility
Facilitator	Initiate and coordinate a legal review with relevant stakeholders.
Academia	Establish a research project regarding the legal aspects of soil carbon ownership, which could, for example, be undertaken by the Faculty of Law at the University of Namibia.
Government	Crucially, MEFT as the ministry responsible for the introduction of the Carbon Market Framework, needs to be involved and provide sector-wide guidance.

2 Implement a communal governance framework

MEFT has introduced a governance framework facilitating the commercial use of bush in communal lands. Upon its active implementation, the Directorate of Forestry (DoF) within the MEFT, as the entity responsible for current restrictions, may consider undertaking a review of current provisions. If deemed appropriate, the DoF could consider revising or lifting these restrictions, allowing communal areas the opportunity to apply for permits. The implementation of this recommendation could significantly promote economic opportunities on communal lands.

Table 13: Actors and responsibilities – governance

Actors	Responsibility
Government	MEFT to implement communal governance framework to allow commercial bush use in communal areas

4.2.1.2 Carbon market regulations

Potential impact: Ease of addressing:

The Government of Namibia, supported by the UNDP, is currently working on the development of the national Article 6 framework. The objective of this framework is to lay down the rules for carbon market regulations in Namibia, ensure that carbon market activities support national decarbonisation plans, and give clarity to market players. The draft Article 6 strategy, which was presented for stakeholder consultation in June 2023, included a number of important provisions which may impact

the future development of biochar projects in Namibia (Box 15: Aspects of the draft Namibia's Article 6 framework relevant for biochar projects).

Box 15: Aspects of the draft Namibia's Article 6 framework relevant for biochar projects

The draft national guidelines on future international carbon market interactions propose a classification system for mitigation activities, consisting of three lists that are valid for the time period 2023–2025, namely, a positive list, an eligible list and a negative list.

Mitigation activities on the positive list may be authorised for cooperative approaches, i.e. for international transfers that are credited against a country's Nationally Determined Contribution (NDC) or other International Mitigation Purposes (IMP). Mitigation activities on the eligible list may be developed under the Article 6.4 mechanism of the Paris Agreement or for the voluntary carbon market. Activities on the negative list will not be recognised under regulated or voluntary carbon markets, as they are not considered additional to Namibia's NDC.

Biochar is listed under the positive list, as well as the eligible list, thereby allowing biochar projects access to both regulated and voluntary carbon markets. Similar to other project types on the positive and eligible lists, biochar activities must obtain approval by the carbon markets taskforce (CMT), which is envisaged to be established under the MEFT. In the case of internationally transferred credits that require a corresponding adjustment, Namibia will impose a 'corresponding adjustment fee', which is proposed to be capped at USD 5 per transferred credit. While such a fee has significant implications for the generation and export of low-cost credits, biochar credits are likely to be relatively less affected, due to the already high abatement cost associated with this project type.

Source: Based on Namibia's National Guidelines for International Carbon Markets (draft version), Government of Namibia (2023)

Biochar projects are included[18] in both the positive and the eligible list under the activity 'Enhance soil carbon sequestration using biochar and compost in grassland'[19]. Being included on both lists gives biochar project developers the opportunity to choose the way in which they want to engage with carbon markets, as all three mechanisms (i.e. Article 6.2, Article 6.4 and the VCM) are opened to them (see Figure 5). This is a unique position, as all other technologies are included only in one of the two lists, which could be indicative of the importance of biochar projects in the Namibian decarbonisation plan. Further, a clear distinction/definition has to be established to ensure that biochar carbon removals are not double counted when biochar is produced and subsequently used for soil carbon stock increase.

All the methodologies and/or voluntary standards allow biochar to be applied in the soil and grasslands as an eligible sink location. For Article 6.2 and Article 6.4, the context differs only in that these do not rely on VCM carbon standards. Under Article 6.2, the choice of standard and methodology remains at the discretion of the host and buyer country, who will mutually agree on the standard and

[18] Biochar is currently listed as positive and eligible at the time of this report's publication, but it is subject to review during the finalization of the framework.
[19] Since all biochar-focused projects use a methodology that requires demonstrating the application of the material into permanent locations (including soils), the activity complies with VCM methodologies.

methodology to be used. Host and buyer countries could refer to an existing methodology from any carbon standard or decide to develop another methodology that meets their requirements. For credits generated under Article 6.4, methodologies to account for BCR still have to be created and approved by the Article 6.4 Supervisory Board.

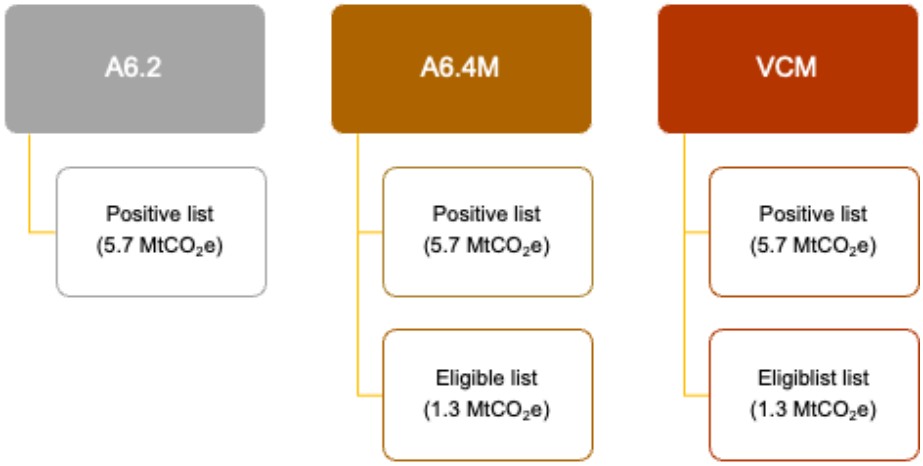


Figure 5: Application of positive and eligible lists in Namibia's draft Article 6 strategy

Source: Namibia's National Guidelines for International Carbon Markets (draft version), Government of Namibia (2023)

It is noted that there are growing concerns among project developers with regards to the emerging regulations in host countries which limit the ability to export generated carbon assets, and/or the potential imposition of charges on carbon asset sales. While establishing a national Article 6 strategy may give certainty to project developers, and thereby attract carbon project investment to the country, the current version of the rules outlined in the Namibia's draft strategy document indicates government's intention to strictly regulate both the compliance and voluntary markets (i.e. limiting the types of eligible VCM project and the requirement to register them), which may be viewed as possible 'over-regulation', thereby possibly limiting the willingness of potential project developers to establish BCR projects.

Therefore, it will be important to ensure that project developers are provided with clear guidance on what the emerging Article 6 strategy means for their activities. In the case of biochar, it would refer to how the inclusion in both the positive and the eligible list will be dealt with. Additionally, while the strategy provides an applicability timeframe for biochar projects on the positive list (until 2026), it would be important to address possible concerns with regards to longer-term eligibility given that it is likely that for biochar projects in Namibia carbon credits will be the largest and possibly in many cases the only source of revenue.

Recommended actions

3 Provide regulatory clarity through carbon market framework

The introduction of a carbon market framework will provide carbon project developers with guidance and clarity on the implications of biochar's inclusion in both the positive and eligible list. While regulating the carbon market holds significant advantages for Namibia, it should prioritise investment certainty and the facilitation of commercially viable carbon projects, unless it is the intention that private-sector actors are to be actively excluded from the sector.

Table 14: Actors and responsibilities – carbon market framework

Actors	Responsibility
Government	• Provide clarity regarding the long-term eligibility of biochar projects, extending beyond the current applicability time frame until 2026 as outlined in the draft framework. • Make or clarify legal provisions for carbon credit ownership in communal areas. • Clarify relation between future commercial BCR projects and biochar targets under the Namibian NDCs. • Strike a balance between regulatory measures and the promotion of investments in carbon projects. • Maintain active engagement with project developers, systematically collecting their feedback, and integrating it into the ongoing evolution of the Article 6 strategy. • Include civil society organisations in a participatory process.
Other actors	Civil society organisations, including NNF, NCE and N-BIG, have been actively engaged and participated in the consultation workshop organised by UNDP/MEFT. It is crucial for these organisations to continue their involvement in the process of drafting a practical and supportive framework, including the initiatives led by UNDP and the Article 6 Framework.

4.2.1.3. Lack of regulations/requirements on post-harvesting activities

Potential impact: Ease of addressing: 

The lack of regulations and requirements on post-harvesting activities pose a challenge to achieving the sustainable restoration of savannah grasslands. After bush harvesting, it is essential to apply aftercare measures to limit the strong regrowth of encroacher bush. Among others, such measures include browsing sprouts, pesticide application on stumps, select burning and others, to

ensure that the bush-thinning activities have lasting effects. Currently, typical agreements with bush-thinning service providers often only include the initial bush harvesting, bush thinning or clearing phase, excluding specifications on who will be responsible for aftercare. In the absence of thorough aftercare measures, bush will regrow, and thereby possibly delay or even prohibit the (re-)emergence of natural savannah landscapes. Without carefully designed payments or obligations for aftercare measures, regrowth of bush and subsequent sales of the biomass would incentivise a 'bush farming' business, instead of ecosystem restoration. It is also for this reason that sustainable post-harvest treatment or aftercare is a key priority in the National Strategy on the Sustainable Management of Bush Resources 2022-2027 (MEFT 2022).

From a carbon standard perspective, aftercare is not an element required for a BCR project, but credits with demonstrated environmental and social benefits may be able to fetch higher prices on the market. The given standards do not require the application of aftercare measures for crediting. However, it is well observed that projects that can demonstrate additional benefits, so-called 'co-benefits', can be sold for higher prices (Ernst & Young, 2022), even more so if the benefits are quantified. These include, for instance, positive health impacts, impacts for women's empowerment or other impacts in line with the Sustainable Development Goals. For the Namibian context, this means that if projects demonstrate the positive impacts of the applied aftercare measures on the environment (e.g. biodiversity) or community impacts (e.g. people's livelihoods), the BCR credits might be able to secure a premium**, which emphasis also the Namibian National Strategy on the Sustainable Management of Bush Resources.** However, given the relative low number of trades, it is not possible to quantify the premium that aftercare measures can achieve. It is also noteworthy, that the Namibian National Strategy on the Sustainable Management of Bush Resources also emphasises aftercare measures in the context of a holistic approach on ecosystem restoration.

Regardless of the carbon perspective, aftercare measures should be part of biochar production. Any comprehensive project focused on ecosystem services and biodiversity must integrate aftercare practices to ensure the provision of essential ecosystem services in the future. In this context, the Namibia Nature Foundation has undertaken a cost-benefit assessment which emphasises the costs and limitations of proper aftercare measures. The study highlighted that aftercare can be financially beneficial to farmers if additional livestock and water benefits are taken into account. However, the net benefits are relative and may not be enough to incentivise the uptake of such. In addition, some aftercare measures require initial capital investment costs to cover net losses in the first years of intervention (Namibia Nature Foundation, 2020). Also, there is currently still uncertainty about which aftercare measures work best in which kind of environments and terrains. Although further trials are necessary to develop a comprehensive understanding of the most appropriate aftercare measures for various environments, it is evident that there is a need to establish an incentive framework that promotes the implementation of post-harvesting measures, ensuring sustainable restoration. An incentive framework could, for example, include the integration of aftercare measures in FSC guidelines, or the inclusion of specific aftercare commitments by relevant land owners.

Recommended actions

4 Enhance knowledge on best practice and aftercare

To further enhance knowledge on best practice regarding aftercare measures, it is best to set up consultation with industry and organisations, as well as NGOs to ensure that the restoration of the savannah landscape is sustainable and long lasting. Currently, a best practice guide of bush control and aftercare methods is under development, coordinated by NNF and NCE under the umbrella of the National Dialogue Platform. Discussions with the NNF highlighted the challenges in determining best practices due to differences in results based on location and other site-specific factors. However, there is strong support[20] for aftercare, and improved knowledge will play a key role in incorporating these measures into FSC guidelines (see recommendation 5 below for further details).

Table 15: Actors and responsibilities – best practice and aftercare

Actors	Responsibility
Facilitator	To coordinate with entities listed below on the necessary activities to develop a best practice guide. Disseminate results of cost-benefit analysis of aftercare measures among farmers, harvesting companies and other related practitioners.
Academia	Conduct scientific trials and evaluate ongoing pilots to determine which suite of measures work best in the different land environments on bush-encroached lands.
Other entities	NGOs and other relevant and affected entities can collaborate with practitioners, harvesters and farmers, as well as academia on research initiatives focused on identifying optimal aftercare measures, creating awareness and bridging the gap between government and practitioners.
Aggregator	Disseminate best practices with participating biochar producers.

5 Integrate aftercare measures into FSC and/or related bush harvesting guidelines

To facilitate the integration of aftercare measures into an incentive framework, it is advisable to incorporate these measures into FSC guidelines, or other guidelines that farmers, harvesters and related entities may adopt to ensure the application of effective aftercare measures. The FSC plans to update the Namibian FSC standard in 2024, offering a chance to incorporate aftercare measures directly into the standard.[21]

[20] In the second stakeholder workshop conducted on 14 September 2023, participants were surveyed regarding the need for aftercare measures. The overwhelming response indicated strong support for the necessity of aftercare.
[21] This information was disclosed during the stakeholder consultation held on 14 September 2023.

