



SMEs as Key Drivers of Climate Change Adaptation in Southern Africa

Market Opportunities and Challenges for
Adaptation SMEs in Botswana, Malawi
and Zambia



Imprint

Publisher: SEED
c/o adelphi research gGmbH
Alt Moabit 91, 10559 Berlin, Germany
www.seed.uno | info@seed.uno

This snapshot by SEED / adelphi research gGmbH is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License.

Suggested citation: SEED (2022): SMEs as Key Drivers of Climate Change Adaptation in Southern Africa. Market Opportunities and Challenges for Adaptation SMEs in Botswana, Malawi and Zambia.

Author: Luis Ebert

Contributors: Chandkachorn John Chandratat, Julia Rohe-Frydrych, Jonas Restle-Steinert, Linde Wolters, Simon Mühlbauer

Photo credits: SEED

Contact us: info@seed.uno

ABOUT SEED

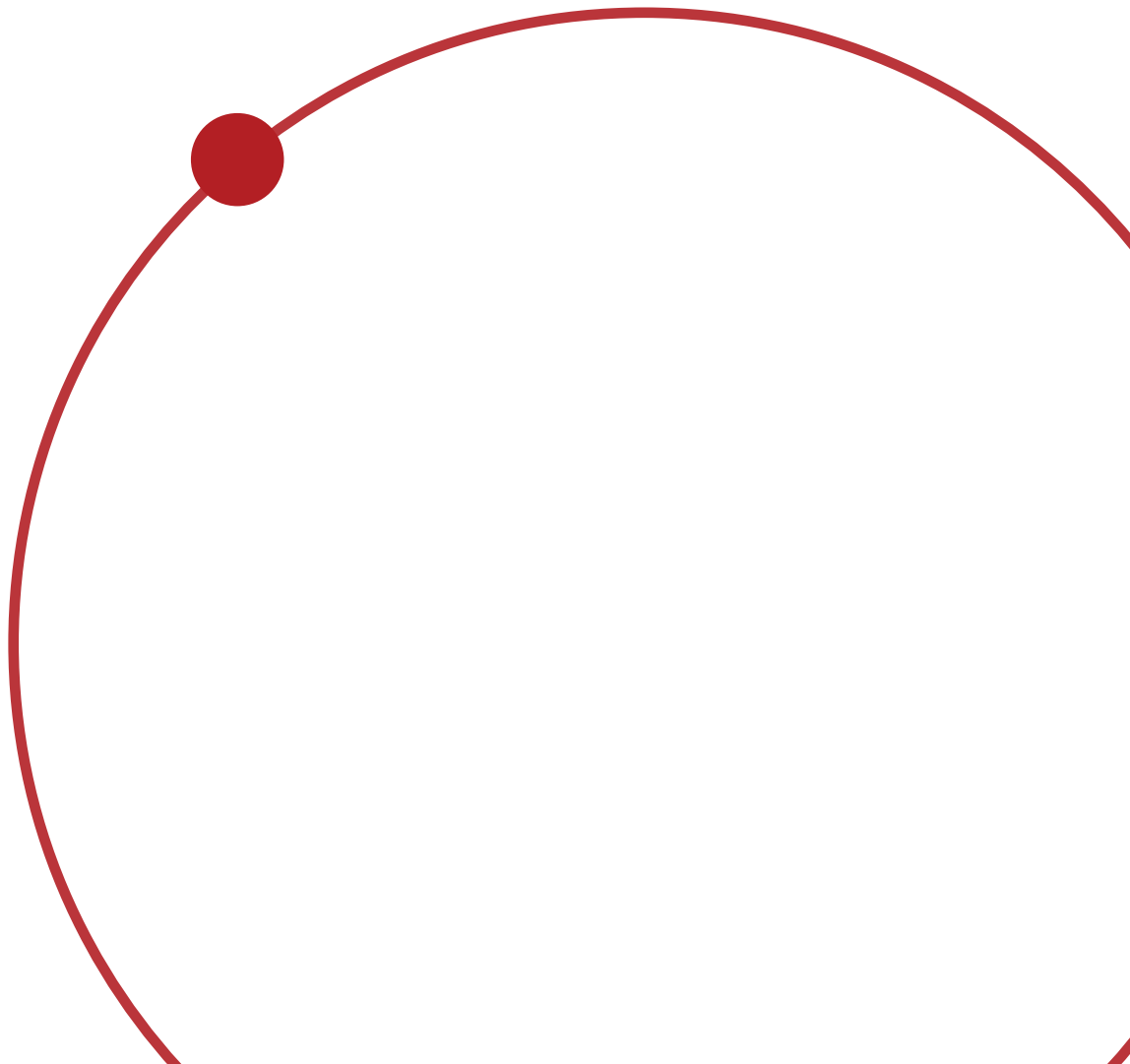
SEED was founded in 2002 at the World Summit on Sustainable Development in Johannesburg by UNEP, UNDP, and IUCN. It is a global partnership for action on sustainable development and the green economy. Today, we seek to unlock the full potential of social and environmentally focused ('eco-inclusive') market-based enterprises. We help tackle climate change effects and contribute to solving the world's social problems, as captured in the Sustainable Development Goals (SDGs).

ACKNOWLEDGEMENTS

We express our gratitude to all those who were instrumental in the completion of this publication. Our sincere gratitude goes to all the enterprises (see annex) who participated in the interviews and shared valuable insights as well as local experts from the Botswana Climate Change Network, Botswana Community Based Organisations Network (BOCOBONET), Business Botswana, Centre for Coordination of Agricultural Research and Development for Southern Africa (CCARDESA), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Esoko, NGO Council Botswana, UMODZI Consulting and the University of Botswana for their contributions as knowledge and network gatekeepers. Many thanks also to our SEED colleagues (see contributors) for their support in design, proofreading and providing critical feedback. Finally, we would like to thank the Government of Flanders for enabling this publication as a component within a regional project that the Government of Flanders commissioned and funded.

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES.....	IV
LIST OF ABBREVIATIONS.....	IV
EXECUTIVE SUMMARY.....	1
1. INTRODUCTION	3
2. CONCEPTS: ADAPTATION SOLUTIONS AND THE ROLE OF ADAPTATION SMES	4
3. COUNTRY-LEVEL ADAPTATION SME MARKET ANALYSIS: BOTSWANA, MALAWI & ZAMBIA	9
4. CONCLUDING REMARKS AND RECOMMENDATIONS.....	22
BIBLIOGRAPHY	24
ANNEX	29



LIST OF FIGURES AND TABLES

Figure 1: SMEs and Climate Change Adaptation	5
Figure 2: Adaptation SME Definition.....	6
Figure 3: Climate change and SMEs	7
Figure 4: Climate Change Adaptation Solutions.....	8
Figure 5: Climate Projections Southern Africa	9
Table 1: Overview of interviewed enterprises.....	14
Figure 6: Challenges and Opportunities of Adaptation SMEs in Southern Africa	22

LIST OF ABBREVIATIONS

BAU	Business-as-usual
CSA	Climate-smart agriculture
FISP	Malawi’s Farm Input Subsidy Programme
GDP	Gross Domestic Product
SME	Micro-, small and medium-sized enterprise
TFP	Total Factor Productivity

EXECUTIVE SUMMARY

Southern Africa already suffers from the effects of climate change, with business-as-usual (BAU) scenarios projecting a rise of 4°C in regional mean temperatures within the 21st century and a significantly increased prevalence of extreme weather events (IPCC 2014). This calls for urgent measures to empower citizens in increasing their adaptive capacities to reduce climate change-induced vulnerabilities. Establishing such capacities is traditionally perceived as a task of public actors. In light of insufficient adaptation funds and policy frameworks, however, governments in Southern Africa require support in providing adaptation support by local private actors. As the “backbone” of Southern African economies due to their contribution to regional employment and GDP (Alibhai et al. 2017), SMEs are a central actor group within the private sector and a crucial but underestimated partner in building local climate resilience. Apart from dealing with climate change only from a business risk perspective, an increasing number of SMEs in Southern Africa embraces climate change as a business opportunity. These “*adaptation SMEs*” offer products or services such as drip irrigation systems, organic fertilisers or small hydropower plants that help local communities and the private sector adapt to climate change. As locally embedded business ventures, *adaptation SMEs* provide adaptation solutions geared towards underserved and climate-vulnerable communities, thus significantly contributing to strengthening the region’s adaptive capacities. These enterprises, however, underlie local market conditions that highly influence their abilities to deliver adaptation products or services and their prospect to scale.

This study examines the characteristics of adaptation SMEs and investigates adaptation market opportunities and challenges that impact these enterprises in the three Southern African countries Botswana, Malawi and Zambia. Based on our experience with supporting over 1000 eco-inclusive SMEs in 38 countries that are part of the SEED enterprise database and in-depth interviews with eleven aspiring adaptation entrepreneurs across the energy and climate-smart agriculture sectors, the paper finds substantial opportunities for adaptation SMEs to scale and sustainably grow their operations, but also several considerable challenges that threaten adaptation SMEs’ success in Southern Africa:

OPPORTUNITIES

Adaptation SMEs targets groups that are severely underserved by large corporations and NGOs

Large corporations that offer adaptation solutions are not interested in non-affluent, often rural and smallholder dominated communities. Adaptation SMEs, therefore, tap into a market with tremendous potential, as they are locally rooted and thus can tailor their products to local communities’ needs.

Climate change already impacts adaptation SMEs

Adaptation SMEs’ customers need imminent solutions as they already face the effects of climate change. In agriculturally dominated communities, agricultural productivity and food security are already threatened by droughts, floods and forest degradation. Customers in Malawi and Zambia suffer from increasingly uncertain electricity supply as the countries’ hydropower-based grids are experiencing frequent climate change-induced disruptions, calling for a more diverse energy mix.

Adaptation SMEs have zero to sparse direct competition (sector- and country-specific)

Adaptation SMEs barely face direct product competitors operating in their markets. Greenhouse, hydroponic and irrigation system providing entrepreneurs identified other businesses with similar products, but geared towards a different clientele (large-scale commercial farms). Organic fertiliser and eco briquette SMEs see providers of non-organic fertiliser and charcoal products as potential market competitors, but rarely find other providers of their green products. Malawian and Zambian adaptation SMEs generally face a low but detectable degree of competition, whereas Botswana entrepreneurs were first movers in markets hardly populated by competitors.

COVID-19 pushes national governments to move towards less import dependence (country-specific)

Trade disruptions due to COVID-19 are leading to governments reassessing their dependency on resource imports. This is particularly the case with Botswana, as the country’s food security and own agricultural production is largely dependent on agricultural inputs and produce from other countries. As a counter-measure, Botswana is actively pushing for more import independence in the framework of the country’s recovery plan for the private sector.

CHALLENGES

There is a substantial lack of financial support programmes and schemes for adaptation SMEs

The lack of financial products that SMEs generally suffer from (SEED 2021) is more pronounced among adaptation SMEs. There are no specific climate adaptation finance schemes available for adaptation entrepreneurs in the three Southern African countries. This lack of financial support products extends to adaptation customers, with no national-level subsidy schemes for adaptation products available at the time of publication.