Table 16: Actors and responsibilities – aftercare and guidelines

Actors	Responsibility
Facilitator	Advocate for the integration of such best practice into FSC guidelines

4.2.2 Technical

4.2.2.1. Lack of demonstrated impacts of biochar in the Namibian soil

Potential impact: Ease of addressing:

The positive impacts of biochar on land productivity need to be demonstrated, noting that substantive evidence under Namibian conditions is still lacking. In order to establish BCR as a scalable climate action solution for Namibia, and ensure that stakeholders are incentivised to use biochar accordingly, it is important to demonstrate to farmers the positive impacts of biochar on the productivity of farmland. Yet, such Namibia-specific evidence is currently lacking for the country's soil types, and the different land use practices used. While multiple international studies demonstrate the positive impacts of biochar, its impacts are specific to each type of soil and climatic conditions and multiple concerns have been raised with regards to its effectiveness in the dryland conditions benefitting from very limited rainfall. The added value of biochar as a soil application is a key motivation and justification for farmers to transform their land management and invest financial and labour resources. In the absence of clear evidence and proven benefits for their operations and respective ecosystems, farmers will most likely not be willing to apply biochar and bear the respective costs. Since the documented biochar utilisation in soils is a pre-requirement to obtain carbon finance, the current lack of evidence and resulting lack of motivation by farmers to apply biochar will therefore limit the future scalability of BCR in Namibia.

In addition, there is uncertainty and a lack of scientific evidence regarding how SOC stocks are affected by bush thinning. From a carbon accounting point of view, if SOC contents decrease after bush thinning, the respective volume needs to be subtracted from the carbon sequestered in the biochar, leading to the generation of fewer credits. However, VCM methodologies do not account for changes in SOC, assuming that biomass is harvested sustainability (i.e. FSC or other relevant guidelines). If there are decreases in SOC content, it would go unaccounted purely from a VCM methodology perspective. SOC stocks might be accounted for in Namibia's reported GHG inventory, and changes should be reflected in the inventory. At worst, this implies that the removal capacity of Namibia that is reported in the inventory is less than what is 'exported' in the sale of credits. Based on this uncertainty, there should be further scientific investigation on SOC and its changes, to determine whether these pose a threat to the environmental integrity of the VCM methodology.

There are a number of research projects and related activities with relevance to the development of a biochar sector in Namibia. Table 17 provides a non-exhaustive list of ongoing activities:

Table 17: Actors and responsibilities – ongoing activities

Actor	Description
PyroNam	PyroNam is the Namibian subsidiary of German PyroCCS GmbH, which promotes biochar as a global strategy. PyroNam has constructed one pyrolysis plant, which is supplied by farmers with biomass in exchange for payments. The entity's operations are financed by carbon credit sales.[22]
Environment Investment Fund (EIF)	The EIF funded the purchase of biochar and its application in soils in the Zambezi region.
Prime Biochar	Prime Biochar is a producer of biochar, and has partnered with PyroNam.[23]
NUST BUSH Project	A three-year project exploring sustainable biomass utilisation entitled biomass utilisation by sustainable harvest (BUSH) ran from November 2018 to July 2021 This initiative focused on researching and developing products derived from bushes, technology transfer, and applied research in bush control. Sub-Project 2 on 'Biochar Production, Processing, and Testing' is overseen by the Faculty of Natural Resources and Spatial Sciences. Within this project, NUST has designed a Kon-Tiki burner, created various nutrient-enriched biochar compositions, and conducted experiments to assess the impact of biochar on productivity. The project has also produced an assessment report and published an operational booklet detailing the process of producing, conditioning, and applying biochar derived from Namibian bushes.[24]
Perivoli Rangeland Institute	The Perivoli Rangeland Institute has initiated several pilot projects to demonstrate best practices for harvesting encroacher bush. These projects involve applying wood and biochar into the soil to enhance moisture retention and restore SOC levels. The first pilot project started in April 2023 at Farm Krumhuk, located 25km south of Windhoek. Another pilot project commenced at Ombe Farm in Hochfeld in October 2023, and a third pilot is scheduled to begin in

[22] At the time of publication of this report, PyroNam has successfully generated carbon credits under the EBC C-Sink standard. It holds the distinction of being the first African project to produce EBC C-Sink carbon credits.
[23] Shared with the authors during an online consultation held on March 23, 2023.
[24] https://bush.nust.na/projects/techdev/proj2

	February 2024, at Tsumore Farm close to Tsumeb. All these projects aim to produce biochar.
UNAM	UNAM is part of the African Wild Dog Biomass Hub Project, which aims to strengthen communal capacities to utilise bush biomass to generate income, improve livelihoods and support the bush-value addition. Amongst others, biochar is key value chain for its capacity building component.[25]

Source: South Pole (2023)

It will be important to undertake additional pilot studies demonstrating the impacts of bush removal for biochar production and its application under the Namibian conditions. While established research institutions, including UNAM and NUST, are well-suited to lead such research, it is equally essential to engage the perspectives of farmers and industry representatives. This collaborative approach ensures that the generated insights align with practical requirements and contribute to the existing knowledge base. Of particular significance is the concept of cascade utilisation, where biochar is enriched with nutrients sourced from other organic waste streams, such as compost or chicken manure (as seen in the Planboo model). This approach is viewed as promising to enhance nutrient delivery to soils, and merits additional investigation.

It is also important to note that, from a carbon standards perspective, scientific evidence of the positive impacts of biochar application are not required for crediting carbon removal. However, the evidence is needed to incentivise farmers' uptake of biochar for soil applications. Depending on the success of these pilot studies, it would be possible to understand the level of interest of stakeholders in the agricultural sector, and if the emergence of a market for biochar as a material which is a precondition for BCR to be economically viable.

Recommended actions

6 Launch pilot projects to test the impacts of biochar on Namibian soils

Pilot projects should be conducted to create tangible evidence of the impacts of applying biochar in the Namibia's specific climatic conditions.

[25] https://www.awdbiomasshub.com/index.php/about-us

Table 18: Actors and responsibilities – pilot projects

Actors	Responsibility
Academia	The academic community provides scientific support in setting up pilots and systematically analysing results of such pilots.
Facilitator	To collaborate with researchers in determining the necessary pilot programmes, ensuring that they generate meaningful evidence that can stimulate demand by farmers.
Farmers	Provide land for the implementation of pilot programmes.

7 Consolidate existing knowledge on biochar impact on dryland savanna ecosystem

Compile and synthesise existing knowledge regarding the impact of biochar on dryland savanna ecosystem services, with a specific focus on:

- SOC formation and stability.
- Effects on grass growth and grazing capacity.
- Influence on water holding capacity and drought resistance.
- Soil microbes and biodiversity.

Table 19: Actors and responsibilities – existing knowledge

Actors	Responsibility
Academia	Conduct scientific review of existing knowledge on the impact of biochar on soils and various associated parameters (grazing capacity, drought resistance, etc.)

4.2.2.2. Technical facilities for biochar analysis

Potential impact: Ease of addressing:

To ensure that biochar available in Namibia not only meets the material requirements of carbon methodologies but also responds to the requirements of farmers, advanced technical analysis facilities are needed. This refers to test centres and laboratories that are able to provide the analysis and certification of biochar samples following the International Biochar Initiative (IBI)[26] or EBC[27] requirements based on standardised testing procedures. As of now, neither the IBI[28] nor the EBC[29] list

[26] International Biochar Initiative, IBI Certification Program, Version 5 December 2014
[27] European Biochar Certification, Guidelines for a sustainable production of biochar, 5April 2023 (Version 10.3)
[28] International Biochar Initiative, Testing laboratories for IBI Biochar Certification, n.d.
[29] European Biochar Certification, EBC/WBC Accredited Laboratories, n.d.

any accredited laboratories in Namibia. In the absence of recognised facilities, which can provide these services, it is possible to send biochar samples to labs overseas to obtain the necessary certification. This allows Namibian biochar projects to be developed, but having to send samples overseas implies higher costs and logistical efforts.

Given the existence of several laboratories in Namibia, it is likely that necessary capacities would become available, once there is a demand for such services from national biochar producers seeking local certification of their products. Analytical capacity is being built, for example by AnaLab at Walvis Bay, at NUST, and at UNAM. Of note is the German Biomass Research Centre's (Deutsches Biomasse Forschungszentrum, DBFZ) readiness assessment of the NUST laboratory, in order to introduce EBC aligned testing services for producers of biochar.[30] Upscaling laboratory capacities for biochar certification is likely to be actioned by existing analyses facilities as soon as the Namibian biochar sector gains momentum.

Recommended actions

8 Accreditation of laboratories

Once the biochar sector gains further momentum, it is expected that private-sector laboratories will rapidly achieve relevant accreditations. In addition, the laboratories at NUST and UNAM may also gain accreditation from IBI and EBC. Public universities often lack sufficient resources to allocate funds for accreditation, whereas private laboratories prioritise quick market entry, especially when profits are involved. For instance, AnaLab is already performing analyses of biomass. Biochar services could become part of the offerings if there is demand in the market. Private and public laboratories need training that emphasises establishing a robust quality assurance and management system. In general, this involves developing standard operating procedures (SOPs) and providing training to staff members, allowing them to operate devices correctly and understand the specific parameters for analysis. In addition, accreditation will also require the successful analysis of biochar samples and the participation of ring trials.

Table 20: Actors and responsibilities – laboratory accreditation

Actors	Responsibility
Facilitator	Collaborate with established private-sector and university laboratories, to assess their current capacity for the analysis of biochar samples, and map these against accreditation requirements of IBI and EBC.
Academia	Private-sector and university laboratories to build capacity and gain IBI/EBC accreditation. This includes the development of assurance and management systems that meet EBC/IBI requirements, development of SOPs, training of staff with devices.

[30] The results of the study are unpublished as of the time of writing.

4.2.2.3. Suitability of feedstock standards

Potential impact: | Ease of addressing:

Stakeholders have raised concerns that biomass from encroacher bush (as opposed to invasive species) is not listed as sustainable feedstock by the relevant carbon standards, thereby potentially limiting the credibility of BCR projects. Carbon standards have defined ecological safeguards, to ensure that the project activities, including biomass sourcing, does not lead to degradation, especially decrease of forest carbon pools. A detailed list of feedstock categories and subsequent environmental safeguard requirements can be found in VM0044, where encroacher bush would fall under 'forestry and other wood processing'. The respective safeguards reference to the existence of either 'proof of sustainable use' include sustainable management plans approved by a relevant state or regional authority or the FSC. Documents for both requirements can be found, qualifying encroacher bush as a suitable feedstock for BCR.[31] However, Puro.earth's biochar methodology might not permit encroacher bush based on their invasive species definition.[32] See below for quotes from the respective guidance of Puro.earth, Verra, and Carbon Standards International (CSI) on the suitability of feedstock.

Table 21: Position of standards on suitability of feedstock

Standard	Position on suitability of feedstock
Verra	*'Material from pruning or thinning of woody vegetation (not including merchantable timber) such as shade trees, orchards, windbreaks, stream buffers, silvopasture, or *invasive removal on rangeland*'* (Verra, 2023).
Puro.earth	*'Use of invasive species, meaning plants that are not native to the region of activity and are causing environmental harm, are eligible biomass for biochar activity when following requirements are met: i) the species to be cleared are recognised by an appropriate state or national authorities'* (Puro.earth, 2022).
CSI	*'It is not permitted to use forest biomass and to slash forest wood. The only exceptions are residues from sustainable and, as such certified forest management.'*[33]

[31] FSC(2019). The FSC National Forest Stewardship Standard for the Republic of Namibia. https://connect.fsc.org/document-centre/documents/resource/418

[32] Use of invasive species, meaning plants that are not native to the region of activity and are causing environmental harm, are eligible biomass for biochar activity when following requirements are met: i) the species to be cleared are recognised by an appropriate state or national authorities'

[33] In communication with the authors, CSI acknowledges the Namibian case but emphasises the need for a review to be conducted once a project is registered.

It should be noted that PyroNam has successfully generated carbon credits under the EBC C-Sink standard, which is housed under CSI. This indicates that the suitability of feedstock is not an issue of major concern.

Recommended actions

9 Clarify Puro.earth's revision of permitted feedstock

The definition of Puro.earth includes invasive species that are non-native to a particular environment. This definition might exclude encroacher bush in Namibia, since not all types of bush are non-native to the region. When engaging with the standard, the facilitator should ensure to document and explain Namibia's particular situation and point the eligibility of feedstock under Verra's methodology.

Table 22: Actors and responsibilities – Puro.earth

Actors	Responsibility
Facilitator	Contact representative of Puro.earth to discuss a revision of the standards with regard to the eligible feedstock definition.

4.2.3 Economic and market-related aspects

4.2.3.1 Biochar demand

Potential impact:  Ease of addressing: 

Given the limited evidence of the benefits of biochar application in the dryland soils, there is currently no commercial demand for biochar as a product. The uncertainty surrounding the impact of biochar application on soils greatly limits farmers' willingness to invest in biochar as a soil enhancer. In the absence of clear evidence demonstrating the positive benefits of biochar, farmers are most likely to hesitate to allocate resources towards purchasing and utilising biochar. While this might complicate the initial implementation of biochar projects, reliable scaling and investment to scale BCR in Namibia to the necessary scale is certainly challenged as project developers need to create incentives for farmers to apply biochar into their soils. Such incentives could, for example, include offering free bush-thinning services, in exchange for biochar application, noting that viable business models for such services are yet to be developed.

The limited demand for biochar in Namibia can be attributed, in part, to a lack of diversification in its applications beyond its use as a soil enhancement agent. To address this issue, it would be crucial to expand its uses within Namibia, leveraging it as a local solution to address some of Namibia's land-based local challenges. For instance, one promising avenue of exploration lies in harnessing the water retention properties of biochar. This could be beneficial in areas like tourism or in sports facilities (e.g. sports fields and golf courses), where there is significant water consumption, as well as in

irrigation agriculture in the context of Namibia's Green Scheme policy.[34] Furthermore, exploring additional applications for biochar within the construction industry, specifically in cement production, could be promising. This aligns with Namibia's existing infrastructure, as there is already a bush biomass fired cement plant in operation, i.e. Ohorongo Cement. By pursuing innovative uses of biochar and ensuring that the material remains within Namibia, local challenges can be addressed while opening up the local market for biochar.