National policies that affect adaptation SMEs are non-conducive

National policies, frameworks, action plans and initiatives are ill-adapted to the local realities of agriculture and energy-based adaptation SMEs. Climate-smart adaptation-focused programmes disappoint due to a lack of consideration of actual customer needs and preferences. Subsidy input programmes in Malawi and Zambia promote the inflationary usage of chemical fertilisers, resulting in reduced market share potential for organic fertiliser producers.

There are educational and socio-cultural barriers to adaptation products/services

Adaptation SMEs' customers commonly lack knowledge about climate change adaptation and the benefits of purchasing climate change adaptation products or services. Furthermore, there are cultural misconceptions about eco briquettes being substandard compared to wood-based cooking fuel.

Customers suffer from low purchasing power

Adaptation SMEs' primary customer groups often live in agriculture-dependent rural communities with relatively low average household incomes and irregular income inflows. In the absence of public financial support programmes, customers' low budgets prevent larger adaptation product investments – despite their potentially substantial positive economic impacts (e.g. productivity increase of greenhouse farms). Although adaptation SMEs have resorted to a variety of payment schemes such as pay-as-you-go models and community loans, client purchasing power remains a central barrier to adaptation SME success.

COVID-19 affects adaptation SMEs

The effects of the pandemic and political countermeasures taken have resulted in a regional economic downturn, leading to a decreased customer purchasing power, production halts due to lockdowns and sourcing disruptions for adaptation SMEs. This is particularly affecting enterprises who depend on internationally imported machinery and production inputs, such as eco briquette and greenhouse producers.

Through its assessment of Southern African adaptation SMEs, this report expands the still-nascent body of case study-based literature on adaptation entrepreneurship and is thus suited for academia and practitioners active in this field. It is the first one to identify opportunities for successful adaptation entrepreneurship as well as barriers to growth and scale in the region. It, therefore, aims at current and future Southern African adaptation entrepreneurs, potential investors, national financial institutions and policy-makers seeking to support adaptation SMEs. The study furthermore urges international players of climate action to consider adaptation entrepreneurship as an important (cost-effective) and sustainable tool for successful climate change adaptation. While recent climate action events such as the COP26 indicate a global tendency to a more adequate consideration of adaptation action (UNEP 2021), private sector engagement in the form of small and medium-sized businesses as providers of adaptation solutions is still a largely neglected topic.



1. INTRODUCTION

The Southern African countries Botswana, Malawi and Zambia face an uncertain future. The region is witnessing substantial climate change effects and daunting future climate scenarios. In a business-as-usual (BAU) scenario, temperatures are projected to exceed a 4°C mean temperature increase in most land areas within the course of the 21st century (IPCC 2014). Projections also show drier winters, rainfall decreases in austral spring months and concerning drying signals over the region's climatologically dry areas in particular (ibid). These macro effects of climate change have a significant impact on the region's ecologies, livelihoods and economies: yield losses in the coming 30 years are estimated to oscillate around 18% for the region (Zinyengere et al. 2013), regional GDP is expected to decrease annually to rates between 3.3 and 5% (ACPC 2018)¹ and inequalities and migration dynamics are expected to intensify (The White House 2021).

The anticipated socio-economic effects of climate change in the region call for urgent action to increase climate change resilience. Public adaptation-oriented programmes, however, are only inadequately funded by global and regional climate action players (CPI 2019).² Their efficiency moreover suffers from short programme life cycles, rootlessness within affected communities and high access requirements for users (Ludi et al. 2012). Thus, progress in increasing Southern African countries' adaptive capacities needs to stem from the affected countries themselves. Botswana's, Malawi's and Zambia's public institutions, however, find themselves overwhelmed by the task of steering their communities into more resilient waters due to a lack of funds, inadequate national-level climate action policy frameworks and overlapping institutional competencies (Heinrich Böll Foundation 2011; Climate Emergency Institute 2015). In light of these insufficiencies, the private sector ought to step in as a contributor to climate change resilience. The economic fabric of the countries' economies being predominantly made up of SMEs (Polity 2014), these smaller-sized enterprises can have a substantial impact on the countries' adaptive capacities to climate change through multiple channels:

1. their support of communities' adaptive capacities through the provision of adaptation products and services (ASAP 2020),
2. their function as providers of climate adaptation information (ASAP 2020)

3. their role as locally rooted partners in multi-stakeholder adaptation programmes (Pauw/Chan 2018)
4. their need to adapt to a changing climate themselves (adelphi 2019)

Surprisingly, there is little consideration for SMEs as adaptation product/service providers in the current academic discourse and international policy debates. The lion's share of publications, projects and programmes focus on building business climate resilience and the unlocking of SMEs as funders of adaptation measures (Druce et al. 2016; Schaer/Kuruppu 2018). Against this backdrop, SEED set out to investigate what still constitutes a black box for climate change and entrepreneurship academia and practitioners – the case of adaptation SMEs, who provide products and services that increase consumers' resilience to climate change. In this regard, and with our geographical focus on the three Southern African countries Botswana, Malawi and Zambia, we seek to answer the following questions:

1. *In which markets and with what products/services are adaptation SMEs active?*
2. *What challenges hinder adaptation SMEs to foster their adaptation impact?*
3. *Which opportunities can enterprises capitalise on in order to scale their business growth and impact?*

As experts in the field, SEED engaged with 11 adaptation entrepreneurs from the three target countries who, through in-depth interviews³, shared their experiences of operating in the growing adaptation solution markets. All interviewed enterprises are operating in the agricultural and energy sector. These economic target sectors were selected due to the ubiquity of adaptation SMEs prevalent in the sectors.⁴ All interviewed entrepreneurs were or currently are participating in SEED eco-inclusive enterprise incubation and acceleration programmes.⁵ As adaptation SMEs and business-based adaptation solutions are a fairly understudied enterprise type⁶, the adaptation SME market analysis in the three target countries is preceded by a conceptual approximation of what adaptation SMEs are and how they operate.

¹ Within the bounds of a global 2°C temperature increase

² Despite Paris Agreement commitments to evenly distribute climate finance between mitigation and adaptation programmes, the Climate Policy Initiative (2019) found that adaptation-focused projects only received 5.2% (US\$ 30 billion) of the total funding volume (US\$ 579 billion) in 2019.

³ The interviews were virtually conducted, ranged between 60 and 90 minutes and were semi-structured. Data were collected between March and April 2021.

⁴ The selection of economic sectors due to adaptation SME prevalence limits this report's findings' expressiveness to the selected sectors.

⁵ For an overview of adaptation-oriented SMEs that we currently support, see the 2021 SEED Climate Adaptation Award enterprises here: https://seed.uno/enterprise-profiles?search_by_keyword_e=&search_by_award_category%5B%5D=7&art_state=1&cck=enterprise_profile&search=enterprises&task=search

⁶ One notable example of this lack of research and conceptualisation is the Adaptation SME Accelerator Project's (ASAP) Taxonomy on Adaptation SMEs (2020), which provides valuable groundwork for analysing characteristics of adaptation SMEs.

2. CONCEPTS: ADAPTATION SOLUTIONS AND THE ROLE OF ADAPTATION SMEs

Adaptation SMEs and adaptation solutions as terms require further conceptual framing. Against this backdrop, the following chapter illuminates the different types and effects of adaptation solutions and how adaptation SMEs come to provide said solutions in the form of climate change adaptation products or services.

2.1 Adaptation solutions and the role of the private sector in adaptation

Adaptation solutions are technologies, products, or services that can help identify, assess, transfer, and/or monitor physical climate risks and their impacts (ASAP 2020). Such solutions can be described as either grey, green or soft (Climate ADAPT 2021). Grey measures relate to products or services that are based on technology and engineering solutions, which specifically target the climate resilience of people, territories and infrastructure. This entails sea walls, water-saving and renewable energy technologies (IPCC 2014). Green measures encompass nature-based solutions that utilise resources and the effects of natural ecosystems to bolster communities' resilience to climate change. Green adaptation solutions comprise measures towards afforestation, green infrastructures such as green urban corridors or community-based natural resource management (ibid). Lastly, soft options are solutions that involve the realisation of opportunities in the spheres of finance, law, management and policy, resulting in heightened climate change awareness and improved adaptation resources and capacities. Examples are adaptation taxes and subsidies, land zoning laws or national adaptation plans (ibid). Together, adaptation solutions focus on:

- Countering the effects and losses resulting from climate risks (such as managing community relocation from desertification)

- Compensating for negative socio-economic risks and losses (such as index-based weather insurance)
- Minimising exposure to climate change-induced risks (such as building flood levees and culverts)
- Taking advantage of climate-change opportunities (such as diversifying practices or engaging in new activities that take advantage of changing climate) (Climate ADAPT 2021)

Adaptation SMEs provide communities with grey solutions. Public and civil society (e.g. NGOs) climate actors pursue predominantly green and soft options. On the contrary, the private sector tends to provide and acquire grey adaptation solutions, particularly in increasingly tech-dependent economic sectors such as agriculture and energy, as these solutions are easier to render as commercially viable products or services. Large corporations often dominate adaptation markets while their offer (e.g. drought-resistant crop seeds) is typically tailored to commercial agricultural enterprises and affluent households. Simultaneously, they largely neglect rural smallholder-based communities in remote locations with low incomes and local SMEs, which are highly vulnerable to climate change.

2.2 Adaptation SMEs as holistic and locally embedded adaptive capacity accelerators

Adaptation SMEs combine SME characteristics such as local embeddedness and the inclusion of vulnerable communities in their value chains (SEED 2021) with an adaptation-gear business rationale. While adaptation SMEs typically have at its core the provision of some product of service (grey solutions), they frequently and holistically include green and soft adaptation measures into their operations. Adaptation SMEs are often active in low-income and/or rural communities lacking climate change knowledge and adaptation strategies. Thus they would spend resources on community capacity development and awareness-raising campaigns, looking to increase the willingness of community members to pay for their products or services. Indirectly, this knowledge increase impacts community demands for politico-legal adaptation policies and institutions (soft solutions). Adaptation SMEs' local embeddedness often results in a

sense of responsibility to engage in green measures as an addition to their core business, e.g. via tree planting initiatives (green solutions). Due to adaptation SMEs' traits and business operations, they are often well-known and trusted among their particularly rural and agriculture-focused peer communities.

Apart from providing products or services to increase communities' adaptive capacities, adaptation enterprises fulfil another essential function: they strengthen the resilience of other businesses as consumers of their products. This support is direly needed: evidence drawn from a survey among SEED-supported SMEs in Southern Africa operating in multiple economic sectors show that 96% of surveyed businesses battle with the adverse effects of climate change (SEED 2021).⁷ This overwhelming degree of affectedness is set against an

⁷ The survey was conducted in early 2020 with 80 eco-inclusive SMEs that took part in different SEED programmes in Malawi, Zambia and Zimbabwe. The surveyed SMEs were in different development stages.

alarmingly low level of preparedness. According to a UNEP (2015a) survey of SME decision-makers in eleven developed and emerging markets, only 26% of smaller businesses have a strategy or plan in place to deal with potential climate-related risks. One in four decision-makers believes their business is well equipped to adapt to climate impacts. At the same time, 85% of respondents

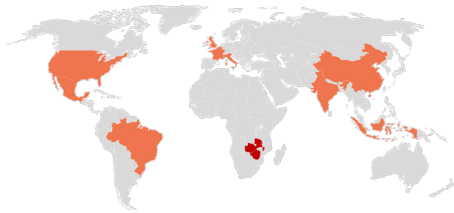
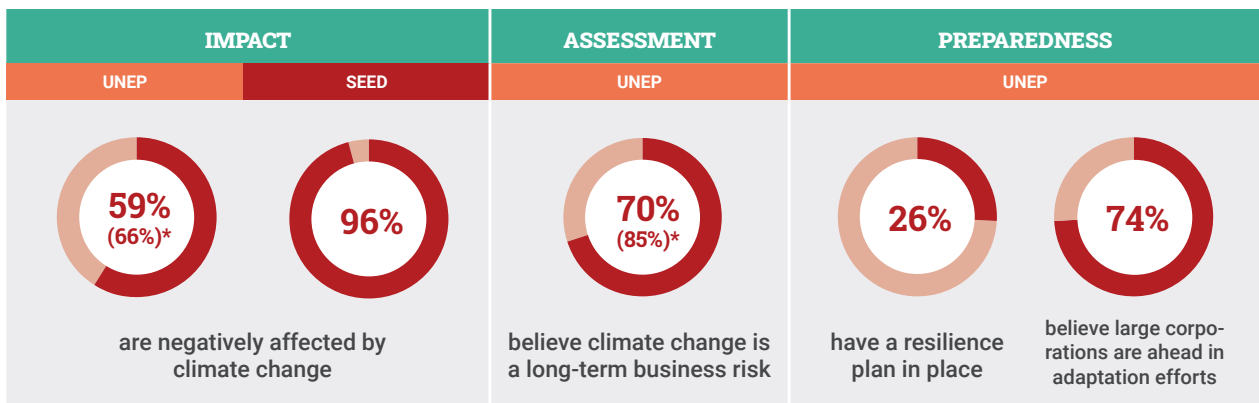
in emerging markets are worried about further climate impacts on their business (ibid). This is where adaptation SMEs are well-positioned to assist these enterprises: they provide solutions to adaptation issues while being knowledgeable about the specific needs and resources SMEs have at their disposal.

Figure 1: SMEs and Climate Change Adaptation



SMEs and Climate Change Adaptation

SME entrepreneurs around the world...



UNEP (2015) survey countries
 SEED (2020) survey countries

* Numbers in parantheses refer to survey results in emerging markets only

Source: SEED, data from UNEP (2015) and SEED (2020).



Chaca Rice Processing Initiative, Zambia

What is a micro-, small or medium-sized enterprise (SME)?

There are various definitions of smaller enterprises across countries and organisations. We approach SMEs in this paper based on the International Finance Corporation's (IFC 2012) working definition of micro-, small and medium-sized enterprises visualised in the table below.⁸⁹

Table 1: Defining SMEs

Indicator	Micro	Small	Medium
Employees	1 < 10	10 < 50	50 < 300
Total annual sales	<USD 100,000	USD 100,000 < USD 3 m	USD 3 m < USD 15 m

Source: IFC (2012).

What are adaptation solutions?

Adaptation solutions are technologies, products, or services that can help identify, assess, transfer, and/or monitor physical climate risks and their impacts (ASAP 2020). Such solutions are highly context-specific as they are directed towards any element under climate-induced risk. Thus, adaptation solutions and applicable sectors vary by geography and system of interest, be it a community, a specific infrastructure or a local ecosystem.

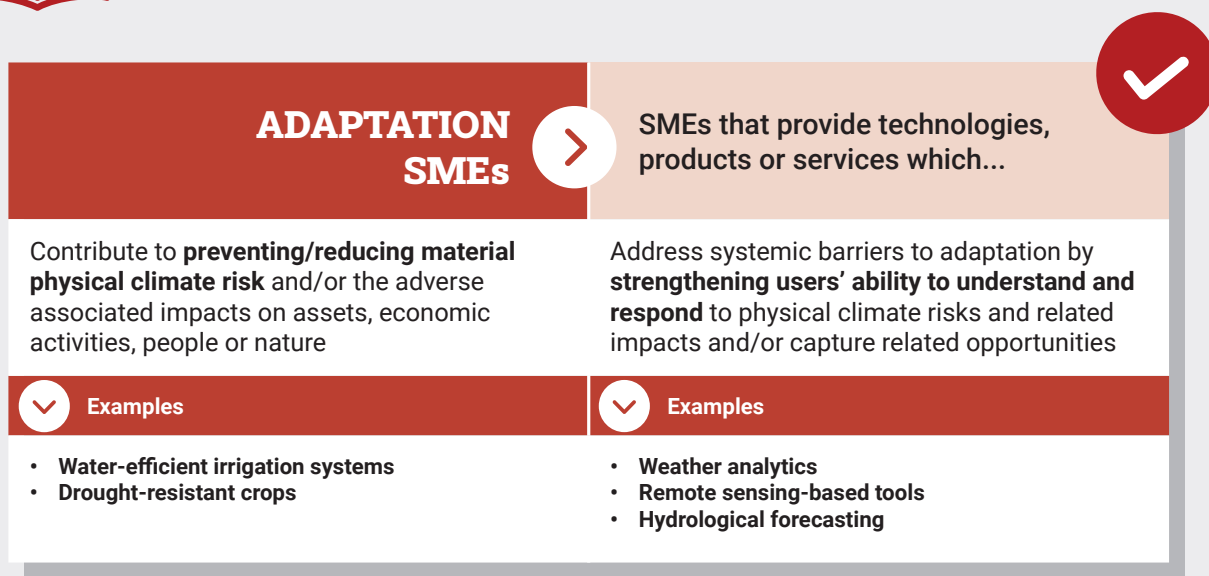
What is an adaptation SME?

Adaptation SMEs provide specific market-based adaptation solutions that 1) increase the climate resilience of elements exposed to climate risk and 2) reduce negative climate change impacts on lives and livelihoods of those affected, as the illustration below visualises.

Figure 2: Adaptation SME Definition



Definition of Adaptation SMEs



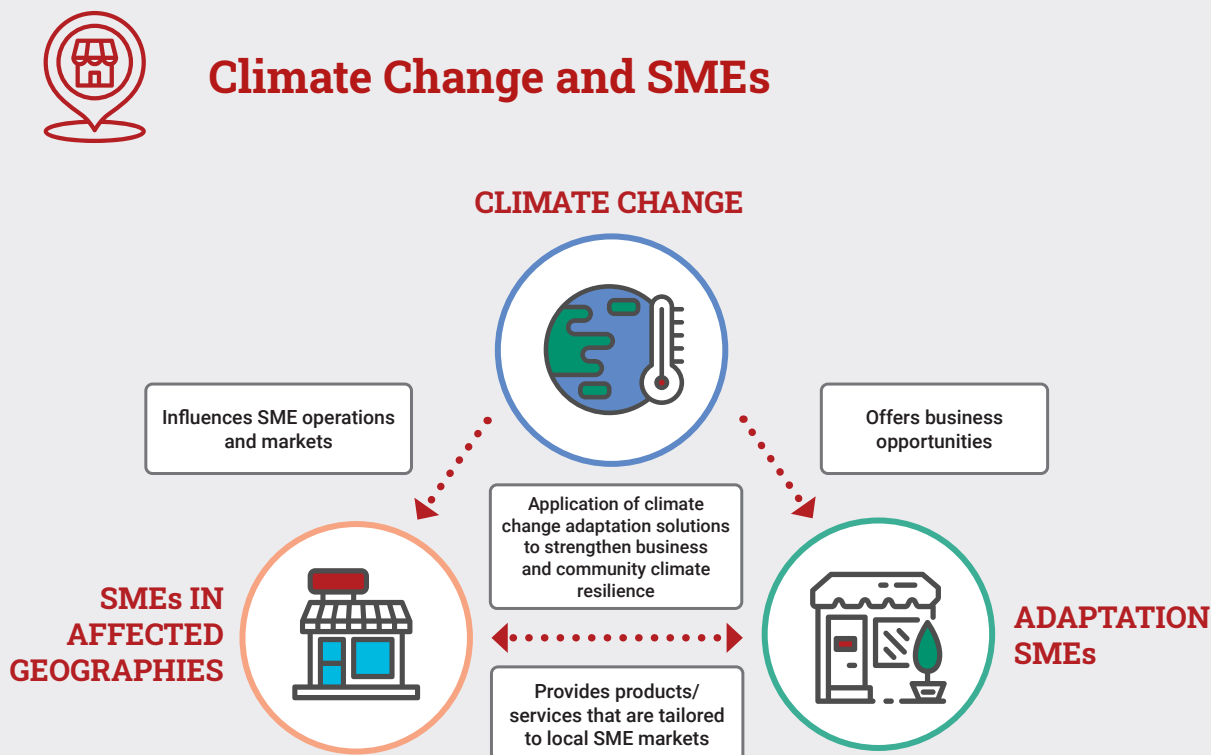
Source: ASAP (2020).

⁸ An enterprise is ascribed a firm class when it meets at least one of the two indicators.

⁹ We refer to the term SME instead of MSME since it is the more common form of abbreviation. Although other publications on SMEs omit micro-sized enterprises, we explicitly include them as part of this enterprise cluster.

Adaptation SMEs only represent a small share of overall SMEs. SMEs' scope of impact on climate change adaptation capacities varies substantially, ranging from a mere focus on building business-focused climate resilience to the provision of specific adaptation solutions. While strengthening climate resilience for businesses ensures business continuity under worsening climate conditions, the application of adaptation solutions substantially impacts the climate resilience of local communities, livelihoods, and ecosystems. The provision of adaptation solutions, be it technical, ecosystem-based, knowledge- or capacity-based solutions, positively impacts the economic sector that SMEs are serving with potential spill-over effects for other related sectors.

Figure 3: Climate Change and SMEs



Source: SEED.

Adaptation SMEs are part of the eco-inclusive enterprise continuum

We understand adaptation SMEs as part of the eco-inclusive enterprise spectrum. Eco-inclusive enterprises look for economic profit and integrate environmental and social objectives into their business model. Locally embedded, eco-inclusive SMEs are well-positioned to understand local social and environmental issues challenges and develop targeted solutions to effectively address them. They are dependent on local resources and capacities and often serve marginalised communities that are highly vulnerable to climate change.

2.3 Sectors, products and services offered by adaptation SMEs

Based on SEED's database of over 1000 eco-inclusive SMEs in 38 countries, we found that adaptation SMEs are predominantly active in the fields of:

1. Climate-smart agriculture and forestry,
2. Water protection & management as well as
3. Climate-smart energy systems and energy efficiency (see figure 4).