In addition, the absence of a biochar market and transparent pricing prohibits the formulation of a business case for biochar projects, and thereby makes them fully reliant on the often volatile international carbon market prices. An important factor in this regard is that ongoing biochar pilot projects in Namibia are considering the free distribution for biochar. This bears the risk of potentially creating the lasting expectation among farmers that biochar has been offered free of charge, possibly impeding the introduction of a cost for biochar at a later stage.

To address this challenge, it will be important to raise awareness among potential future off-takers, including farmers, as to the benefits of biochar application. This should be supported by the evidence produced through the local biochar pilot projects discussed earlier. Furthermore, it is important to enhance awareness regarding the potential applications of biochar beyond the agricultural sector, including areas such as cement production, construction material development and animal fodder utilisation, among others. However, at the moment the draft Article 6 strategy which is being developed in Namibia only allows soil application projects for international carbon trading.

Recommended actions

10 Explore additional use cases beyond soil applications to develop products meeting local demand

Exploring additional applications beyond soil applications needs particular focus on sectors such as Namibia's construction and road infrastructure. A major challenge stems from the lack of understanding about the possible applications of biochar. Therefore, conducting a comprehensive assessment of additional use cases and evaluating their potential for Namibia is crucial. There are already certain developments in this regard, such as the use of biochar in cement production or the addition of biochar to animal feed as undertaken by certain farmers. The diversification of use cases creates a robust revenue foundation for biochar that extends beyond carbon revenues and fosters the development of comprehensive and diverse value chains. To support potential future biochar users in Namibia, it's crucial to determine which types of biochar can be utilised. This focus will support sectors that might become significant biochar consumers down the line. Figure 6 gives an overview of potential applications of biochar that can serve as a starting point for an in-depth investigation of Namibia-specific use cases.

[34] The Namibia Green Scheme Policy is a national policy that aims to create a financially sustainable irrigation sector. Biochar could be utilised to support cost-efficient irrigation methods in line with this policy.

Figure 6: Sample use cases of biochar

Source: South Pole (2023) based on EBI (2023)

The question of what biochar can be used for in Namibia needs to be answered to focus on supporting those sectors that may become the more important biochar off-takers in future.

Table 23: Actors and responsibilities – additional use cases

Actors	Responsibility
Facilitator	• Coordinate efforts to studies into a range of use cases of biochar that are applicable in the Namibian context. • Establish a biochar processing value chain and subsequent retail market to consolidate the biochar material market. • Mature and differentiate distinctive products that meet local demand, favouring livestock and small-scale agriculture farming.
Academia	Support efforts to explore additional use cases by conducting research into various properties of biochar and how this may be applied to different settings.

4.2.3.2 Biochar supply and business case uncertainty

Potential impact: Ease of addressing:

The biochar industry encounters challenges regarding the demand for biochar as both a product and a carbon credit. This creates substantial uncertainty for potential producers, especially regarding the viability of such business undertakings. In the absence of markets for biochar products, producers in Namibia are likely to rely primarily on revenue generated from carbon credit sales, making them vulnerable to fluctuations in the international carbon markets. This uncertainty poses a major barrier for investment in the sector and the subsequent scaling of operations. Furthermore, this factor is likely to reduce the overall appeal of biochar production to potential producers, particularly when compared to the already firmly established charcoal production industry in the country. Designing a commercial model to access the VCM through a selected carbon asset development partner can help to find an effective balance between reliability and higher carbon revenues.

Producers tend to prioritise the carbon-intensive charcoal business, without building experience and expertise in biochar production. From a local perspective, farmers are likely to hesitate to adopt biochar production, mainly due to its higher workload and cost compared to traditional charcoal. Convincing farmers to engage in biochar production requires that the long-term benefits are highlighted, and the producer's immediate concerns are addressed. Moreover, given the lack of a clear business case, biochar standards and application requirements, producers will likely not meet the quality requirements without external support. Yet, such experience is crucial to gain a better understanding of the techno-economic requirements necessary to establish reliable biochar production capacities. This leads to a cycle where charcoal remains the primary focus, while the development of biochar is impeded. To address this challenge, it is necessary to develop a detailed technical and economic study analysing implications of switching from charcoal production to biochar production or vice-versa.

Additionally, industrial biochar production requires high upfront investments and it may be challenging to secure this financing given the volatility of the carbon market prices. While this problem is typical for many biochar projects, it is more acute in Namibia, since additional revenue streams, resulting from the use of byproducts of the biochar productions (e.g. residual heat) or the use of biochar in industry, are less relevant in Namibia. This increases the reliance of biochar business cases on revenues from carbon credit sales, which remain volatile and uncertain for the foreseeable future. To address this, it would be necessary to further analyse the possibility of incorporating any additional revenue streams in the biochar business model, where possible capturing the value of created co-benefits (e.g. bush-thinning charges).

Artisanal production units, often referred to as 'Kon-Tiki kilns', might come at lower prices (< USD 1,000). However, the compliance with established carbon methodologies is often missing (Puro.earth[35]) or leads to reduced carbon credits generation due to the CH4-emissions during the production process (VM0044[36]). Also, the CSI artisanal biochar standard demands the integration of a

[35] Puro.earth's methodology states that 'in the biochar production process, the pyrolysis gases must be combusted or recovered through an engineered process that either negates or makes negligible any methane emissions to the atmosphere', which most kilns cannot guarantee.
[36] VM0044 allows for projects that emit CH_4 during the production but requires a deduction of occurring emissions, which can range from 0.049 tCH_4 to 1.37 tCO_2e per t biochar.

combustion mechanism for pyrolysis gases, which is often missing in current charcoal kilns. Therefore, it is recommended to focus on industrial facilities that can ensure environmental and economic integrity, an aspect frequently appreciated by capital investors and secure reliable demand and offtake of the BCR credits. Please see Box 16 for more information on differences between different installations.

Box 16: Different biochar production installations

Currently, there are two distinct approaches present in Namibia to produce biochar. First, within the widespread charcoal production sector, producers are exploring the use of locally manufactured Kon-Tiki kilns to process the finer offcuts from the harvesting of bush biomass, as this feedstock is less suitable for the established bush-to-charcoal value chain. Kon-Tiki kilns are open burning installations which, if correctly operated, allow for high production temperatures and reduced GHG emissions. While producers using Kon-Tikis mostly operate in a highly decentralised manner, a second and more technologically advanced but centralised production system is currently being piloted by other businesses. The technology employed by such operators is characterised by a semi-continuous production process with higher mechanisation that also allows for a more controlled production system. In particular, the ability to document production temperature, as well as the combustion of pyrolysis gases, are key aspects for the development of a climate action project.

(Source: South Pole, 2023)

Recommended actions

11 Create investment cases for BCR projects

BCR projects must establish their financial viability, and revenue that is generated from the sale of carbon credits can serve as a risk-mitigation strategy by diversifying income streams.

Table 24: Actors and responsibilities – investment

Actors	Responsibility
Aggregator	Prepare the business case, coordinate producer involvement and implement de-risking and risk management strategies to ensure that finance arrives to farmers.
Facilitator	• Facilitate the projection of demand through offtake agreements with local demand sources, such as cement producers and retailers, to secure a consistent demand for biochar as a material product. • Initiate conversations with farmers to determine their readiness for production and assess potential quantities. • Facilitate communication and transactions between producers and consumers by serving as an intermediary.
Carbon project developer	Engage in discussions with potential biochar off-takers to explore their interest in acquiring the resulting removal credits.

4.2.4 Capacity

4.2.4.1 Technical expertise among actors in the sector

Potential impact: Ease of addressing:

Given that biochar production and applications are a relatively recent development and is just starting to get piloted in Namibia, technical expertise with regards to biochar production and application is mostly lacking. On the production side, potential project developers would need to understand the technical requirements and characteristics of the biochar production process, including: the types of eligible installations and machinery; trusted brands; availability and reliability of biochar pyrolysis technologies; technical properties; scalability; and production costs, among others. At the moment, there still exists confusion in the sector as to when a product is actually classified as biochar and which technical and quality requirements have to be met for specific applications (e.g. as animal feed and for industrial application). Today, practical experience in Namibia primarily revolves around charcoal production, using charcoal kilns and retorts. While there are similarities between the production of charcoal and biochar in decentralised artisanal production systems, future biochar producers will have to be trained, in compliance with the methodology's requirements.[37] Further, where top-lit updraft gasifiers (also known as TLUDs) are supposed to be used under the Artisanal C-Sink methodology, these need to be confirmed to be eligible on a case-by-case level through the respective auditors. However, there is limited experience in operating larger facilities capable of producing biochar with consistent quality and adhering to the environmental criteria set by the relevant carbon standards. This situation is further complicated by the uncertainty surrounding material demand. The properties of biochar and its subsequent effects on soils and the

[37] The artisanal methodology requires that 'the Artisan Biochar Producer received a qualified training in the craft of biochar production and succeeded in a final examen'.

ecosystem are heavily influenced by the production methods employed. To establish the necessary capabilities for operating larger machines to meet the demands of the Namibian market, it is important to define and characterise the specific demand requirements. Additionally, it is essential to develop national expertise in the diverse applications of biochar within horticultural and agronomic contexts.

Additional capacity building and knowledge-sharing events would need to address this capacity gap. The language used in awareness and training materials used to promote biochar must be understandable by those who are most likely to produce biochar, which implies that it must be tailored towards farmers (including farm staff). While some initiatives, including this project that was funded by GIZ, are already looking to address it, more effort on this front will be needed, in particular once clear implementation examples are available on the ground.

Recommended actions

12 Develop technology guidance

To develop guidance on suitable and applicable technologies, small- and large-scale applications need to be included, as well as the associated training materials. CAoN already offers biochar training sessions and such efforts can be upscaled further. The training is of particular importance for small-scale producers, who need to ensure that their kiln operations follow the guidelines for developing biochar that meets material specifications. The training materials must include detailed instructions on biochar production methods, emphasising the significance of quenching (using water) and the specific temperature requirements for different quality grades, along with the techniques to attain them.

Table 25: Actors and responsibilities – technology

Actors	Responsibility
Aggregator	• Develop technology guidance on different types of kilns. • Develop training materials to inform on production method (temperature, effect of temperature on biochar properties, importance of quenching, activation with nutrients if applicable).
Facilitator	

13 Establish national regulatory framework

A national regulatory framework for biochar production and product quality assurance, along with product registration for specific purposes (e.g. under the fertiliser, Farm Feeds, Agricultural Remedies Act, or FAN Meat Standard), should be established to increase local demand and enhance the possibilities for product export. In addition, biochar certification, for example via the FSC or similar entity, should be pursued. This may be initiated as early as 2024, when the Namibian FSC standard will be revised, thus offering an incentive to prepare for and pursue such certification soonest.

Table 25: Actors and responsibilities – national regulatory framework

Actors	Responsibility
Facilitator	• Develop a national framework for production that outlines the different methods and their relation with corresponding biochar quality grades. • Collaborate with pertinent organisations and governmental bodies to secure approval for various types of biochar, as stipulated in the framework, for their designated purposes.
Group Manager	Group Manager to develop training based on facilitator's knowledge to disseminate to farmers.
Government	Authorise the use of biochar products for regulated applications, e.g. as a supplement in animal feeds.

4.2.4.2 Lack of carbon market understanding

Potential impact: Ease of addressing:

To date, Namibia has witnessed very limited carbon market activities, and none of the existing projects are trading carbon credits internationally. In addition, there is a significant lack of awareness relating to the potentials of carbon market participation. This lack of awareness and experience may deter individuals from initiating activities, ultimately resulting in missed opportunities for new business opportunities and emissions reductions. In addition, a lack of understanding may create unrealistic expectations of the volumes of finance that carbon markets may bring. This situation, however, is improving with a number of capacity-building initiatives taking place, such as those undertaken by UNDP.

As for the potential biochar projects, it would be important to make sure awareness is raised among stakeholders that have potential to produce biochar (e.g. companies currently involved in charcoal production and other biomass-related activities), and well as other actors in the related value chains (e.g. farmers looking for ways to fight the encroacher bush in their territories). Targeted workshops for potential biochar producers have constituted an integral part of this consultancy project, and lay an important foundation for the further development of Namibia's fledgling biochar sector, noting however that these efforts would need to be continued well-beyond the scope of the current project.

Recommended actions

14 Enhance local knowledge on international carbon markets

To date, of the appreciation of the opportunities offered by international carbon markets remains limited in Namibia. This should be addressed, for example by ensuring that future carbon market capacity initiatives involve biochar producers. In addition, a dedicated carbon market education programme and/or a centralised information hub specific to Namibia can be established.

Table 26: Actors and responsibilities – local knowledge

Actor	Responsibility
Facilitator	Build easily understandable carbon market information repository for potential biochar producers

4.2.4.3 Lack of MRV governance and capacity

Potential impact: Ease of addressing:

There is a noticeable lack of capacity with regards to MRV processes, which exists both on the level of project development, the VCM space, as well as in government. Carbon projects need MRV capacities for two reasons.

1. Monitor project implementation: projects need to collect data, such as data on biochar production volumes or amount of biochar used in soil application, as per the requirements of the selected standard
2. Verify and validate: validation and verification bodies (VVB) audit the project to verify if the project is implemented according to the guidelines of the standards. Only then can credits be generated.

While MRV capacities for carbon projects might already exist within several private-sector companies, not all entities interested in setting up carbon projects can produce the required level of detail. In addition, if a group manager is implementing a carbon project with several producers of biochar, a significant amount of resources will be required for the monitoring. With regards to carbon crediting in the VCM, verification and validation of removals are a key requirement and must be provided by an eligible third party, a so-called 'VVB'. At present, VVBs are not based in Namibia, meaning that overseas verifiers will have to be used. While this is not an insurmountable barrier, this aspect may increase the transaction costs for project developers.

Regarding the level of government, BCR projects developed under Article 6 necessitate both knowledge and capacity within the respective public institutions, mainly within the MEFT and Namibia's Designated National Authority, which is not yet fully operational. Further, it still remains uncertain who will establish national rules and regulators for a national MRV framework that will guide public/governmental climate action projects. Such a system should track the projects implemented under the NDC, along with the achieved results, which then are reported in biennial transparency reports. Such monitoring is necessary in order to ensure that Namibia meets the objectives of its NDC.

This capacity gap can be addressed by involving international experts, individuals and organisations from neighbouring countries where carbon market activities are developed further. In the short term, and until national carbon market activities accelerate in Namibia, using this approach appears suitable, after which national capacity would need to be built. Additionally, private-sector project

developers that establish climate projects with potential for commercialisation will bring their own expertise, thereby assisting the establishment and strengthening of local capacity in Namibia.

Recommended actions

15 Explore providers of monitoring solutions and VVBs

The implementing entity of a carbon project needs to collect data, including: the volume of biochar produced; where the feedstock comes from; or where and how much ultimately the biochar is applied. To ease the resource burden of the data collection, interested parties should consider interacting with providers of such monitoring solutions.

For a project to generate credits on the voluntary carbon market, an independent third party, a VVB, needs to verify and validate the removals. The VVB checks if a project works in accordance with project design documents and requirements of the standards. At present, such parties have to be flown in from abroad, thereby increasing transaction costs.

Table 27: Actors and responsibilities – monitoring

Actor	Responsibility
Group Manager	Explore and engage with suitably experienced providers of monitoring solutions. These may include, for example, entities such as Carbonfuture, Planboo, or other providers.

16 Build Article 6 infrastructure

In the Paris Agreement, countries need to comply with reporting and accounting requirements set out under Article 6 and the Enhanced Transparency Framework under the Agreement. This requires:

- know-how of the Paris accounting requirements in the relevant ministries;
- registry infrastructure to undertake corresponding adjustments;
- technical competencies to harmonise MRV requirements at a project level with those set by MRV at the national level, for reporting in like terms.

In the context of Article 6, MEFT and Namibia's Designated National Authority for Article 6.4 need to build knowledge and capacity on MRV processes.

Table 28: Actors and responsibilities – Article 6 infrastructure

Actors	Responsibility
Government	• Participate in Article 6 infrastructure and institutional readiness programmes (e.g. as offered by UN organisations), to kickstart national processes on setting up these structures for Article 6 participation. • Using a pilot project, test how removals from biochar can be integrated in Namibia's NDC reporting, for cases when the resulting credits are converted to ITMOs and hence will be subject to corresponding adjustment.

4.3 Gaps, barriers and recommended actions: conclusions

The present analysis has focused on a national enabling environment to define and analyse a set of gaps and barriers that are likely limiting the development, or are preventing the scaling, of the biochar industry in Namibia. The current focus is to raise awareness and thereby incentivise producers, end users and diverse stakeholders in the creation of a coordinated biochar strategy. This goal is underpinned by the willingness of charcoal producers to explore biochar, as well as the upcoming 2024 review of FSC standards, which may result in the inclusion of biochar.

The identified barriers impact the biochar industry at different scales. It will therefore be important to address such barriers to provide opportunities and steer industry to initiate the next steps towards a more comprehensive production and use of biochar in Namibia. An overview of the identified barriers and their ease of addressing is provided in Figure 7 (below).

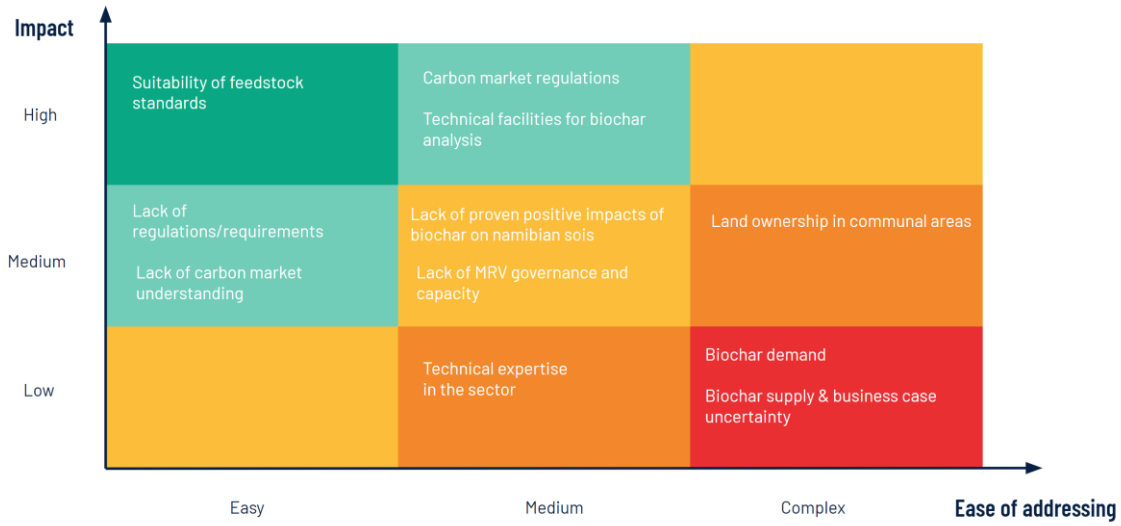


Figure 7: Overview of barriers according to impact and their ease of addressing

Source: South Pole (2023)

The most important barriers, as summarised in Table 29 (overleaf), include creating a market demand for biochar in Namibia, which in turn will help address the challenges associated with the uncertainties of business cases. Lack of sectoral governance, which could be addressed by establishing a national biochar coordinating and governing body, will also be important. In addition, building the technical capacity on biochar production and application among the Namibian stakeholders, will be critically important too.

Table 29: Barriers and gaps with high potential impact

Barrier/gap	Ease of addressing	Key considerations to address
Biochar demand		The uncertainty surrounding the impact of biochar application on soils greatly limits farmers' willingness to invest in biochar as a soil enhancement. Lack of domestic demand makes projects fully reliant on often-volatile, international carbon market prices.
Biochar supply and business case uncertainty		Biochar production requires high upfront investments, for which it may be challenging to secure financing. Lack of demand and volatile carbon credit prices place additional uncertainties on the business case for biochar projects.
Technical expertise among actors in the sector		The lack of technical expertise with regards to biochar production and application prevents the creation of larger facilities capable of producing biochar at consistent quality and adhering to the environmental criteria as are required by the relevant carbon standards.

Source: South Pole (2023)

The barriers and gaps assessed as having a medium level of impact, while not preventing the development of the biochar industry, can impact the speed of its development and the market size, and are therefore important to address. These include: the project development limitations associated with land ownership; lack of Namibia-specific evidence of positive biochar impacts; and regulations related to the carbon markets and post-harvesting activities, among others (see Table 30).

Table 30: **Medium potential impact barriers and gaps**

Barrier/gap	Ease of addressing	Key considerations to address
Land ownership in communal areas		Current land ownership stipulations prevent commercial investments in bush biomass production in communal areas. In addition, carbon credits generated by projects on communal lands would be owned by the Government of Namibia, which may limit the potential for a fair sharing of benefits with those persons in communal areas who generated such credits through their projects.
Lack of proven positive impacts of biochar on Namibian soils		In the absence of clear evidence, farmers will most likely not be willing to apply biochar to soils and bear the respective costs, which is a requirement to generate carbon credits.
Lack of MRV governance and capacity		There is currently no local technical capacity to provide validation and verification services for carbon projects.
Carbon market regulations		The draft national Article 6 framework developed by the UNDP creates uncertainty with respect to the government's involvement and the long-term eligibility of private-sector biochar activities.
Lack of regulations/requirements on post-harvesting activities		Lack of requirements on post-harvesting soil management poses a challenge to the sustainable and enduring restoration of savannah rangelands.
Lack of carbon market understanding		Lack of understanding of carbon markets may prevent seizing finance opportunities or create disproportionate and unrealistic expectations about potential benefits.

Source: South Pole (2023)

The remaining barriers (see Table 31) are likely to have limited impacts on the biochar industry, hence addressing them could be considered at a later stage. These include the development of

technical facilities for the laboratory analysis of biochar, which are expensive to develop. However, they are expected to emerge in step with an increasing local demand for biochar certification and the emergence of growth of the biochar sector.

Table 31: **Low potential impact barriers**

Barrier/gap	Ease of addressing	Key considerations to address
Technical facilities for biochar analysis		Sending biochar samples overseas due to lack of facilities in the country increases costs.
Suitability of feedstock standards		No actions necessary. Carbon standards have defined ecological safeguards to ensure that the project activities, including biomass sourcing, does not lead to degradation, especially decrease of forest carbon pools.

Source: South Pole (2023)

A significant obstacle to scaling biochar production is the limited local demand, primarily attributed to inadequate awareness of the diverse range of biochar applications and the absence of supporting evidence. The key barrier to establishing a biomass value chain focused on biochar production that is able to meet the triple bottom line of business, people and the planet, is to ensure that biochar material is used and therefore demanded in Namibia.

As stipulated above, current markets for ecosystem services do not yet seem to provide sufficient revenues to support a scalable business case for producers. The absence of a coordinated value chain, especially material retailers that engage and inform end users, is considered another major barrier. Therefore, it is crucial to acquire comprehensive knowledge regarding all potential applications of biochar in Namibia. This will enable the creation of additional revenue sources that are not solely dependent on the sale of carbon credits. Stakeholder consultations and workshop participation have highlighted the existing gap in awareness regarding the diverse range of potential biochar applications in the country.

As the biochar industry is at the very beginning of its development in Namibia, the analysis has shown that many of the key actions are likely to benefit if supported by a national coordinating and governing body. To support the development of the biochar sector in Namibia, including addressing the gaps and barriers outlined in this assessment, it would be necessary to establish an organisation responsible for the overall coordination, support and development of the sector, as well as for sector-wide governance. Alternatively, an existing organisation could be vested with such a mandate. The responsibilities of this governing body would include providing coordination of the implementation of the biochar pilot projects in Namibia, supporting raising technical capacity and awareness and helping deliver organised and coordinated action among biochar-related stakeholders. The research,

stakeholder consultations and workshops undertaken under the present project made it clear that the organisations most suited to assume this role are N-BIG and CAoN. This report does not aim to favour any specific organisation, as both options have their respective advantages, and a definitive conclusion is not provided. N-BIG may be well positioned to further explore additional use cases that potentially lead to new revenue streams. CAoN is well connected to farmers and charcoal producers who might decide to invest in biochar production once they become convinced of its viability. What is needed is an entity that can be committed long-term to this sector and its development, which implies that a suitable entity must have sound capacities to finance and sustain such activities. Considering these factors, it is entirely conceivable that the two organisations collaborate together in this leading body, since they broadly share the same objectives.

N-BIG, CAoN, or another governing body comprised of both could become the sectoral focal point in future. Such an entity could support the dialogue with other industrial bodies as well as the government, spearhead efforts to create a national biochar strategy, as well as approach relevant government stakeholders in creating the opportunities for communal lands to establish biochar operations that can attract carbon finance. Examining comparable structures from other regions, such as the IBI, USBI, European Biochar Initiative (EBI) and the Australia New Zealand Biochar Industry Group (ANZBIG) underscores the necessity for a respective Namibian-based organisation to provide, guide and consult Namibian stakeholders from the public and private sector on:

A. Biochar production technology, including both small-scale and larger industrialised units, respective manufacturers, prices and how to operate these;
B. Biochar product guidance to ensure that a Namibian biochar market emerges, working with biochar producers as well as off-takers;
C. guidance on business model development, including both material, heat and carbon revenues;
D. Catalysing the emergence of an enabling socioeconomic environment with the respective stakeholders from the private sector (i.e. investors) as well as policy makers to address identified barriers; and
E. Collaboration and dialogues on the above issues.

In conclusion, the present analysis has delved into the complexities of the establishment of a biochar industry in Namibia, identifying critical barriers that hinder its growth and scalability. The focus has been on creating a national perspective to address the challenges faced by the industry. A central goal for the way forward is to raise awareness of government officials, as well as among prospective producers, end users and other stakeholders, to foster a coordinated biochar strategy. It will be key to investigate the different ways that biochar can be utilised within Namibia to ensure a diversified revenue base for the biochar-based business models. Given that the biomass sector in Namibia is already strengthened and holds a diverse set of capacities, it holds potential to contribute to a carbon dioxide removal economy, assuming that the necessary institutional arrangements are established.

5 Potential business model

The aim of this study is to promote the emergence of a biochar sector in Namibia, which could yield social and environmental advantages for the country and the global community. The purpose of this chapter is to offer a perspective on what kind of projects seem feasible. To this end, it introduces financial considerations through a business case tool, which allows prospective biochar producers to run the numbers themselves, and assess whether taking up biochar production would be viable. In addition, this chapter provides prospective biochar producers with some practical guidance on establishing their own BCR projects, by outlining the process to set up a BCR project.

The analysis of the gaps and barriers present in the biomass sectors indicates that a key barrier to a scaling of biochar production lies in the lack of demand for biochar as a material product. As a result of the lack of demonstrated impact of biochar on the productivity of soils, there is little to no demand for farmers to use biochar as a soil enhancer, and to replace the use of conventional chemical fertilisers. Also, there is a general lack of awareness of what the potential uses of biochar could be in that the development of these value chains will require a significant amount of time. This implies that the business case for venturing into biochar without there being a substantial market with significant revenue expectations remains small, and as a result, farmers tend to opt for more practical and well-established alternative uses of bush biomass, including the production of charcoal, animal fodder from encroacher bush, locally referred to as *boskos*, as well as wood chips.