SEED has supported 71 enterprises since 2018 that work in the fields of sustainable agriculture, water and clean energy. Among them, 50.7% are actively offering adaptation-based products or services as an integral

component to their business models – showcasing how adaptation SMEs are a validated and promising vehicle to attain adaptive capacities among communities. Among the 29 enterprises that SEED has supported in Botswana, Malawi and Zambia, 22 adaptation-targeted products or services were stated. Among these, the provision of solar systems (8) was the most prevalent activity, followed by eco briquettes and the provision of drought-resistant crops or seedlings (3 each), organic fertilisers, solar-powered irrigation systems and greenhouses (2 each), and offering of small hydro and hydroponic systems (1 each).¹⁰

¹⁰ Some enterprises engage in the provision of more than one adaptation-targeted business activity.

Figure 4: Climate Change Adaptation Solutions



Climate Change Adaptation Solutions

Adaptation SME Prevalence

ENERGY

Climate-smart energy systems & energy efficiency

- Small hydro
- Decentralised solar grids
- Eco briquettes and palletes

IT and DATA

Early warning and environmental assessment

- Remote sensing
- Hazard mapping
- Improved weather forecasting

BIODIVERSITY & ECOSYSTEMS

Marine, fishery & coastal zone protection and management

- Seaweed farming
- Geo-synthetics
- Anti-forest fire systems

AGRICULTURE

Climate-smart agriculture & forestry

- Organic fertilisers
- Protected cultivation
- Drought-resistant crops

WATER

Water protection and management

- Hydroponic systems
- Water storage and harvesting
- Drip irrigation systems

HEALTH

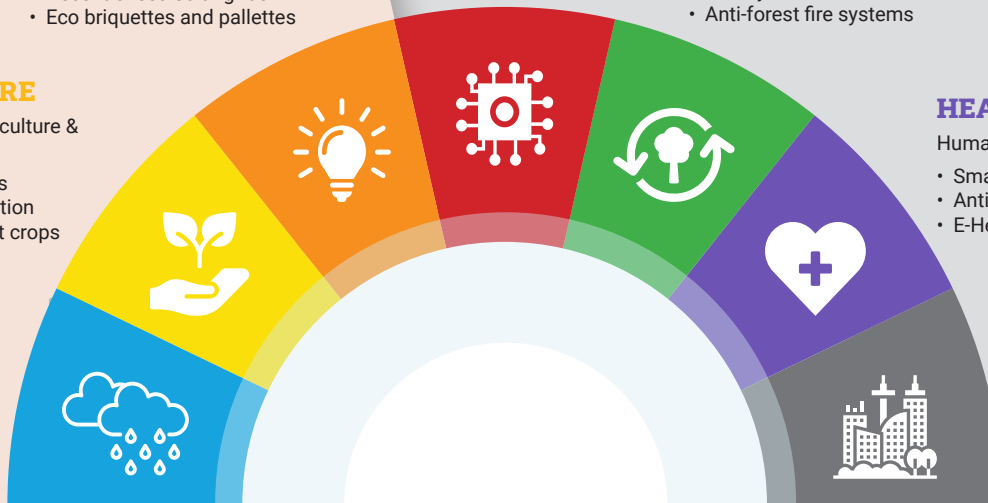
Human health

- Smart sanitation systems
- Anti-malaria measures
- E-Health

INFRASTRUCTURE

Climate-smart infrastructure and urban planning

- Decentralised power grids
- Heat/cold resistant pavement
- Motion-dampening systems



Source: SEED, solution typology derived from ASAP (2020).



Mooto Cashew Suppliers, Zambia

3. COUNTRY-LEVEL ADAPTATION SME MARKET ANALYSIS: BOTSWANA, MALAWI & ZAMBIA

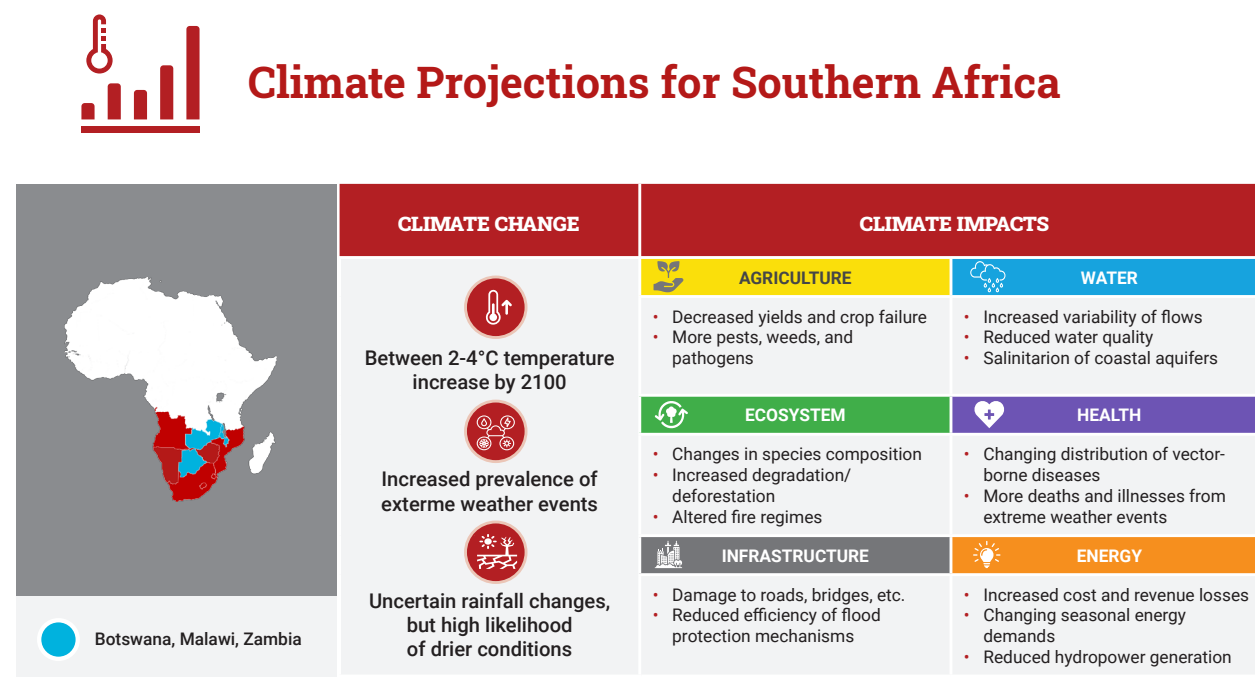
This section examines market opportunities and challenges for adaptation SMEs in the three Southern African countries. The scope is limited to climate change impacts in the countries' agricultural and energy sectors, as these are crucial for stable national economies. The first sub-chapter gives an overview of adaptation needs in Botswana's, Malawi's and Zambia's agriculture and energy sectors, which is succeeded by identifying core opportunities and barriers through insights of interviewed energy and agriculture adaptation SMEs in the target countries.

3.1 Adaptation needs in the target countries

Southern Africa in general and particularly the three target countries – Malawi, Zambia and Botswana –, are anticipating substantial climatic changes to negatively affect ecosystems, markets and social fabrics, which call for urgent measures to strengthen adaptive capacities. Climate projections indicate mean temperatures increasing by over 2°C in the coming decades, with increased incidences of extreme heat waves and increasingly irregular precipitation patterns (IPCC 2014).

The region's rapid growth in population, urbanisation of coastal agglomerations, prevailing water scarcity and high poverty levels (USAID 2016) are further stressors that accelerate both severity and breadth of looming climate change-related socio-economic challenges. The following sub-chapters limit the scope to climate change impacts in the countries' agricultural and energy sectors, as these are crucial for stable national economies.

Figure 5: Climate Projections Southern Africa



Source: SEED, data from USAID (2016).

Agriculture

Southern African food systems will be under increasing climate stress as an effect of increasing temperatures and volatile rainfall patterns. The overwhelmingly rainfed agricultural economies in the region will be particularly affected (Nhemachena et al. 2020), with yield decreases across major crops in the high single-digit areas (Lobell et al. 2008; UNFCCC 2020).

Malawi's and Zambia's economies are heavily dependent on and dominated by smallholder agricultural production, which is, in over 90% of cases, rain-fed and therefore highly susceptible to high rainfall variabilities, floods, droughts and heatwaves (CIAT 2018). More than 90% of Malawi's population is active in agriculture, with smallholders producing 80% of all crops used for domestic consumption

(ibid). Malawi's agricultural sector accounts for as much as 30% of its total GDP, emphasising its central role in the country's economy (ibid). As for Zambia, its economy is similarly characterised by a strong smallholder-dominated agricultural sector, albeit integrated into a more diversified economy (AOEC 2021). Almost 50% of the population works in agriculture, with 71.5% of farmers in possession of fewer than two hectares of arable land (FEWS NET 2014). The agricultural sector accounts for 8.2% of the country's GDP (World Bank 2018). The two countries are likely to experience weighty threats to their economic systems as a result. Malawi and Zambia's crucial maize yield is projected to decrease by 11% and 9%, respectively, by 2050 (CIAT 2017; 2018).

Botswana's food system is viewed as comparatively less vulnerable to the effects of climate change due to its higher development status and associated disaster response readiness (CARIAA 2016) and the low importance of domestic agriculture. Agriculture only accounts for roughly 3% of GDP (USDA 2015), with the

Energy

The electricity grids in Malawi and Zambia are characterised by their dependency on hydropower with low levels of rural electrification, which increasingly threatens grid security in the face of intensifying climate change. 98.2% and 93.3% of the countries' electricity productions are derived from hydropower from water bodies such as Lake Malawi and the Zambezi river basin. Hydropower, however, is likely to be heavily impacted by climate change (ADB 2013; Burillo 2018; Ebinger/Vergara 2011; IHA 2019; US EIA 2019; WMO 2017), as its electricity output is directly dependent on variations of rainfall and temperature patterns, which affect streamflow shifts and surface evaporation. African hydropower is particularly vulnerable to climate change due to general water scarcity: the continent has less than 9% of the global renewable freshwater resources, and hydropower competes with all other productive water usages (IEA 2020). In drought periods, these hydropower dependencies can have disastrous effects on the countries' electricity security. The El Niño weather phenomenon in 2015 and 2016 showed that drought conditions led to widespread and frequent blackouts (LSE 2018). In recent years, drought-induced hydropower blackouts have left large parts of Malawi's and Zambia's residential and business agglomerations in the dark (BusinessDay 2019; NBC 2015; New York Times 2016; The Guardian 2017). These blackouts are further underlining the threat of overreliance on energy resources that are vulnerable to the effects of climate change. Malawi and Zambia's fragile energy generation systems mandated to connect the countries' populations to the central energy grid face an enormous task. Malawi and Zambia rank 214th and 202nd out of 216th globally in electrification and have only 5% and 11% of their rural population connected to the energy grid (USAID 2020a; USAID 2020b). Both Malawi's and Zambia's electrification efforts involve vast investments and the need to rethink electrification in times of increasing climate change effects.

country's agricultural potential limited due to the Kalahari Desert occupying a large share of Botswana's area. About 85% of Botswana's agricultural output is derived from livestock production and as much as 90% of its agricultural produce is imported. (Moseley 2016). The country's major concern regarding agriculture and climate change is the dependency on other heavy-hit agricultural exporters such as South Africa – resulting in high price volatility and uncertain food security (ibid).