While the lack of demand for biochar is a key factor, the use of biochar is a central aspect of creating a viable business model for biochar production. There are two main reasons for this. Firstly, existing carbon crediting methods necessitate biochar applications in soils**,** either by integrating it into soil or utilising it in non-soil applications with long-term permanence. Secondly, following this requirement, the application of biochar presents an opportunity to monetise additional revenue streams.[38] The approach of a diversified business model, relying both on the sales of carbon revenues and the sales of biochar material, is crucial, as it shields producers from significant price fluctuations in the carbon market, which simultaneously mitigates uncertainty. This strategy not only ensures stable production but also allows scaled biochar production to become a driving force for sustainable development in the country. By tapping into the international carbon market, the revenue generated can be channelled to support the growth of local value chains. This approach establishes a non-extractive business sector that aims to retain the material within the country.

There are two predominant business models in biochar production, each aligned with specific technological options. One approach involves the use of high-tech facilities, which employ semi-continuous production processes characterised by advanced mechanisation. Such technology enables a more precise control over production variables such as temperature and the combustion of pyrolysis gases. These factors are crucial in the context of a BCR project, especially when accounting for GHG crediting. The feedstock should be obtained from the nearby region, since sourcing materials in proximity is preferable due to reduced emissions and lower transport costs. On the other hand, there are Kon-Tiki kilns, which can be operated in a highly decentralised manner. To achieve the required scale for a viable BCR project, multiple kiln operators would be needed. Unlike high-tech facilities, Kon-Tiki kilns emphasise a distributed operational model, whereby local operators collectively achieve the necessary scale of production.

[38] Permanence refers to the duration the carbon is stored safely out of the atmosphere.

The study's main finding is that for biochar production to be economically viable, it needs multiple sources of revenue. This means that a reliance on carbon credits alone is not sufficient to create a sustainable business model.

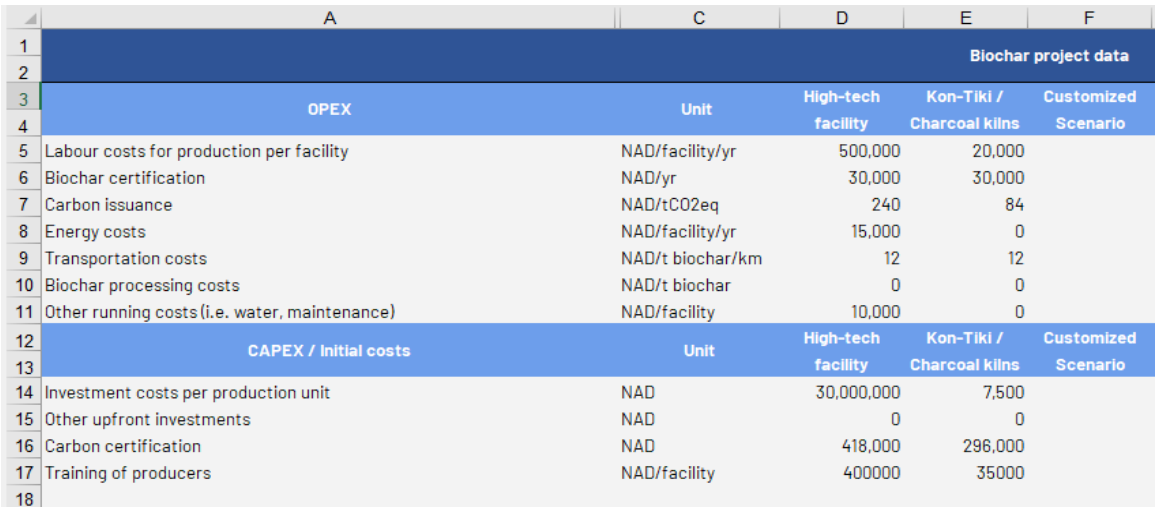
The following sections introduce the business model tool that was developed under the project. The tool enables potential biochar producers to conduct a cost-benefit analysis, experiment with different numerical parameters, and understand the financial implications and requirements of a potential venture into biochar production. A subsequent section provides guidance on how a carbon project could be set up. The following section offers instructions on establishing a carbon project, outlining the initial steps for potential producers to take in order to integrate carbon revenue into their business models.

5.1 Financial considerations and business model tool

Establishing a new business operation includes uncertainties and requires a thorough financial assessment and planning of the operations. A business case simulation tool has been developed to aid decision makers in the biochar sector. This tool, conceived as an Excel-based workbook, helps them comprehend the implications of project design and assess the actual costs and benefits. The focus of this tool is on biochar production as the primary business activity. It is designed for prospective producers interested in establishing a biochar production system, which processes biomass from external sources and sells biochar, along with byproducts like BCR credits or energy. This tool is not designed to provide a thorough feasibility assessment but aims to provide high-level estimates to guide investment and business cases.

The Excel-based workbook enables biochar producers to simulate different project design options and provides price estimates for key factors influencing investment and operational costs. The primary factor influencing project costs and benefits is the quantity of biochar produced in each operational year. By considering this information along with additional factors like production capacity per facility and necessary staff, both initial (capital) and ongoing (operational) costs are calculated. Additionally, revenue options which depend on biochar output are determined, based on the input parameters provided.

Figure 8: Screenshot of the Excel-based workbook



	A	C	D	E	F
1					Biochar project data
2					
3	OPEX	Unit	High-tech facility	Kon-Tiki / Charcoal kilns	Customized Scenario
4					
5	Labour costs for production per facility	NAD/facility/yr	500,000	20,000	
6	Biochar certification	NAD/yr	30,000	30,000	
7	Carbon issuance	NAD/tCO2eq	240	84	
8	Energy costs	NAD/facility/yr	15,000	0	
9	Transportation costs	NAD/t biochar/km	12	12	
10	Biochar processing costs	NAD/t biochar	0	0	
11	Other running costs (i.e. water, maintenance)	NAD/facility	10,000	0	
12	CAPEX / Initial costs	Unit	High-tech facility	Kon-Tiki / Charcoal kilns	Customized Scenario
13					
14	Investment costs per production unit	NAD	30,000,000	7,500	
15	Other upfront investments	NAD	0	0	
16	Carbon certification	NAD	418,000	296,000	
17	Training of producers	NAD/facility	400000	35000	
18					

Source: South Pole (2023)

The critical decision to be made in the context of the cost-benefit analysis (CBA) involves choosing between two options: a decentralised, kiln-based operation, or a centralised pyrolysis plant using (semi-) continuous production systems. It is important to note that the certification pathways for the latter option offer higher carbon credit prices but also involve more complex MRV requirements, as detailed in Annex III. This choice will significantly impact the factors considered in the subsequent CBA.

The business case tool requires the specification of a number of parameters that users can chose from. For clarity, these parameters are further described in Table 32 (investment costs), Table 33 (operational costs), and Table 34 (revenue streams) below.

Table 32: Investment costs

Parameter	Description	Main driver
Investment costs per facility	Purchase costs per production facility (either per kiln or larger facility) and required number	Depends on production capacity per facility and envisioned production volume
Other upfront investments	This parameter is a placeholder for any secondary investments, such as the provision of water infrastructure, electricity supply and others.	Independent from number of facilities, as it assumes an initial investment
Training of producers	Costs related to training operating staff per facility to ensure operational capacity as well as compliance with standards	Depends on the number of facilities operated
Carbon programme registration	Costs to open a registry account under carbon standards as well as develop and validate project documentation as per	Can be absorbed by i) a carbon asset

	standard regulation	developer, which provides this as a service and recovers costs as % of BCR sales revenue, or ii) through operator's staff, which assumes absolute costs for registration to be born

Source: South Pole (2023)

Table 33: Operating costs

Parameter	Description	Main driver
Biochar processing costs	Costs for processing biochar for determined end use, i.e. charging with nutrients, or addition to cement production process	Amount of biochar produced multiplied by indicated processing costs
Other running costs	Placeholder for further annual operational costs per facility (i.e. to meet the cost of water purchases, maintenance costs, and others)	Depends on the number of facilities that are to be operated
Labour costs	Wages to plant operators, either on a per kiln basis, or for the operations of a larger plant. In the latter case, all costs related to staff are to be added and used.	Depends on number of facilities operated
Feedstock costs	Cost to acquire one tonne of feasible bush biomass feedstock of required quality and characteristics, incl. necessary documentation from suppliers as well as the transport to the site where such feedstock is to be converted to biochar	Differs between mechanised or manual harvesting suppliers.
Biochar certification	Costs to ensure that biochar is tested on an annual basis, to determine quality and raise buyers interest (CSI accredited laboratories)	Lump sum
Energy costs	Cost of external energy used at the production facility	Depends on number of facilities operated, and price per MWh
Transportation costs	Cost to transport produced biochar to customers (biomass transportation costs are covered under *Feedstock costs*)	Depends on produced biochar and predefined average transportation distance
Carbon issuance (ongoing)	Costs to monitor, report and verify carbon credits as well as cover issuance under registry	Can be absorbed by i) a carbon asset developer, which provides this as a service and recovers costs as % of BCR sales revenue, or ii) through operator's staff, which assumes absolute costs for registration to be born

Source: South Pole (2023)

Table 34: Revenue streams

Parameter	Description	Main driver
Biochar material	Revenues for biochar that is sold to customers, either end users or processors	Application context is important as applications in communal lands might not offer commercial value for producers
BCR sales	Revenues from selling carbon credits	Depends on production system and related BCR certification with the assumption that non-ICROA carbon standards (CSI) need to apply a defined discount compared to Puro.earth price benchmark
Energy	Revenues from selling generated energy to customers, which might only be viable for larger high-tech facilities	Defined energy output and respective tariff indication

Source: South Pole (2023)

The business model tool empowers potential biochar producers to assess the feasibility of their biochar production facility on their own terms. Various factors influencing viability can change over time. For example, carbon removal credit prices might increase to a level where the operation can sustain itself solely through the sale of carbon credits. Additionally, new applications may merge, creating a stable market and increasing revenue from biochar material sales steadily. Users can adapt the parameters in the tool to reflect such changing parameters, based on current or anticipated situations and enhance it by incorporating new factors as needed.[39]

5.2 BCR project setup guidance

Biochar producers may be able to generate revenue by selling carbon credits. Participating in carbon markets might seem complicated, especially as there are numerous participants and project stages, each requiring careful consideration. This section aims to simplify the process for prospective biochar producers. It provides insights into carbon crediting principles, outlines a typical project cycle and explains how this cycle can be adapted to the Namibian context.

The ICROA is the industry group for providers of carbon credits in the voluntary carbon market. Its role is to provide quality assurance and guidance on emissions reductions and high-quality credits. According to ICROA's Code of Best Practice, projects should adhere to a set of principles, which are

[39] Adding parameters requires careful connecting with the overall calculation.

also upheld by standard-setting organisations such as Verra and Puro.earth, which offer ICROA-approved methodologies for biochar.[40]

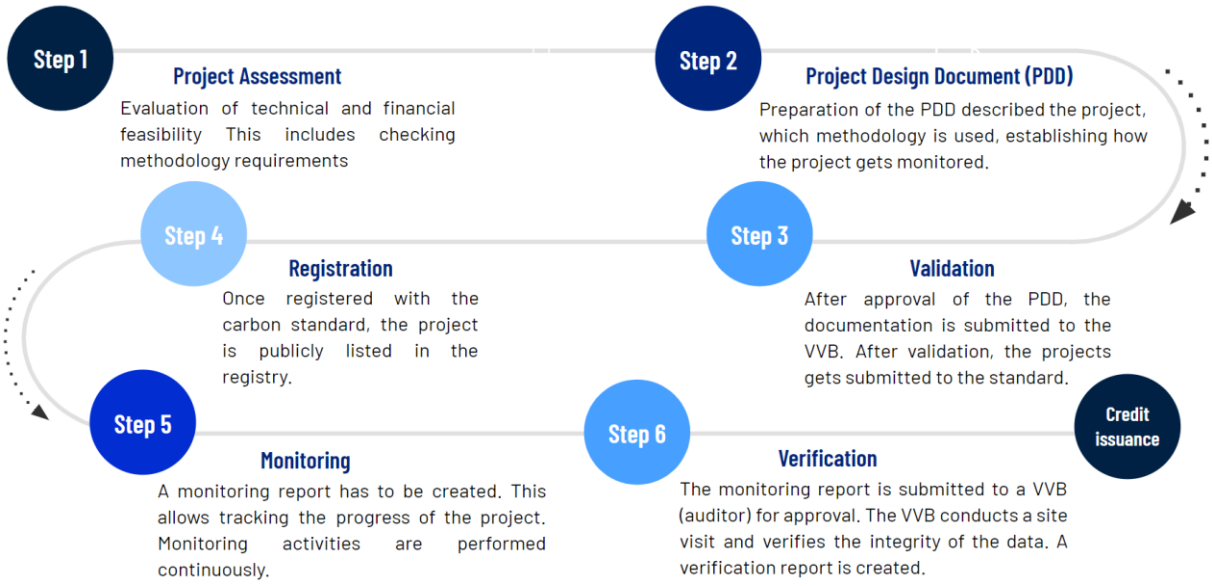
ICROA promotes the following principles (ICROA, 2023).

1. **Real:** a project must be proven to have genuinely taken place.
2. **Additional:** the project must not be able to be built or operate without the revenue from carbon credits. In addition, the project must go beyond merely satisfying regulatory requirements.
3. **Measurable:** the emission reductions or removals must be quantifiable. Adjustment must be made for uncertainty and leakage.
4. **Verifiable:** an independent third-party auditor must verify the emission reductions. The auditor must be accredited under one of the ICROA-approved standards in the sector, in which the project is taking place.
5. **Permanent:** credits must represent permanent emission reductions and removals for 100 years. Where projects carry a risk of reversibility, at minimum, adequate safeguards must be in place.
6. **Unique:** only one carbon credit can be associated with a single reduction or removal of one tonne of CO_2e, there can be no 'double counting'. Carbon credits must be stored and retired in an independent registry.

The process of establishing a carbon project for the voluntary market typically follows a structured series of steps. First, a technical assessment evaluates the project's feasibility, considering technical viability, relevant methodologies and eligibility criteria. Financial feasibility assesses if the project is not only technically possible but also financially viable, ensuring that the project costs can be covered by the revenue from sales. Once the positive assessment is confirmed, a detailed project design document (PDD) is created. This document outlines the project, methodology selection and monitoring procedures. The PDD is then submitted to a third-party entity known as the 'VVB'. The VVB validates the PDD's coherence, confirming its alignment with established standards and methodologies. Upon successful validation, the project is registered, and the PDD becomes publicly accessible. Throughout the project implementation phase, continuous monitoring is conducted. Regular monitoring reports are submitted, detailing the project's progress. These reports are again reviewed by the VVB, which conducts site visits to verify the emission reductions or removals claimed by the project. Once these reductions and removals are verified, the carbon credits are issued. Figure 9 outlines the project development process, and is included for clarity.

[40] Note that the methodology of the EBC is not endorsed by ICROA, which implies that credits generated under this methodology cannot be sold or marketed by members of ICROA.

Figure 9: The project development process



Source: South Pole (2023)

In the Namibian context, the process to set up a BCR project will follow the same process as outlined above. The only specification to make is that the responsible entity that establishes the carbon project differs according to whether it is a decentralised, low-tech production system or a centralised, high-tech production system. In the former case, a group manager represents several small producers who operate Kon-Tiki kilns. Table 35 outlines the project development process in the Namibian case.

Table 35: Process of BCR project development

1	**Preliminary estimation of production volume**	In this first step, the prospective producer should conduct a rough estimation of the anticipated biochar volumes. If the estimated volume is less than 2,000 tonnes per year, it's advisable that the producer joins a project with a group manager/aggregator. This is because large production volumes are needed to cover the carbon certification costs. See Chapter 4.1 on the role the group manager/aggregator.
2	**Aggregate prospective producers** (only group manager)	In case of low production volumes, producers should aim to integrate their projects under a group scheme led by a group manager. The group manager/aggregator 'groups' the individual producers and acts as the counterparty for the project developer (see Chapter 4.1 on the role the group manager/aggregator). The group manager needs to collect information on the estimated production volume to obtain a total expected production volume for the project.

3	**Contact project developer**	With this information, the producer or group manager approaches a project developer to scope how the project could be developed. Among the factors that the project developer will consider for feasibility are the following: • stage of development of the project • feedstock (type of feedstock, where it's sourced, what happens to the feedstock without the project) • transportation (of the feedstock to the production site) • high- or low-tech production system • utilisation of biochar (what is the end-use application, who are the end users, transportation distance from production to application site) Based on this feasibility assessment, the project developer will take a decision to develop the project or not.
	Financial close	See Table 36 below.
4	**Development of carbon project**	The project developer takes care of the carbon-related aspects of the project. This includes, for example: selecting the best carbon standard and methodology; developing the PDD in accordance with the standard; and collecting the monitoring-related information from the project owner.
5	**Implementation and monitoring**	The project owner is responsible for collecting the information required by the standards. Depending on the number of producers and the resources required to conduct the monitoring, the group manager may decide to procure a provider of monitoring solutions.
6	**Verification and validation**	Before carbon credits can be issued, the projects need to undergo validation and verification by an accredited VVB.
7	**Issuance of carbon credits**	After verification, the credits are issued by the respective standard.
8	**Sale of credits**	Credits can be sold via different methods and media. For example, they can be sold directly to an end user (e.g. a corporate entity) in an over-the-counter or an exchange platform, where spot trades with carbon credits take place.

Source: South Pole (2023)

In structuring a carbon project with a developer, various approaches are employed, tailored to the project's capital requirements and the risk level assumed by the partners involved. One prevalent

method is the at-risk project development model, where the carbon asset manager (CAM) bears the complete cost of the project development, including managing credit sales. The developer's compensation is predetermined as a commission based on credit sales. Another option is the purchase guarantee approach, where, similar to the at-risk model, the project developer guarantees the purchase of a specific quantity of credits at a predetermined minimum price.

The CAM is most often the project developer, but it can also be another entity that wishes to participate in a project. In this case, the CAM receives an increased commission reflecting the additional risk undertaken. For projects facing substantial capital needs and financial constraints, the pre-purchase/investment option is viable. Here, credits are bought before generation through an investment in a joint venture or equity investment, providing upfront financing. The investment is compensated through a percentage of revenue streams. It's important to note that these options serve as conventional models and are not exhaustive. Table 36 (below) summarises the outlined approaches:

Table 36: Commercial collaboration approaches for the VCM

1.	**At-risk project development:** • The project developer fully absorbs carbon asset development costs. • CAM performs the entire carbon asset development process and covers all associated expenses, relieving the project operator of additional financial burden. • CAM manages the sales of the credits. • CAM's compensation is a predefined commission based on the sales price. • CAM is motivated to sell credits at optimal prices due to the incentive structure.
2.	**Purchase guarantee option:** • Similar to option 1, CAM absorbs carbon asset development costs entirely. • CAM additionally offers a purchase guarantee for a predetermined quantity of carbon credits at a specified floor price. • CAM receives an increased commission on the sales price to accommodate the higher risk associated with the purchase guarantee.
3.	**Pre-purchase/investment option:** • This option provides upfront financing through: • Pre-purchase of carbon credits at a defined price through investment in a joint venture, or equity investment. The investment is compensated through a percentage of one or several revenue streams.

Source: South Pole (2023)

5.3 Potential business model: conclusions

In summary, this study emphasises the potential for the development of a biochar sector in Namibia, but highlights a significant challenge, namely the limited local demand for biochar as a material product. For biochar production to be economically viable, it needs multiple sources of revenue beyond the revenue from carbon credit sales. This chapter outlined the possible business models that are aligned with the two main technological options of a high technology facility and the use of Kon-Tiki kilns. An Excel-based workbook developed as part of this study serves as a tool to simulate the numbers related to the different design options and estimating the revenue from the sale of carbon credits necessary for a profitable operation.

Biochar producers can generate revenue from selling carbon credits if their activity and its outcomes are real, additional, measurable, verifiable, permanent, and unique. To develop a BCR project, biochar producers can choose to collaborate with a project developer. With models such as purchase guarantee options or pre-purchases of carbon credits, project developers and carbon asset managers may need to explore various and the most adequate approach to maximise the chances of commercial viability.

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Annex I Case studies

This Annex describes 12 international case studies that were reviewed as part of the analysis undertaken for this study.

PES mechanism	Description	Success level
Payments for application of sustainable practices	1) National PES, Costa Rica	Limited
	2) FONAG, Ecuador	Considerable
	3) BIOFUND, Mozambique	Considerable
	4) CBNRM, Namibia	Limited
	5) FSC certification, global	Limited
Voluntary markets	6) EcoAustralia, Australia	Promising
	7) SSI, India	Promising
	8) VRC, global	N/A (recently implemented)
	9) Sustainable development units programme, New Zealand	N/A (recently implemented)
	10) VCMs, global	Considerable
User charges/compliance markets	11) BioBanking, Australia	Limited
	12) Carbon tax allowing offsets, Colombia	Considerable

(Source: South Pole, 2023)

National PES, Costa Rica

Case study: Costa Rica's national PES
Mechanism: Operational since 1997, Costa Rica's national PES scheme (or Pago por Servicios Ambientales) is a reference for national-level application of the environmental services approach. The scheme was supported by a variety of donors through the Ecomarkets project implemented by the World Bank. The project compensates landowners for activities that have been identified as contributing to a sustainable environment, including: conservation of natural forests; reforestation through sustainable plantations; and agroforestry. The PSA programme compensated forest landowners for value created by either planted or natural forest on their land and recognised four services: 1) GHG mitigation; 2) hydrological services; 3) scenic value; and 4) biodiversity. The programme did not attempt to measure all four services on a given parcel at once. An identically valued bundle of these services was assumed to be provided by each hectare of enrolled parcel (Sanchez et al., 2007). Funding sources for this programme are obtained from: a fuel tax (80% of funds); a forestry tax; a World Bank loan; as well as grants from the Government of Germany (for forest protection); the Government of Norway (for carbon sequestration); and the Green Environment Facility (GEF).

Characteristics	
Instrument type	Payments for application of sustainable practices
Type	Compensation
Funding	Public (supported by tax, loans and grants)
Flexibility	Mandatory
Sectoral applicability	Forest management, forest conservation

Results:

- Costa Rica's PES programme has been a leader in the institutionalisation of ecosystem investments through the now popular idea of payments for ecosystem services.
- Around 300,000 ha of primary, secondary or planted forest received funding in the first phase of the PSA programme through 2000.
- Sanchez et al. (2007) estimated that the level of PES contracts in an area did not generate a statistically significant reduction in the country's deforestation rate. It is found that the success of previous programmes left the PSA programme with little forest clearing to prevent, thereby constraining the maximum possible impact of PES payments.
- Results of Sierra and Russman (2006) indicate that payments had limited immediate effects on forest conservation in the region. The study suggests that conservation impacts were indirect and realised with considerable lag because they are mostly achieved through land-use decisions affecting non-forest land cover.
- Results from Tafoya et al. (2020) suggest that the most effective strategy to simultaneously curb tropical deforestation, protect primates and ensure community benefits may depend on a complete portfolio of protected areas, PES and ecotourism, rather than a subset of these strategies.

Success level	Limited

FONAG, Ecuador

Case study: FONAG	
Mechanism: FONAG is the water conservation fund of the city of Quito, Ecuador. FONAG relies on a 1% surcharge on monthly water bills and financial support from a local electrical utility and beer company directed to finance projects protecting forests and grasslands in the watershed. In 2000, the Municipal Sewer and Potable Water Company of Quito (now EPMAPS) and the Nature Conservancy created a private trust called FONAG, which is regulated by the Securities Market Law of Ecuador. This was established as a growing patrimonial fund over a period of eighty years. The returns of the patrimony are invested in different projects that contribute to the supply of water of the city of Quito and areas of influence. The Electric Company of Quito, the National Brewery, Tesalia Springs Co. and CAMAREN, a non-profit private Ecuadorian consortium, joined this Fund as adhered constituents.	
Characteristics	
Instrument type	Payments for units of ecosystem services (results-based finance)
Type	Commoditisation
Funding	Public, private
Flexibility	Mandatory
Sectoral applicability	Water, land management

Results:

- FONAG is the first Water Fund created in the world.
- The current accumulated equity of the Fund is USD 16 million. The generated interest is added to other contributions that generated a total of USD 2.5 million invested in annual programmes.
- Currently, FONAG comprehensively manages 20,000 ha of conservation areas (property of FONAG or EPMAPS).
- Comparative studies carried out in areas not managed by FONAG showed a very significant increase in the presence of suspended solids from 6 to 70 mg/l between 2014 and 2017, compared to sites managed by FONAG, which in the same period registered an increase of 4 to 11 mg/l. The high costs of water treatment to remove the sediments motivated EPMAPS to make a Return on Investment (ROI) study, related to the conservation work carried out by FONAG. The study compared the projected cost of conservation in 20 years, showing a positive ROI of USD 2.15 million for each USD invested (Latin American Water Fund Partnership, n.d.).

Success level	Considerable

BIOFUND, Mozambique

Case study: BIOFUND in Mozambique

Mechanism: BIOFUND is a Conservation Trust Fund set up in 2011 in Mozambique in accordance with the parameters of the Conservation Finance Alliance. It is a non-profit Mozambican private institution with a public utility statute, which mobilises, applies and manages financial resources for the exclusive benefit of biodiversity conservation in Mozambique. BIOFUND brings the contribution of the private sector, civil society and academia to the conservation effort in Mozambique. Most of the public or private organisations related to biodiversity conservation in Mozambique are members. BIOFUND directly funds the costs of protected area management.

BIOFUND has two types of funds: investment funds and funds for direct application. Investment funds started in 2016 with the contribution of international donors and are invested for the long term. Funds for direct application are used entirely for financing specific projects that have been defined in advance with the donors. By 2017, BIOFUND had drawn up agreements with two donors, the French Development Agency (AFD) and the World Bank, through its MozBio programme, to channel funds to conservation areas.

BIOFUND Innovative Financing Department was created in 2019 to: generate new long-term financing; diversify sources of revenues for biodiversity conservation in Mozambique; and explore new sources of sustainable financing, assessing its viability to support biodiversity conservation. One example is the Emergency Biofund, created in July 2020 to support protected areas during the COVID-19 pandemic.

Since 2017, BIOFUND has been implementing the Biodiversity Offsets Programme. This programme is part of the strategic actions of BIOFUND to explore innovative financing mechanisms to support the conservation of biodiversity in Mozambique (BIOFUND, 2022). BIOFUND expects to serve as a recipient of offset funds, which will be deployed for the management of conservation areas and investment in sustainable development programmes (UNEP, 2020).

Characteristics	
Instrument type	Payments for application of sustainable practices
Type	Compensation/co-investment
Funding	Blended (public, philanthropic, private)
Flexibility	Mandatory
Sectoral applicability	Conservation, land use, biodiversity

Results:

Main results of the Emergency Biofund (as of 2020, according to BIOFUND, 2021) include:

- 12,695,911 ha biodiversity protected;
- 24 public, private and community protected areas;
- 61% of the total protected area in Mozambique;
- 958 rangers supported;
- 30,869 workhours/patrol per month (in private areas); and
- approximately USD 2 million disbursed by June 2021.