All three target countries lack climate policies that support or encourage adaptation entrepreneurship. Although Malawi and Zambia have put several climate policies in place that focus on agricultural adaptation, most of such frameworks only regard smallholder farmers as consumers of products. The policies largely fail to support the private sector in its role as providers of agricultural adaptation solutions. Botswana, in comparison, displays a considerable lack of climate policies in general.

In contrast to the two other target countries, Botswana derives 99.6% of the country's energy production from fossil fuels.¹² The country's relatively high energy consumption per capita leads to half of Botswana's power being imported (UNEP 2015b) from South Africa and Zambia. Botswana's energy security is therefore affected by climate change through third countries. However, its dependence on Zambian hydropower-generated electricity underlines the importance of recent policy steps for more independence from such energy resources (All Africa 2020).

All three countries have a high potential to diversify their energy mix towards more renewable energy sources, which is considered to different degrees in policy frameworks. With extremely high solar irradiation levels, Malawi and Zambia are highly suitable for solar energy for domestic use, irrigation and small business operations (Gamula/Hui/Peng 2013; REEEP 2012). Key policy frameworks such as Malawi's and Zambia's National Energy Policy highlight the role of the private sector in achieving energy diversification, increase in solar energy shares and a decentralised power grid (MoE 2019; GoM 2018). However, there is no further analysis of what the "private sector entails" and the extent to which SMEs are included. With about 3,200 hours of sunshine per year, solar radiation in Botswana is abundant and highly suitable for large-scale exploitation. The country's lack of comprehensive guiding policies on climate action also translates into its energy policy frameworks, with very low levels of adaptation programmes or projects (CARIAA 2016). This absence of regulatory frameworks inhibits private sector involvement generally, including that of renewable energy SMEs.

¹¹ <https://databank.worldbank.org/reports.aspx?source=2&series=EG.ELC.ACCS.ZS>
¹² <https://data.worldbank.org/indicator/EG.ELC.ACCS.RU.ZS?locations=BW>

Population

 **2.2m**

Rural population 29.8% ^[1]

Human Development Index

 **100 / 189** ^[2]

GDP per capita

 **7,961 USD** ^[3]

Main economic sectors (GDP) ^[4]

- Financial & business services **38%**
- Mining **28%**
- Tourism **16%**



Botswana is Africa's largest diamond producer with diamond exports worth **USD 4.85bn** (2018) ^[5]

AGRICULTURE



Agriculture accounts for only **2%** of GDP ^[6]



Only **0.5%** of Botswana is arable ^[7]

Agriculture is dependent on groundwater ^[8]

Import dependency:

11.7% of Botswana's imports are agricultural products ^[9]



85% of agricultural output is livestock production ^[10]



Livestock production (in tonnes) ^[11]

- cattle **34,000**
- goats **4,644**
- chicken **2,403**
- pigs **332**

ENERGY



CAPACITY
730 MW ^[12]

99.6% of energy is produced from fossil fuels ^[14]

50% of power requirements are imported ^[15]



Electrification rate: **81.1%** Urban / **27.9%** rural ^[16]

Global Ranking: **177** out of 216 ^[17]



CONSUMED
3.64 TWh ^[13]

Viable current and future energy sources



COAL



BIOMASS



SOLAR



GEOTHERMAL



HYDRO



OIL/GAS



NUCLEAR



WIND

CLIMATE CHANGE VULNERABILITIES

FUTURE CLIMATE SCENARIO



2071-2095

+ 3.5 - 6.0 °C

2050-2074

+ 2 - 4.5 °C

- ↑ Increased temperatures
- ↓ Decreased in precipitation (up to 25%)

AGRICULTURE

CLIMATE RISKS

- Reduced precipitation
- Shift in seasonal rainfall
- Increased incidence of extreme weather events
- A 2°C increase would reduce Okavango river streamflow by 12% and Limpopo catchment runoff by 36%
- Drought

POTENTIAL IMPACTS

- Reduced agricultural yield and crop failure
- Further reduction in arable land
- Increased cost of pumping water for livestock
- Increased incidence of mortality and heat stress in livestock

ENERGY

CLIMATE RISKS

- Drought and reduced rainfall
- Increased incidence extreme weather events

POTENTIAL IMPACTS

- Reduction of forest biomass for energy generation due to increased wildfires and droughts
- Increased vulnerability of energy infrastructure to extreme rainfall events
- Deforestation leading to reduction of forest biomass for energy generation
- Higher risk of damaged energy infrastructure



Climate Change Country Profile

MALAWI

Population

19.1m

Rural population 83% ^[1]

Human Development Index

174 / 189 ^[2]

GDP per capita

625 USD ^[3]

Main economic sectors (GDP) ^[4]

- Services **55.6%**
- Agriculture **22%**
- Manufacturing **11.7%**



45% of Malawi's export is made up of unmanufactured tobacco ^[5]

AGRICULTURE



80% of population active in agriculture ^[6]



Agriculture accounts for **30%** of GDP ^[7]

70% of agricultural GDP is from smallholder production ^[9]



Over **90%** of agricultural production is rain-fed ^[8]



Major food crops (% land use) ^[10]

- maize **28%**
- beans **5%**
- groundnuts **6%**
- cassava **4%**



Livestock production (in tonnes) ^[11]

- pigs **314,979**
- goats **58,321**
- chicken **135,725**
- cattle **52,045**

ENERGY



CAPACITY **532 MW** ^[12]



98.4% derived from hydro sources ^[14]



Electrification rate: **37.1%** Urban / **2%** rural ^[15]

Global Ranking: **216** out of 221 ^[16]



CONSUMED **1.32 TWh** ^[13]

Viable current and future energy sources



WIND



SOLAR



NUCLEAR



HYDRO



BIOMASS



OIL/GAS



COAL



GEOTHERMAL

CLIMATE CHANGE VULNERABILITIES

FUTURE CLIMATE SCENARIO



2090
+ 2.3 - 6.3 °C

2040
+ 0.5 - 1.5 °C

- ↑ Higher evaporation
- ↕ No clear trend in average annual rainfall change

AGRICULTURE

CLIMATE RISKS

- Rising temperatures
- Increased intensity and frequency of heavy rainfall events
- Increased drought conditions and dry spell length

POTENTIAL IMPACTS

- Decreased yield of rainfed crops (15% potatoes, 11% maize, 6% groundnuts by 2050)
- Increased risk of aflatoxin contamination in groundnuts, limiting export opportunities
- Further degradation of soil quality and productivity
- Destruction of agricultural infrastructure and crop losses due to flooding
- Food shortages, leading to increases in grain prices and imports

ENERGY

CLIMATE RISKS

- Reduced runoff and surface water availability
- Increased evaporation rates of existing water storage facilities
- Increased temperature
- Increased variability of river flows
- Increased heat stress and reduced water availability from rainfall

POTENTIAL IMPACTS

- Reduced hydropower generation potential
- Increased production costs, increasing prices for consumers
- Changing seasonal demands for energy with increased demand for peak loads during hotter summers; projected increased net electricity use
- Revenue loss from overbuilt and undersupplied hydropower

Population

 **16.2m**

Rural population 56% ^[1]

Human Development Index

 **146 / 189** ^[2]

GDP per capita

 **1,305** **USD** ^[3]

Main economic sectors (GDP) ^[4]

- Wholesale/retail **25.4%**
- Financial & business services **11.6%**
- Mining **13.4%**



Zambia is Africa's second largest copper producer ^[5]

AGRICULTURE



More than **6 out of 10** Zambians are employed in the agricultural sector ^[6]



Agriculture accounts for **8.2%** of GDP ^[7]



Smallholder dominated: **95%** of farms are less than 5 hectares ^[8]



Over **90%** of agricultural production is rain-fed ^[9]



Major food crops (% land use)

- maize **49%**
- legumes **14%**
- cassava **8%**
- vegetables **2%**



Livestock production (in tonnes) ^[10]

- cattle **191,349**
- pigs **34,506**
- chicken **50,772**
- goats **10,420**

ENERGY



CAPACITY **2,800** MW ^[11]



CONSUMED **11.04** TWh ^[12]

Energy composition ^[13]

- hydro **80.8%**
- coal **10%**
- heavy fuel oil **3.5%**
- solar PV **3%**



Electrification rate: **67.3%** Urban / **4.4%** rural ^[14]

Global Ranking: **202** out of 216 ^[15]

Viable current and future energy sources



SOLAR



COAL



BIOMASS



GEOTHERMAL



HYDRO



OIL/GAS



NUCLEAR



WIND

CLIMATE CHANGE VULNERABILITIES

FUTURE CLIMATE SCENARIO



2060
+ 1.2 - 3.4 °C

- ↑ Hot days and nights to increase by **15-29%** and **26-54%**, respectively ^[16]
- ⊕ Changes in rainfall seasons
- ↑ Increase in heavy rainfalls
- ⊕ No clear trend in average annual rainfall change

AGRICULTURE

CLIMATE RISKS

- Increased temperatures
- Increased rainfall variability
- Increased rainfall intensity
- Drought

POTENTIAL IMPACTS

- Less predictable growing seasons
- Increased pests, weeds and pathogens affecting crops and livestock
- Increased soil erosion
- Limited field operations due to waterlogging
- Decreased productivity and crop failure (yields are expected to reduce by 8.7% for maize, 5.2% for groundnuts, and 6.2% for vegetables by 2050)
- Reduced water and feed resources for livestock
- Increased incidence of mortality and heat stress in livestock

ENERGY

CLIMATE RISKS

- Drought and reduced rainfall
- Increased frequency of strong rainfall events

POTENTIAL IMPACTS

- Reduced hydropower generation capacity
- increased vulnerability of energy infrastructure to extreme rainfall events
- deforestation leading to reduction of forest biomass for energy generation

3.2 Market opportunities and challenges of adaptation SMEs in the target countries

The eleven interviewed adaptation SMEs offer a variety of products and services but can be subsumed as active in the fields of 1) climate-smart agriculture (CSA) and 2) energy provision. As illustrated in the table below, CSA-related products range from protected cultivation systems such as greenhouses or drip irrigation systems to organic fertilisers and drought-resistant seedlings. Energy-focused adaptation SME interviewees provide solar-

powered water pumps and irrigation systems, biomass charcoal briquettes as well as solar household systems.¹³ The following sub-chapter is firstly summarising general challenges and opportunities for adaptation SMEs. Secondly, the study highlights the interviewees' specific offered adaptation products and their opportunities and challenges in the three target countries.

Table 1: Overview of interviewed enterprises



Overview of interviewed enterprises

Enterprise	Country	Sector*	Size	Products/Services offered
BIO-WATT			Micro	Organic charcoal and eco briquettes, solar water pumps and offgrid systems
Chaca Rice Processing			Micro	Eco briquettes from rice husks
Green Ventures			Micro	Organic fertiliser
Hydroponics BW			Micro	Greenhouses, hydroponic systems
InteWaste			Micro	Eco briquettes from biomass
Kukula Solar			Small	Solar panels and lights
Mooto Cashew Suppliers			Micro	Drought-resistant cashew siblings
Noble Agriculture Technologies			Micro	Greenhouses, drip irrigation and hydroponic systems
Organic Fertilizer Manufacturers Botswana (OFMB)			Small	Organic fertiliser
RECAPO			Small	Solar systems (lighting, panels, charging stations, solar-powered water pumps)
Smart Energy Enterprise (SEE)			Micro	Solar pump irrigation systems + PAYG finance model

* = Energy = Agriculture

¹³ The enterprises' contact details can be found in the annex.



Kukula Solar, Zambia

General challenges and opportunities for adaptation solution SMEs

CHALLENGES



Lack of financial programmes and schemes

Adaptation SMEs have expressed a lack of financial support programmes and suitable finance schemes as the gravest barrier to growth and scale. There were no specific climate adaptation finance schemes available for the interviewed SMEs at the time of the interviews; entrepreneurs stated a severe lack of knowledge on adaptation practices and adaptation business models by local financiers. This is largely in line with other findings that underline the lack of sufficient SME climate finance infrastructure (SEED 2021). However, it is even more pronounced for SMEs providing adaptation solutions due to the relatively recent global focus on climate change adaptation. Adaptation enterprises shared that partnerships ensuring longer-term financial stability were crucially needed to attain deeper market penetration, explore new markets, and bridge cash cycle shortages in economically volatile times such as the COVID-19 pandemic.

Similarly, the lack of financial schemes such as subsidies for adaptation products impedes scaling product sales. On the one hand, this leads to an inability of adaptation SME clientele (e.g. smallholder farmers) to invest in adaptation-sound practices and equipment. On the other hand, adaptation SMEs themselves cannot purchase technical equipment to scale up their production or introduce new products to the market. Governments in the target countries recently focused increasingly on policies related to adaptation issues. There is reason for cautious optimism that countries' financial infrastructures may start accommodating adaptation both for consumers and producers in the near future.



Non-conductive policies

A second central barrier is the non-conductive fabric of national policies impacting adaptation SMEs' operations. Policies, frameworks, action plans, agendas and initiatives are ill-adapted to the local realities of agriculture and energy-based adaptation SMEs. Climate change adaptation knowledge among policy-makers and supporting local academia lacks expertise and suffers from poor coordination. As a result, CSA-focused agricultural programmes in the region disappoint due to a lack of consideration of local realities and preferences while neglecting the incorporation of already proven CSA products and technologies offered by adaptation SMEs. Subsidy input programmes such as Zambia's and Malawi's Farmer Input Support Programs (FISP) promote heavy usage of chemical fertilisers among smallholder farmers, reducing market share potential for organic fertiliser producers. As for energy providers, the lack of renewable energy-supporting policies such as subsidy programmes was stated as a substantial challenge across countries. In addition, a lack of national certification systems for adaptation products such as eco briquettes or organic fertilisers prevents adaptation SMEs from strategic partnerships with wholesalers and retailers, reducing their local market access and export potential.



Socio-cultural barriers

Another barrier illustrated by adaptation SME entrepreneurs were educational and socio-cultural barriers from customers in purchasing adaptation products, stemming from 1) a lack of knowledge about climate change adaptation, 2) traditionally embedded misconceptions on particular resources, and 3) a lack of awareness for the advantages of purchasing adaptation products over conventional means of agricultural production and energy consumption. Providers of protected cultivation systems such as greenhouses, hydroponics, and drip irrigation systems often voiced their frustration with the extensive awareness campaign and marketing efforts required to make customers realise the critical climate change adaptation need. Potential customers of eco briquettes commonly expressed their preference of cooking with firewood due to their deeply embedded community culture and rejected the usage of eco briquettes based on the misconception that organic waste could not be equally good as wood. This lack of information and the strength of misconceptions is partially attributable to the absence of educational campaigns from the respective countries' administrations.



COVID disrupting supply chains

A further critical challenge put forward by interviewed entrepreneurs was the low purchasing power of their primary clientele. Adaptation SMEs predominantly serve rural and rainfed agriculture-dependent communities with relatively low average household incomes. 9 out of 11 interviewees stated that climate change had already significantly affected their customers' ability to pay for adaptation products, particularly if said products necessitated larger financial investments. While the seasonality of agricultural produce has always impacted these communities' spending options, climate change, along with pre-existing poor long-term saving strategies, has exacerbated income insecurity and made smallholder households increasingly averse to farming or energy investments. In the absence of public financial support programmes supporting consumers with up-front financing mechanisms, several interviewed adaptation SMEs have resorted to a variety of creative payment schemes such as pay-as-you-go models and community loans.



Clients with low purchasing power

Finally, the COVID-19 pandemic has had a series of direct and indirect effects on the businesses in the target countries. Already faced with a general economic downturn, decreased customer purchasing power, and lockdowns, three interviewees explained that their largest COVID-related challenge was sourcing production inputs and machinery. Due to a lack of nationally produced inputs, hydroponic systems and sustainable charcoal briquette providers temporarily halted their production. Since revenues simultaneously dropped significantly, these enterprises still struggle to re-start production.

OPPORTUNITIES



Severely underserved target groups

All interviewees stated the opportunity of target groups being severely underserved by large corporations and NGOs. This is mainly due to large corporations' preference of tailoring products to commercial larger farms and more affluent customers. At the same time, rural smallholders are forced to attain expensive products unsuitable for their specific needs. In recent decades, many NGOs have taken on the quest to supply enterprises with products to increase their resilience to climate change. However, NGOs are heavily dependent on donor demands and political currents. Generally, they suffer from high bureaucratic entry barriers and temporary implementation roll-outs, resulting in planning uncertainty for local communities. As Malawian solar system adaptation SME RECAPO fittingly puts it, "there are many NGOs around who offer what we sell. But they just come, install the systems and leave – no training, no maintenance, no long-term service. Farmers come to us instead of NGOs."

With large corporations and NGOs not meeting rural communities' needs, adaptation SMEs have key advantages in stepping in and filling the gap with products and payment schemes tailored to the needs of smallholders and their communities. Adaptation SMEs are locally rooted, with personal connections to community leaders. Most of these enterprises' staff come from rural backgrounds and speak the local dialect, with salesforce agents often being members of the targeted communities. As these SMEs can address climate change and its adaptation needs face-to-face, they take over public institutions' roles to raise awareness for a broadly recognised need for adaptation. Being knowledgeable about local complexities, said SMEs are offering affordable small-scale solutions for smallholder communities, who enjoy long-lasting customer support by local staff. Due to their rootedness, they are trusted among the communities, which serves as a foundation for long-lasting beneficiary relations between adaptation SMEs and their customers.



Climate change effects for customers

A second key opportunity factor for adaptation SMEs is the impact that climate change already has on the majority of customers. All interviewees stated that a large share of their customers is adversely affected by climate change. Agricultural production is not secure due to irregular rainfall, prolonged dry spells or flooding according to 81% of the interviews; soil erosion due to deforestation according to 27% of the interviews, and increased difficulty of finding firewood as well as increased power shortages due to hydropower instability according to 18% of the interviews. Therefore, a common finding by adaptation SME founders was that customer bases grew, while efforts to change pre-existing critical conceptions on climate change could be significantly reduced. This was most pronounced among providers of solar-powered irrigation, greenhouse and hydroponics systems.



Lack of competitors

Consequently, a further identified opportunity factor was the lack of direct competitors for many adaptation SME products. Greenhouse, hydroponic and irrigation systems providers stated that competition was present but rather focused on commercial farmers as a focus customer segment. In adaptation-relevant sectors with significant competition by non-adaptation products (e.g. organic versus chemical fertiliser providers or eco briquette versus traditional charcoal sellers), respondents stated that they were actively looking into the possibility of forming cooperatives to provide a counterweight to larger corporations. Looking at country-level insights, Malawian and Zambian enterprises experience some degree of competition across sectors, while the three interviewed Botswana adaptation SMEs noted that they were first movers in a hardly populated field of competitors.



COVID leading to autarkic policies

Finally, COVID was identified as an opportunity for adaptation SMEs across countries. While the pandemic constituted a major challenge to supply chain and cash cycle management for the majority of enterprises worldwide, it appears that pandemic-induced border closings in Southern Africa have resulted in national governments reassessing their resource dependence on other countries. In the case of Botswana, this has resulted in actively pushing to reduce dependency on agricultural inputs and produce as part of its national recovery plan for the private sector (Business Botswana 2020).



Adaptation SME Snapshot Organic Fertilisers



ENTERPRISES

GREEN VENTURES | Malawi

Product: Organic fertiliser from household/smallholder org. waste

- Collects organic wastes from smallholder farmers and households for recycling via composting into high-quality organic fertiliser
- Sells the nutrient-rich, eco-friendly, safe and affordable organic fertiliser back to smallholder farmers as an alternative to chemical and environmentally-harmful fertilisers which acidify soils in the long-term

OFMB | Botswana

Product: Poultry-source organic fertiliser

- Offers organic fertiliser made from poultry manure, sourced from own poultry population and imported manure
- With a production capacity of 100.000 tons per year, the enterprise is exporting large shares of its production to South Africa, Zimbabwe and Zambia

Why are organic fertilisers adaptation solutions?

The usage of organic fertilisers helps farmers to cope with and combat soil degradation due to climate change-induced droughts or flooding events. While chemical fertilisers can be used for the same purpose, they are responsible for high nitrous oxide emissions, accounting for 2.5% of anthropogenic GHG emissions. Excessive usage of chemical fertilisers can also lead to nutrient toxicity, which impairs soil health and furthers soil degradation.



CHALLENGES

Inflationary usage of chemical fertilisers

The main obstacle for SMEs who produce organic fertilisers is the inflationary usage of chemical fertilisers and the underlying mindset fostering it. In the case of Malawi, this is promoted by the government. The state-led Farm Input Subsidy Program (FISP) reflects this controversial trend: it receives 16% of the entire Malawian government budget, supporting close to a million Malawian farmers in accessing chemical fertilisers (Oakland Institute 2020). Critics of this policy direction state that the FISP has not lifted Malawians out of hunger while producing significant profits for multinational agribusiness companies, whose chemical fertilisers are bought for the programme (ibid). These policies reduce demand for organic high-quality fertilisers. Similarly, Botswana organic fertiliser producers encounter a similar issue of farmer mindsets influenced by decades of being flooded by chemical fertilisers.

High certification requirements

A second challenge identified by the two interviewed organic fertiliser entrepreneurs was that export orientation requires the meeting of high certification requirements. This constitutes substantial entry barriers for non-major fertiliser producers, which particularly carries weight for producers based in countries with limited market size, such as Botswana.



OPPORTUNITIES

Regional demand for (organic) fertiliser

Only 1% of the world's fertilisers are used in the Southern Africa Development Community, starkly contrasting the importance of the region's domestic agricultural production. South Africa, Malawi, Zambia and Zimbabwe alone account for over 3.6% of the global corn field coverage (USDA 2021). Investigating agricultural total factor productivity (TFP), SSA has the lowest regional agricultural TFP rate globally. Since 2000, SSA countries saw a productivity increase of a mere 5%, compared to Southeast Asia with productivity increases of well over 60% in the same timeframe (USDA 2019). This demand for fertilisers generally is accompanied by a growing interest in organic fertilisers. According to a market report by Mordor Intelligence (2020), organic fertilisers are becoming increasingly demanded in Africa: although the continent's 1.9 million hectares of area under organic cultivation measured in 2017 only constitute 3% of global organic fertiliser usage, this represents an increase by over 5.2% compared to the previous year, with following years expected to follow a similar trajectory (ibid). This is reflected in the organic fertilisers' growth rate in Africa, which is projected to reach 9.3% compound annual growth rate (CAGR) in 2021 (ibid).