Success level	Considerable

CBNRM, Namibia

Case study: CBNRM, Namibia

Mechanism: CBNRM is an approach to managing natural resources that involves local communities in the decision-making process.

Under CBNRM, local communities are granted rights and responsibilities over the management of natural resources, including economic activities (e.g. tourism, trophy hunting) managed by private operators and intermediaries. The income arising from the activities, after payment to the operators, is handed over to community conservancies, which are established in community-managed areas set aside for conservation and sustainable use of natural resources. The conservancies use the revenues to fund community projects and/or for redistribution among community members. State authorities oversee the PES scheme without directly intervening, allowing private operators to run it. Government authorities accept or reject applications for setting up conservancies, determine hunting and levy quotas, ensure the ex-post monitoring of activities and take administrative actions against non-compliant parties (AFD, 2012). Namibia's CBNRM programme has had the benefit of a long period of sustained donor funding. USAID has been a major donor (R. Naidoo et al., 2011).

Characteristics	
Instrument type	Payments for application of sustainable practices
Type	Compensation/co-investment
Funding	Philanthropic, private
Flexibility	Voluntary
Sectoral applicability	Biodiversity, forest, land management, water

Results:

- Some studies considered the approach to have been successful in Namibia, with more than 80 community conservancies established across the country, and a model for community-based natural resource management around the world (AFD, 2012).
- Other studies suggested that many CBNRM programmes have failed to live up to expectations: in some instances, CBNRM schemes have enriched political elites through the incomplete devolution of resource rights; other CBNRM programmes, by privileging conservation, facilitated community disempowerment; in other cases, biodiversity protection has been ignored due to a focus on socioeconomic development (R. Naidoo et al., 2011).
- A number of authors have broadly discussed the implications of increasingly engaging with market forces to conserve biodiversity and/or improve human livelihoods. They provided some evidence to suggest a programme focused on conservation and development has benefited in both domains from engaging more robustly with the market (R. Naidoo et al., 2011).

Success level	Limited

FSC certification, global

Case study: FSC certification

Mechanism: the FSC was established in 1993, as a follow-up to the United Nations Conference on Environment and Development (the Earth Summit at Rio de Janeiro, 1992) with the mission to promote environmentally appropriate, socially beneficial and economically viable management of the world's forests. FSC is an international organisation that provides a system for voluntary accreditation and independent third-party certification. This system allows certificate holders to market their products and services as the result of environmentally appropriate, socially beneficial and economically viable forest management, therefore allowing them to charge a premium on the market for their products. FSC also sets standards for the development and approval of FSC Stewardship Standards, which are based on the FSC Principles and Criteria (International Trade Centre, n.d.).

In 2018, FSC International published a new procedure, 'Ecosystem Services Procedure: Impact Demonstration and Market Tools', which aims to introduce PES into forest management (FM) certification schemes. The procedure focuses on five ecosystem services: biodiversity conservation, carbon sequestration, water preservation, soil conservation and recreational services, and twenty benefits under those services (World Wide Fund for Nature [WWF], 2022).

Characteristics	
Instrument type	Payments for application of sustainable practices
Type	Compensation co-investment
Funding	Private
Flexibility	Voluntary
Sectoral applicability	Biodiversity, carbon, water, land use, recreational services

Results:

- 42 forest management (FM) certificate holders certified for their ecosystem services around the world, as of August 2022 (WWF, 2022)
- WWF's assessment of the FSC ecosystem services procedure highlighted remaining gaps and challenges in the process, such as: inadequacies in the technical document as a way of communicating with interested parties; shortcomings in governance; incomplete economic dimensions of PES (technical document does not explain the costs generated by the project, how they are calculated, what is actually offered for sale, or the share of financing sought); insufficient assessment of the benefit of the project on the other services (i.e. to remove the risk of accidentally degrading another service); and high certification costs, which can reduce the participation of small-scale PES projects or landowners (WWF, 2022).
- The system is based on sovereign state functions through the enforcement of laws and regulations that guarantee labels and contracts (AFD, 2012).

Success level	Limited

EcoAustralia™, Australia

Case study: Australian biodiversity units (also Australia EcoAustralia™ credit)

Mechanism: developed by a private project developer in February 2018, this mechanism introduced a stapled carbon and biodiversity product for voluntary buyers, called an 'EcoAustralia™ credit'. Each EcoAustralia™ credit combines one ABU (issued under the state-level biodiversity compliance scheme) with one carbon credit (issued by internationally recognised standards, such as Gold Standard or Verra). An ABU is a standardised unit that represents 1.5 m^2 of protected land delivering biodiversity outcomes for Australian flora and fauna species. ABUs are a division of the larger biodiversity units used on the state-based Native Vegetation Credit Registers, termed a Biodiversity Equivalence Unit in Victoria and a Significant Environmental Benefit in South Australia (South Pole, n.d.).

Purchasers of EcoAustralia™ credits support Australian biodiversity conservation projects voluntarily (i.e. there is no corresponding vegetation removal to offset). An example of a biodiversity project for which ABUs have been issued is the Mount Sandy project, located on a rare pocket of intact native vegetation in South Australia's Coorong region on the traditional lands of the Ngarrindjeri people. Project management is made possible through close collaboration with the Raukkan Aboriginal Community and Ngarrindjeri Elders, Clyde and Rose Rigney, who oversee vegetation management and conservation at the site (WEF, 2022).

These voluntary standards are compliant with the Australia Government's Climate Active Programme (formerly the National Carbon Offset Standard) (South Pole, n.d.).

Characteristics	
Instrument type	Voluntary markets
Type	Commoditisation
Funding	Private
Flexibility	Voluntary
Sectoral applicability	Biodiversity, carbon

Results:

- EcoAustralia™ currently supports three conservation projects: the Myamyn Lowland Conservation project; the Lavers Hill Conservation project in Victoria; and Mount Sandy Conservation project in South Australia;
- EcoAustralia™ leverages Australia's state-based vegetation registers – previously only accessible to organisations with legal obligations to offset vegetation removal – and gives voluntary buyers the chance to make permanent contributions to government-accredited biodiversity conservation within their climate strategies and actions (South Pole, n.d.).
- The combination of biodiversity units with carbon credits was instrumental in meeting the demand from corporate buyers, since at the time the initiative was developed there was no significant demand for stand-alone biodiversity units (South Pole, n.d.).
- Over a period of three years in operation, EcoAustralia™ has proved to be quite successful. Project partners are considering new initiatives building on the positive experience and model structure of this programme (South Pole, n.d.).
- Purchasers of EcoAustralia™ credits include Porsche Australia, the University of Melbourne and CareSuper (WEF, 2022).

Success level	Promising

SSI, India

Case study: SSI – Gold Standard Water Benefit Standard	
Mechanism: the SSI introduces a number of innovations that reduce the amount of water required compared to prevailing practice in sugarcane cultivation. For instance, SSI teaches farmers to plant one-month-old seedlings directly into the field. By raising seedlings in nurseries and transplanting after one month, close to 90% of the water can be conserved. The SSI is based on the Water Benefit Standard by Gold Standard. The Water Benefit Standard was launched in 2014 as the first globally consistent standard that certifies the positive water and socioeconomic impacts of water projects. Using revenue from Water Benefit Certificate sales, the project developers are able to expand the project activities. Water Benefit Certificates represent quantified and certified impacts generated by projects that secure access to water. Certified water projects must deliver impact toward at least three Sustainable Development Goals (SDGs) and demonstrate a clear financial need for additional finance from selling Water Benefit Certificates (Gold Standard, 2023).	
Characteristics	
Instrument type	Voluntary markets
Type	Commoditisation
Funding	Private
Flexibility	Voluntary
Sectoral applicability	Water, land management, agriculture
Results: • According to Gold Standard (2023), the project demonstrated positive results on: yields (increase of at least 20%); use of chemical inputs (25% reduction); water savings (940,000 m^3 of water saved annually); creation of rural jobs; especially female jobs; and increase in smallholder income, for instance by allowing for intercropping vegetables, enhancing income and providing an additional source of nutrition. • According to Parajuli (2019), SSI technique has helped over 5,000 farmers across India to improve their water productivity by 40% and increase their profits by 30%, while reducing their ecological footprint. • Other environmental and social benefits from SSI have been documented by Rott (Ed.) (2017), Mohanty et al. (2015) and Loganandhan et al. (2013), among others.	
Success level	Promising

VRC, global

Case study: VRC Framework	
Mechanism: a VRC is the monetised cost of the estimated impact of climate change, adjusted for the income level of the community, that will be avoided as a result of the project. As a numerical measure, a VRC can be translated across communities and projects as a universal indicator of reduced vulnerability to climate change. Generated VRCs can be: sold on to third parties interested in funding verified climate-adaptation activities; traded to meet obligations under future national or international obligations; or used as a performance metric against organisational goals and guidelines for adaptation. The concept of VRC has been developed by the Higher Ground Foundation (currently operating as an initiative of Climate Mitigation Works Ltd). Current tools available under the framework include the Vulnerability Reduction Project Manager for Urban Flooding, a tool for planners and engineers involved in urban flood reduction to evaluate system vulnerabilities and compare and prioritise the potential impacts of competing and integrated flood management approaches – integrating hydrological, engineering, socioeconomic and climate change parameters into one tool. Future tools will be tailored towards: agricultural adaptation; landslide protection and avoidance; human health and disease prevention; and other adaptation project types (Higher Ground Foundation, n.d.).	
Characteristics	
Instrument type	Payments for application of sustainable practices
Type	Compensation
Funding	Private
Flexibility	Voluntary
Sectoral applicability	Bilateral
Results: • Currently in the conceptual phase and no transactions have happened to date • The framework generated high interest, particularly in the African context, including the option of 'coupling' of mitigation and adaptation credits.	
Success level	TBC

Sustainable development units programme, New Zealand

Case study: Sustainable Development Units programme, New Zealand	
Mechanism: the 'Sustainable Development Unit' launched in New Zealand is a 'habitat hectare' comprising one hectare of biodiversity conservation for one year. Biodiversity benefits need to be delivered, measured and verified (NZ Farm Life Media, n.d.). The launch in 2022 coincided with the first transaction between Sanctuary Mountain Maungatautari (the seller) and Profile Group Limited, parent company to several supply chain businesses (the buyer). This transaction was facilitated by Ekos with funding support from Trust Waikato, the Wel Energy Trust and the D.V. Bryant Trust. The proceeds from the sale of the biodiversity units fund the conservation management of 83 hectares at Sanctuary Mountain Maungatautari for the 2022 financial year (WEF, 2022). In the case of Sanctuary Mountain Maungatautari, the units measured short-term biodiversity outcomes; these include reducing the number of pests and weeds and maintaining these low numbers. About 15% of the project's annual operating budget came from the local council, with the rest from grants, sponsorships, donations and gate entry fees (Stuff, 2022).	
Characteristics	
Instrument type	Voluntary markets
Type	Commoditisation
Funding	Private
Flexibility	Voluntary
Sectoral applicability	Biodiversity
Results: as the scheme is still new, there is no access to its results and success rate. Nevertheless, the project owners of the qualified project have pointed out that local funding to support the project has reduced considerably due to the Covid-19 pandemic. This has led to an increased significance of alternative finance sources, such as biodiversity credits (WEF, 2022)	
Success level	TBC

VCM, global

Case study: VCM

Mechanism: VCM refers to a system where individuals, organisations or businesses can purchase carbon offsets or credits to offset their carbon footprint or emissions voluntarily. Carbon offsets or credits represent reductions in GHG emissions or removals from the atmosphere.

The VCM allow businesses and individuals to take responsibility for their carbon emissions by offsetting them and/or financing sustainable projects, contributing to social and environmental benefits in addition to carbon reductions.

The VCM emerged in the late 1990s and has subsequently grown significantly, with an increasing number of businesses and organisations participating in the market. Verra (formerly Verified Carbon Standard) and Gold Standard are the biggest and best-known independent standards.

According to Donofrio et al. (2022), project development under VCM standards covers a wide range of typologies, sectors and geographical areas: forestry and land use (17 standards, 60 countries); agriculture (7 standards, 8 countries); renewable energy (10 standards, 53 countries); waste disposal (8 standards, 21 countries); household devices ('clean cookstoves', 5 standards, 34 countries); chemical processes/industrial manufacturing (5 standards, 8 countries); energy efficiency/fuel switching (5 standards, 10 countries);: and transportation (4 standards, 3 countries).

After the growth seen in 2019-2020, VCMs entered a period of consolidation of previous growth with ongoing debates over calculation methodologies, particularly in the case of forest carbon projects. Multistakeholder initiatives such as the Integrity Council for the Voluntary Carbon Market have been established to develop new criteria for high-integrity carbon credits – the Core Carbon Principles (IETA, 2022b).

Characteristics	
Instrument type	Voluntary markets
Type	Commoditisation
Funding	Private
Flexibility	Voluntary
Sectoral applicability	Forestry and land use, agriculture, renewable energy, waste disposal, household devices, chemical processes/industrial manufacturing, energy efficiency/fuel switching, transportation

Results: VCMs have delivered USD 8 billion in climate finance to projects since 2005 (Ecosystem Marketplace, n.d.), passing from USD 520 million per year in 2020 to USD 2 billion per year in transactions in 2021.

Success level	Considerable

BioBanking, Australia

Case study: BioBanking in New South Wales, Australia

Mechanism: BioBanking was launched by the state of New South Wales (NSW) in 2007 to offset habitat impacts from development. Developers can purchase credits from conservation management activities such as managing grazing, removing invasive species or creating habitat corridors, for trades that match like-for-like credits and impact according to the habitat type (Salzman, J. et al., 2018). There are two key elements to the Biodiversity Offsets Scheme (BOS): 1) credit obligations (developers and landholders generate a credit obligation due to unavoidable biodiversity impacts from development or vegetation clearing; the obligation must be retired to offset their activity); and 2) biodiversity credits (landholders establish a biodiversity stewardship site on their land, generating credits to sell to developers or landholders who require those credits to securely offset activities at other sites).