Growing health awareness and cannabis production

The interviewees stated that the expanding market for organic fertilisers is driven by growing health awareness among the predominantly urban African middle class as well as continuously high demand for export-oriented organic farmers and cooperatives. This market-based interest in organic fertilisers is further accompanied by governmental efforts to take part in the global trend of medicinal and industrial cannabis production. The Malawian parliament passed a bill in February 2020 factually legalising the cultivation and processing of medicinal and industrial cannabis (Reuters 2020), with the Zambian parliament following in stride in 2021 (CGTN Africa 2021). While the situation in Botswana is not equally clear cut, the country's government has approved the production of cannabis for an enterprise in 2018 (Sunday Standard 2019) and conducted a probe into cannabis as a cash crop in 2020 (Your Botswana 2020).

Lack of direct competitors

The global organic fertiliser market has a highly fragmented competitor scene, with the top five organic fertiliser providers accounting for only 20-30% of the total market share (MI 2020). The multitude of organic fertilisers serves hyperlocal markets in absence of certifications or standards whose compliance would constitute an entry barrier to enterprises looking to penetrate the market (cf. ibid). Malawian enterprise Green Venture had no direct competition in the scope of their operations, while in the case of Botswana, the enterprise OFMB stated they are the only organic fertiliser producer in the whole of Botswana.



Adaptation SME Snapshot Solar Energy Systems



ENTERPRISES

KUKULA SOLAR | Zambia

Product: Solar light, PV water pump, egg incubator

- Purchases solar products wholesale from manufacturers and sells them to customers directly through the solarpreneurs stationed in the community or nearby
- Provides to over 6 districts in Zambia, offering products and services to over 20,000 customers who are living in overwhelmingly rural and poor communities

RECAPO | Malawi

Product: Solar light, PV water pump

- Approaches rural households in Chimutu with solar home systems, offering them PAYG plans

- With a production capacity of 100.000 tons per year, the enterprise is exporting large shares of its production to South Africa, Zimbabwe and Zambia

SEE | Malawi

Product: PV water pump and irrigation systems

- Provides PV irrigation systems to smallholder farmers on their own rice fields on a three-year PAYG loan basis recovered through water user fees and farm produce levies
- Mobilises farmers into cooperatives who assume complete ownership over the irrigation systems after the loan is recovered

Why are photovoltaic systems (PV) adaptation solutions?

The provision of reliable energy is increasingly threatened by climate change in countries with high hydro-power dependency, as extreme weather events (droughts, floods) become more pronounced and unpredictable. Energy infrastructure is also affected by such climate-change induced events, rendering energy grids increasingly vulnerable. PV systems offer an alternative, decentralised source of energy to adapt to these changes.



CHALLENGES

Investment aversion and inability of target groups

The three enterprises unanimously identified investment aversion by their target group, smallholder farmers, as the primary and most challenging barrier to scaling their business operations. While the reasons for this are multidimensional, the interviewees stated the seasonality of rain-fed agricultural production combined with increasingly volatile precipitation patterns as core reasoning behind the caution of rural communities to invest in solar-powered systems. For the founder of Malawian solar-powered irrigation systems provider Smart Energy Enterprise (SEE), this presents itself as a chicken-and-egg problem: “[the farmers] hesitate to buy our products because they depend on the rain to grow their crops and sell their produce. But with climate change they cannot predict this anymore. However, without our product, they cannot gain independence from rainfall patterns”. In this sense, increasingly felt climate change impacts further reduce financial capital to acquire resilience-increasing technologies.

Competing public programmes

The second challenge pinpointed by the three entrepreneurs was the competition with state-led solar electrification programmes. Malawi with its Rural Electrification Programme (MAREP) and Solar Home Systems (SHS) project (Malawi Ministry of Energy 2020; Borgen Project 2020) showcase how private entities have potent public rivals



OPPORTUNITIES

Low electrification rates in Southern Africa

Botswana, Malawi and Zambia have extremely low rural electrification rates, with rural communities in urgent need to continuous access to energy for household and farming activities, provided by as many actors as possible. Fittingly, the Malawian founder of RECAPO illustrated: “of course there are public actors offering similar products. But we do not see them as competition [...]. The cake is vast, and there is a lot of space in the market”. Furthermore, and as noted above in the summary of general challenges and opportunities, the interviewed enterprises were confident in their comparative advantage to public solar institutions: all three solar adaptation enterprises stated that local communities preferred engaging with them compared to public actors due to their reputation, unbureaucratic purchasing process, flexible PAYG payment schemes and long-term maintenance service.

Central grids are unattractive and expensive

A second opportunity factor outlined by interviewees was that communal connection to the respective countries’ central grids remains unattractive for rural villages and costly for governments. Central power grids in Malawi, Zambia and, to a lesser extent, Botswana, continue to struggle providing continuous and blackout-free electrification. According to data gathered by the World Bank Group (2021), central grid-connected enterprises in Zambia experienced 13.3 power outages per month on average, while firms in Malawi suffered from 6.7 and Botswana companies from 4.1 blackouts, respectively. Moreover, even the most ambitious rural electrification programmes indicate that, without a strong push by private actors and decentralised grid distribution, sufficient rural electrification will still likely take up to a generation’s time. As an example, Zambia’s Rural Electrification Master Plan (REMP) identifies the maximum potential to achieve 51% rural electrification by 2030 (Get.Invest 2019).

The region’s solar potential is slowly recognised

As a third and final opportunity factor, the respective countries’ solar potentials in combination with climate change impacts were mentioned. Malawi’s and Zambia’s hydropower dependency increasingly turns into national energy concerns, as temperature increases and irregular rainfall patterns have resulted in intensifying energy volatility and load shedding (Taulo et al. 2015; D+C 2020). In the case of Botswana, dependency on fossil fuel imports has equally resulted in a rethinking of the national energy composition towards alternative renewable energy sources (Upstream 2020). Among all renewable energy sources, solar energy has the highest future potential: according to the World Bank Group’s Global Photovoltaic Power Potential (2020) study, Malawi has an average theoretical potential of 5.6 kWh/m², ranking 55th globally, while Zambia scores 24th at 5.9 kWh/m². With 6.1 kWh/m², Botswana ranks 13th. These irradiation ranges strongly suggest that photovoltaic systems can greatly influence future rural electrification plans. For Botswana, estimates indicate that equipping less than 1% of the country’s area with solar panels could cover the country’s total current electricity consumption (UNEP 2017).



Adaptation SME Snapshot Protected Cultivation Systems



ENTERPRISES

NOBLE AGRICULTURE TECHNOLOGIES | Malawi

Product: Greenhouses, irrigation and hydroponic systems

- Provides agriculture technology products to Malawian farmers, sourced from locally available resources
- Targets export-oriented farmers with high-value products
- Trains farmers in climate-smart agriculture and modern agriculture

HYDROPONICS BW | Botswana

Product: Greenhouses, hydroponic systems

- Offers smaller (3x3m) and regular (10x20m) systems, geared towards smallholder and self-sufficient farmers
- CEO moved from working as a nurse over contract-based greenhouse assignments to full-time greenhouse production

Why are protected cultivation systems (PCS) adaptation solutions?

As the term implies, protected cultivation systems such as greenhouses protect food production from climate and weather effects such as heat waves, storms or floods – which is particularly important in geographies with increased prevalence of extreme weather events and temperature changes. Furthermore, such products also protect from pests and diseases that may be a side-effect of climate change.



CHALLENGES

Investment willingness and inability of customers

The two interviewees both identified investment willingness for customers presented itself as the largest barrier to business success. In the case of the Malawian enterprise, a standard greenhouse measuring 8 x 20m including a complete drip irrigation system as well as a hydroponic system would total USD 7,600 – with a country-level average GDP per capita of just USD 380. Although basic greenhouses specifically designed for subsistence farmers such as with Hydroponics BW can be sold for as little as USD 1,100, this investment size still shows that these products would necessitate substantial subsidisation channels or forming of cooperative structures within communities to enable large-scale adoption (cf. Elings et al. 2015). Although basic greenhouses particularly designed for subsistence farmers such as with Hydroponics BW can be sold for as little as USD 1,100.

Lack of customer knowledge

A second challenge identified by the two interviewees was the lack of knowledge about benefits of greenhouse usage among rural community members. Due to the two providers being relatively new in the market and, in the case of Hydroponics BW, the first ever national business producing greenhouses, smallholders and subsistence farmers have simply not yet had enough exposure to and experience in greenhouse farming, resulting in the two enterprises using considerable resources to educate, inform and advocate. It was, however, mentioned that often it is household members who have previously worked as seasonal workforce for commercial farmers who contract these Noble Agriculture Technologies and Hydroponics BW to build small-scale greenhouses for their own usage.



OPPORTUNITIES

PCS are proven adaptive measures for Climate Change

Greenhouses, hydroponic and irrigation systems can be fundamental building blocks in the struggle for climate-change resilient agricultural economies. Scenarios for the worst climate change scenario indicate a mean yield reduction of 8% in Southern Africa across all crops by 2050 (UNFCCC 2020), with vegetable crops being distinctly susceptible to extreme weather events such as droughts or floods (Naik et al. 2017; Bisbis et al. 2018). Greenhouses are attractive counter-measures to increase resilience against climate change for vegetable farmers in Southern Africa for multiple reasons: They shield off extreme heat, rainfall or cold by sealing, help to efficiently reduce water loss due to evaporation and protect from increased the prevalence of insect pests (Bisbis et al. 2018). This is especially instrumental for smallholders as they lack financial resources and social security nets to bounce back after climatic shocks.

Smallholders are neglected by the big players

Greenhouses markets in Africa are dominated by large US-American and European providers focused solely on commercial farmers (MDF 2020a). As a result, the continent's 33 million smallholders (IFAD 2021) are not catered for, as their financial resources and needed investment sizes are deemed financially unviable (Elings et al. 2015). Both entrepreneurs from Malawi and Botswana supported this claim: in the case of Malawi, there are many international greenhouse producers in the market, however, their products are financially unfeasible and too large for smallholder-dominated communities. The founder of Hydroponics BW further stated that he is the first greenhouse entrepreneur in Botswana with large-scale South African greenhouse producers catering for the commercial farmers, while small-scale farmers remain neglected. Smallholder and subsistence farmers require low-cost and low-tech solutions on a budget, which can be sourced locally (ibid). SMEs producing greenhouses for rural communities are therefore in a prime position to serve a vast potential market without the short-term risk to be outpaced by large corporations.