Entry to BOS is triggered by developments, projects and activities that meet certain thresholds for significant impacts on biodiversity, or on an opt-in basis (NSW Department of Planning and Environment, n.d.). The governance of the scheme is complex and has undergone modifications with the change in legislation. After the reform in 2019, the NSW Biodiversity Offset Scheme became primarily attractive to public landholders, mainly due to the changed assessment methodology which decreased the number of credits generated on a property. Consequently, many landholders did not deem participation in the scheme to be economically viable while participation rates of public landholders increased (Ruoso and Plant, 2020).

Characteristics	
Instrument type	User charges/compliance markets
Type	Commoditisation
Funding	Public, private
Flexibility	Mandatory*
Sectoral applicability	Biodiversity

Results:

- The Audit Office of New South Wales in an audit in 2022 found that the Department of Planning and Environment had not effectively designed core elements of the scheme and that the Biodiversity Conservation Trust lacked safeguards against potential conflicts, creating risks to credit supply. The audit provides recommendations to address the programme's shortcomings (NSW Audit Office, 2022).
- Plant and Ruoso (2022) find that the current working rules of the scheme make certain landholders willing to participate, while others are unwilling due to: concerns around the cost of ecological assessments; uncertainties around land and vegetation management; and potential impacts on land values. The article suggests policy reforms that could address these concerns, including: providing more information and technical support for landholders; mitigating concerns around land values; and developing enforceable standards for ecological restoration.
- Findings from Ruoso and Plant (2020) show that several 'contextual' factors cause distributive inequity in access to BioBanking in NSW. Results show that experience, access to resources and information, support through formal and informal networks and land size explain why some landholders manage to participate in the biodiversity offset scheme in NSW, while others do not.

Success level	Limited

Colombia's carbon tax

Case study: Colombia's Carbon Tax

Mechanism: Colombia's national carbon tax was introduced in 2016. The national carbon tax covers approximately 27% of Colombia's emissions and the 2022 price is 18.82 Colombian pesos per tonne CO_2e (approx. USD 4.96). The following year, the legislation allowing the use of carbon offsets towards the tax obligation was established.

Art. 221 of Law 1819 of 2016 also established a provision for offsetting as part of the carbon tax mechanism, allowing companies to neutralise part or all of their carbon emissions in place of paying their tax obligations. Furthermore, although the law does not have provisions for carbon tax deductions, the tax could be considered a cost for the taxpayer for income tax purposes (Ernst & Young, n.d.). The rules for the offsetting operation are established in Decree 926, published in 2017 (Minambiente, 2017). As taxes are charged to wholesale distributors, companies that purchase fossil fuels can present a request for a tax break if they have purchased offsets from mitigation projects (ICAP, 2020). Entities can compensate up to 100% of their tax obligations with offsets and potentially be certified as carbon neutral in this way.

The market price of national carbon credits has been fluctuating between 80% and 95% of the tax price, around USD 4. However, the main achievement of the Colombia carbon tax was an increased demand for national carbon credits. Interestingly, the Colombian tax was designed with this objective in mind, with the impact on the national budget incorporated into the tax design from the outset.

Characteristics	
Instrument type	User charges/compliance markets
Type	Commoditisation
Funding	Private
Flexibility	Mandatory
Sectoral applicability	Carbon

Results:

- According to IETA (2022), by 2020 the carbon tax and the offset mechanism had led to the cancellation of 42.8 $MtCO_2e$ of offsets;
- 1.42 billion Colombian pesos collected through tax revenue, which was directed to environmental protection alongside other purposes; and
- 108 mitigation initiatives supported (more than 90% of the offsets come from forestry projects).

Success level	Considerable

Annex II Overview of stakeholders in Namibia's biomass value chains

Public Institutions	NGOs	Private Sector	Unions
Ministry of Environment and Tourism	Cheetah Conservation Fund	Biomass harvesters	NLU NAU
Ministry of Mines and Energy	Desert Research Foundation of Namibia	Technology Providers	Namibia Agricultural Union
NamPower	Namibia Nature Foundation	Off-takers	NNFU Namibia National Farmer's Union
	Hanns Seidel Foundation; Perivoli Rangeland Institute	Producers (charcoal, animal fodder, biochar etc.)	NECFU Namibia Emerging Commercial Farmers' Union
		Planboo; PyroNam	

Associations	Academia	Financial Institutions	Other
REIAoN Renewable Energy Industry Association of Namibia	NUST	Environmental Investment Fund of Namibia | ensuring sustainability	FSC Forest Stewardship Council
N-BiG Namibia Biomass Industry Group	UNAM University of Namibia	Development Bank of Namibia	giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
CAoN Charcoal Association of Namibia; NCE Namibian Chamber of Environment		AGRIBANK OF NAMIBIA; CIRRUS CAPITAL	UNDP

Annex III Results of biochar research undertaken by NUST's BUSH project

'The lack of significant short-term benefit of biochar applied to soils may be due to insufficient time for the biochar to be conditioned by the slow processes that are mostly driven by soil microbes. Longer-term studies may be required to observe more significant benefits.

The benefit of improved water-holding capacity from biochar may not have manifested itself due to irrigation that was applied at all test sites. If farmers would be prepared to reduce irrigation, with the risk of placing some of their crops under water stress, then it may be possible to demonstrate this benefit of biochar.

The fact that the application rate of biochar had no significant short-term effect on crop performance is encouraging in that no negative effects manifested from the high application rate of 40 t/ha. This is especially encouraging in the case of charcoal produced at lower temperatures in drums, including the less valuable, and therefore more cheaply available to farmers, charcoal fines that fall through sieves. It seems that their concentrations of components normally considered harmful, such as polycyclic aromatic hydrocarbons, are not excessive enough to cause harm in the soils in which the charcoal was tested."

Regarding trials with livestock

"The lack of significant short-term benefit of biochar applied to animals is somewhat surprising. The low intake of biochar offered to broiler chickens suggests that the quality of the biochar may be insufficient to provide anything they lack under the good conditions under which they were kept.

Since no negative effects of biochar were observed in animals, it may be worthwhile for farmers to offer crushed biochar on a free-choice basis. Any consumption of biochar by their animals would likely indicate some benefit, while non-consumption would be of little cost to the farmer.'

(Source: South Pole, 2023, based on interviews conducted during the preparation of this report)

Annex IV Overview of the BCR methodology

The following table compares the technical requirements from the most relevant BCR methodologies, which can be used in the Namibian context. The information provided is not meant to be used for the prioritisation, but merely to guide interested project developers to select the most appropriate methodology for the respective case.

However, the design of the project might point towards certain methodologies, the marketability of the resulting BCR credits has to be reflected as well. With a global increase of BCR supply (cdr.fyi) as well as the emergence of quality frameworks within the VCM (i.e. recently announced Core Carbon Principles by the IC-VCM) adherence to internationally accredited BCR methodologies will be crucial to ensure access to market and thereby climate finance.

As of now, the ICROA carbon standard endorsement framework is considered an important signal to determine credibility of carbon standards and their methodologies. Currently, the following ICROA-endorsed standards have a relevant BCR methodology[41]:

- Verra: VM0044
- Puro.earth: biochar methodology

Considering the presence of charcoal production in Namibia and the need to establish decentralised production systems, which can reflect the lack of investment capital, especially in communal areas. Consequently the utilisation of Kon-Tiki kilns as the core project activity under the **Global Artisanal C-Sink** methodology by CSI, therefore, has further been added to the comparison, noting that as of August 2023, CSI is not listed as endorsed by ICROA.

[41] GoldStandard has discussed the ongoing development of a biochar methodology but not details on methodology or release schedule are available
The US-focused Climate Action Reserve has released a draft protocol, which blends requirements of VM0044 and Puro.earth but is not applicable outside the US.

Criteria	Verra: VM0044	Puro.earth: biochar	CSI: Global Artisanal C-Sink	EBC C-Sink
ICROA endorsement	YES	YES	NO	NO
Market volume	0 tCO_2eq sold (limited projects listed) high demand due to strong positioning of Verra in market	83,752 tCO_2eq sold (multiple project listed) high demand	Volume listed/sold unknown to CSI demand insecure	Unknown
Price signals Notes and assumptions on developments	unknown Estimated to sell at premium compared to Puro.earth	120 USD/tCO_2eq (by 08/2023) Reflects spot-purchases, which are above structured offtake agreements	unknown Currently lower demand reported from different marketplaces	Unknown
Additionality demonstration	Standardised additionality based on global waste biomass processing	Financial additionality	All projects deemed additional	Contribution to biochar and/or or biomass price, Alternatively: financial additionality
Biomass feedstocks Material requirements	Waste biomass feedstocks, incl. FSC-certified wood residues from thinning → Encroacher bush suitable feedstock source	All biomass, incl. FSC-certified wood resources → Encroacher bush suitable feedstock source	Biomass from farms, forest wood only eligible with sustainability certification, → Eligibility of encroacher bush subject to review by CSI certification	Waste biomass feedstocks, incl. residues of biomass processing operations
Biochar production: General	Includes high- and low-tech biochar production systems	Only high-tech production systems	Small-scale /Kon-Tiki focused production system	Includes anything from traditional to industrial production systems

Biochar production: Eligible technology	• High tech: 1. Pyrolytic GHG gases must be combusted/recovered 2. 70% waste energy recovery 3. Pollution controls 4. Production temperature measured • Low tech: if high tech is not met • Environmental and social safeguards	• No co-firing of fossil fuels after ignition • Pyrolytic GHG gases must be combusted/recovered • Environmental & social safeguards	• Combustion of pyrolytic gases • Temperature may be maintained at > 400°C • TLUD not eligible until and/or subject to review by CSI certification	1. The use of excess heat or the use of liquid and gaseous pyrolysis products must be ensured. 2. Nationally defined emission limit values must be complied with. General: following EBC requirements
Biochar production: Biochar quality requirements	• Biochar has to demonstrate compliance with EBC /IBI criteria • $H:C_{org} < 0.7$	• Biochar has to demonstrate compliance with EBC/IBI criteria • $H:C_{org} < 0.7$	Material certification only for artisanal pro (>100m^3 biochar/a): laboratory testing against EBC requirements	Biochar has to demonstrate compliance with EBC /IBI criteria $H:C_{org} < 0.7$
Biochar production: Production emissions	• High tech: 1. Energy utilisation (fossil /electric) 2. Transportation emissions • Low tech: 1. CH_4 from production (default values) 2. Energy utilisation (fossil /electric)	Project emissions defined via LCA, incl. 1. Energy utilisation (fossil /electric) 2. Transportation emissions 3. (If relevant) LUC from feedstock	Project's CH4 emission compensated through internal compensation mechanism based on cooling effect, incl. tree planting, avoided residue combustion, avoided decay (see p.27ff.)	All GHG emissions from biochar production are included. This includes: 1. Emissions from the provision of the biomass 2. Emissions from the storage of the biomass

	3. Transportation emissions			Emissions from the pyrolysis process and other equipment at the production site.
Application requirements Application types	• Soil application: Surface (in material matrix) or sub-surface application • Non-Soil: all applications with sufficient permanence eligible • One Year after production	All application with sufficient permanence eligible when applied in material matrix	Preferably applied on-farm in material matrix	The EBC will publish a binding positive list of such possible C-sink materials and applications, which can be extended upon request and after appropriate review.
Application requirements Necessary documentation	• Soil application: 1. Location (farm level) 2. Application/sales date • Non-soil application: 1. Intended use 2. Sales date 3. Demonstration of permanence • Confirmation of application requirement compliance • Waiving of carbon claim rights	• Offtake agreement (until matrix mix) • Intended use • Waiving of carbon claim rights	• If sold in material matrix: Documentation of mixing and respective volume • If not sold in material matrix: Georeferenced photo of application • Reference to the registered field, application date and volume	• Incorporating biochar into substrates such as compost, litter, feed, fertilizer or cement, sand, clay, and lime is considered a creation of a carbon sink. • For incorporating biochar into building materials such as concrete, mineral plasters, gypsum, or clay, a permanent sink can be assumed.
Removal quantification Estimation of carbon persistence after 100 years	Based on IPCC (2019): Permanence factor depending on production temperature and application type	Based on Woolf et al. (2021): Permanence based on H/C_{org} and soil temperature	Based on CSI (2022): Default permanence of 75%	Based on CSI (2022): Default permanence of 75%

Issuance process Suggested frequency	Annually High cost per issuance due to monitoring and documentation Only retroactively possible after verification of monitoring report (ex-post)	Quarterly Low-mid costs (covered through Puro.earth's fee) Production facility audit allows issuance for one year (ex-post and ex-ante)	*tbd* Low cost Inspection allows issuance throughout one year (ex-post and ex-ante)	*tbd* Low cost Inspection allows issuance throughout one year (ex-post and ex-ante)
Business model /fees	• Registration fee: USD 500 (once) • Issuance fee: USD 0.2/tCO_2eq (Source)	• Registration fee: USD 900 (annually) • Issuance fee: 10% of sales price per tCO_2eq (Source)	• Registration fee: USD 300 (annually) • Issuance fee: USD 2/tCO_2eq (Source)	Registration fee: EUR 300 (annually) Issuance fee: EUR 1/tCO_2eq • (Source)
Required documentation to register and manage BCR project	• PDD (initially) • Monitoring report (per issuance) All reports need verification through third-party and public disclosure	• LCA estimation and report • Production report (per issuance) Initial LCA has to undergo external audit as well as annual documentation auditing	• Initial project design outline • Proof of training of producers All documents need review by Certifier	Initial project design outline Proof of training of producers All documents need review by Certifier