Adaptation SME Snapshot Eco Briquettes



ENTERPRISES

CHACA RICE PROCESSING

| Zambia 

Product: Eco briquettes, organic rice

- Creates a market for small scale rice farmers while creating revenue streams from its zero-waste processing approach
- Main by-product is rice husk charcoal for rural and urban consumers, for which they engage and train women, youth and local farmers

INTEWASTE | Malawi

Product: Eco briquettes, cookstoves

- Produces briquettes through waste recycling as a sustainable, clean source of energy

- Targets households and public institutions in areas without access to reliable, affordable clean energy sources and also provides add-on equipment for briquette users, such as briquette-compatible cooking stoves

BIO-WATT | Botswana

Product: Eco briquettes, solar water pumps, off-grid PV systems

- Provides affordable clean energy solutions to Botswana communities recovered through water user fees and farm produce levies
- Produces biomass briquettes from organic waste

Why are eco briquettes adaptation solutions?

One effect of climate change is accelerated deforestation. With the majority of Southern African households dependant on wood-based charcoal or firewood for heating and cooking, households need to diversify their energy sources in order to ensure energy security. One „low-hanging fruit“ solution is the usage of eco briquettes, made by carbonising organic waste such as rice husks or coconut shells, as consumers can still use stoves and heaters they previously fuelled with firewood.



CHALLENGES

Socio-cultural barriers

According to Mwampamba et al. (2013), 80-90% of urban and over 90% of rural Sub-Sahara African households depend on charcoal or firewood for cooking and heating. Eco briquettes, however, only take up a niche position in the market, although the product can often compete regarding its price and burning qualities. One fundamental barrier to widespread eco briquette adoption is of sociocultural nature. All interviewees mentioned that they combat the conception of firewood and traditional charcoal being superior to eco briquettes, and partially incompatible with indigenous or tribal culture. This is in line with a study South African study by Semenya and Machete (2019), who find that one of the strongest explanatory variables for firewood usage are perceptions linked to indigeneity and sociocultural elements, in which firewood represents the way “how it is and always has been done”. Connected to this is the misconception that firewood-cooked food tastes better, an argument mentioned by two of the three interviewees. Anecdotal evidence from South Africa (Makhado et al. 2009, Semenya / Machete 2019), Nigeria (Ifegbesan et al. 2016) and Zimbabwe (Remigios 2014) supports this observation.

Costly machinery

Mwampamba et al. (2013) estimate that an average production volume of 15 tonnes per month would necessitate upfront investments amounting to 50,000 USD. In absence of government-led programmes that would subsidise machinery purchases or provide financing instruments, these costs make start-up attempts in the eco briquette field in Southern Africa unattainable for many entrepreneurs. Although the lack of funding or financing instruments tailored to the business' needs is a challenge felt by all adaptation SMEs interviewed, it was particularly pronounced among eco briquette producers due to their costly machinery.

Dependence on imported machinery

None of the interviewed entrepreneurs was aware of locally manufactured densifying and carbonising machinery but sourced their equipment from China. Having only recently started production, Bio-WATT from Botswana was affected by COVID-related trade halts and border closures and had to wait multiple months to receive their carbonising machine.



OPPORTUNITIES

The potential market is gigantic

The potential market for eco briquettes in Southern Africa is gigantic. Investigations into rural firewood consumption in South Africa show that households consume over 4,300kg of firewood per household per year (Dovie et al. 2004). If eco briquettes break through behavioural and sociocultural patterns to substitute wood-based charcoal with production volume estimates for Africa reaching 24.5 billion USD (GRIDA 2013), this could revolutionise household energy consumption. Eco briquettes are in an excellent position to incrementally capture parts of the wood-based charcoal market – they are price competitive, often even cheaper than wood-based charcoal, readily available and easy to produce locally (Owen et al. 2013). Other alternative cooking fuels such as kerosene, liquified petroleum gas (LPG) and ethanol-based fuels are significantly more expensive, lack needed infrastructure or are not available to an extent that could supersede wood charcoal and firewood (Mwampamba et al. 2013).

Eco briquettes may be key to fulfilling national climate goals

Eco briquettes take off pressure on forests already suffering from human-made deforestation and climate change-induced desertification by offering products that do not necessitate logging trees. This is direly needed: between 2002 and 2020, Malawi lost 13% of its tree cover, followed by Zambia with 7.8% and Botswana with 2.5% (GFW 2021). Charcoal usage alone is expected to directly contribute to 7% of deforestation in tropical regions (Chidumayo/Gumbo 2013). Biomass traditionally had a hard stand to be included in national energy policies in Sub-Saharan Africa due to outdated representations of biomass energy as unsustainable and partially responsible for desertification (Owen et al. 2013). As a result, biomass charcoal is neglected in policy drafts in the whole region (ibid). There is, however, reason for cautious optimism. In the case of Malawi, the promotion of the use of eco briquettes as a substitute for firewood and charcoal made it into the country's nationally determined contributions (NDCs), features prominently in the National Charcoal Strategy (2017-2021) and Malawi's Biomass Energy Strategy (MMEWR 2009), and has eventuated in projects such as the Promotion of Alternative Energy Sources Programme (PAESP). As for Zambia, biomass briquettes are mentioned as strategies to diversify electrification programmes and achieve sustainability goals in its National Energy Policy (2019) and the National Development Plan (2017-2021) but remain only vaguely discussed.



Adaptation SME Snapshot

Climate-resilient Seeds and Seedlings



ENTERPRISES

MOOTO CASHEW SUPPLIERS | Zambia

Product: Cashew tree seedlings and seeds

- Sells climate-resilient cashew seeds and hybrid cashew seedlings through softwood grafting of local and resilient cashew trees with improved dwarf cashew trees that mature earlier
- Operates in the Western province of Zambia which is highly affected by deforestation caused by charcoal burning, the main source of livelihood in the area

Why are climate-resilient seeds & seedlings adaptation solutions?

Climate-resilient seeds and seedlings are crops and crop varieties that are adopted to cope with abiotic stressors such as floods, heatwaves, droughts, soil salinity and shortened growth seasons, but also pests associated with alterations in climate or weather patterns (Acevedo et al. 2020). They, therefore, enable communities in climate change-impacted geographies to engage in agricultural production, although climatic conditions would otherwise inhibit or even forbid agricultural activity.



CHALLENGES

Long path to profitability

The key challenge of growing climate-resilient seedlings is the relatively long timeframe and required investment for such businesses to turn profitable (Reliefweb 2019). The interviewed entrepreneur explained that hybrid cashew seedlings require 5-7 years to reach maturity, and can be sold 3-4 years after planting them. This long-term orientation necessitates entrepreneurs to either possess substantial savings, find adequate financial investors or have an alternative business line on the side generating enough revenue to cover operational expenses. For Mooto Cashew Suppliers, the latter option was the only way to finance his business as financial institutions he approached were unwilling to invest in such a long-term business model, and public finance was not available. This is largely in line with other reports stating that the often significant investment needed by such businesses is thwarted by a lack of financial mechanisms and understanding of business models from financial institutions (Reliefweb 2019).

Monopolistic multinational corporations

A weighty factor impeding climate-resistant seed sales is the monopolistic position that multinational corporations the likes of Bayer-Monsanto, Syngenta, BASF or Corteva have taken globally: in 2018, the big four agrochemical corporations accounted for over 50% of the global agrochemical sales (Armstrong 2019). Traditionally, farmers in Africa have used a variety of primarily local and indigenous seeds that are naturally adapted to local climatic conditions. With international seed producers successfully pushing into African markets, these smallholder farmers are increasingly pressured into dependency relations with international seed producers, consequently leading to seed monopoly markets and irreversible losses of local indigenous plant varieties (GreenBiz 2015). With these big players in the game, local seed and seedling producers are limited to non-commercial and rural farmers that have not yet been tailored to by international seed producers, due to their lack of financial attractiveness.



OPPORTUNITIES

Monopolistic multinational corporations

the lack of availability and access to international crop producers' products for smallholders is likewise a major opportunity for SMEs providing climate-resilient crops. Acevedo et al. (2020) find that in low- and middle-income countries, a key issue for smallholders is that they lack advisory services and subsidy mechanisms to purchase international producers' crops. SMEs such as Mooto Cashew Suppliers can effectively cover this market "blind spot" by offering affordable and locally known seeds and seedlings. Given that seed markets in the Middle East and Africa are expected to grow at a CAGR of 8.24% until 2026 (MDF 2020b), there is plenty of potential for smaller private actors offering solutions.

Movements for food sovereignty

A third opportunity relates to broader movements for "food sovereignty", sometimes labelled as "seed activism" – which captures all activities aimed at working against the enclosure and concentration of seeds (Peschard / Randeria 2020). Oftentimes, seed activism takes shape as a reaction to communities perceiving multinational seed corporations as violating individual or collective rights to seeds, as they contaminate plant genetics and customers can be prosecuted for infringing on seed patent rights when attempting to generate their own seeds from bought crop seeds (ibid). In Africa, a variety of regional coalitions and NGOs focus on seed-related issues, often emphasising the importance of protecting local crop diversity (ibid). Rising discontent about the current status quo of farmer dependencies on international seed providers may constitute an advantage point for climate-resilient crop-producing SMEs that engage in non-GMO, local and indigenous crops. Some of these coalitions and NGOs are the Coalition for the Protection of African Genetic Heritage (COPAGEN), the West African Committee for Peasant Seeds (COASP), the African Center for Biodiversity (ACB) and the Alliance for Food Sovereignty in Africa (AFSA).

4. CONCLUDING REMARKS AND RECOMMENDATIONS

This report highlights the various market opportunities and challenges that adaptation SMEs in the Southern African countries Botswana, Malawi and Zambia navigate. Adaptation SMEs can take a key role in climate change adaptation through their functions as 1) agents of strengthening the adaptive capacity of their target groups through the provision of adaptation products and services, 2) providers of climate adaptation information, 3) locally rooted partners in multi-stakeholder adaptation programmes and 4) customers of adaptation products and/or services. Yet, they only receive marginal recognition by policy actors and climate action practitioners academia. Adaptation SMEs in Southern Africa have substantial opportunities to grow and scale their operations. These opportunities are largely based on the fact that adaptation SMEs cater to target groups (rural, less affluent, smallholder-dominated communities) that are vastly un- or underserved by public and large-scale private actors. These communities are

disproportionately hit by the effects of climate change (due to their limited resources and adaptive capacities), rendering support through adaptation SMEs all the more relevant and adaptation solutions highly demanded. With a lack of direct competitors, these enterprises have the potential to gain market shares rapidly. Adaptation SMEs, however, face several considerable hurdles that they need to overcome to scale successfully. These enterprises are critically underserved by financial institutions and overlooked by policy-makers – resulting in non-existent financial products and a fabric of policies that either disregard adaptation SMEs or inhibit their operations. COVID has further exacerbated the previously low purchasing power of adaptation SMEs' primary clientele. The political measures set in motion to contain the virus' spread have further led to raw material and machinery supply disruptions, affecting many adaptation SMEs sourcing production inputs or technical equipment from other countries.

Figure 6: Challenges and Opportunities of Adaptation SMEs in Southern Africa



Source: SEED.

For adaptation SMEs to unfold their full market and scale potential in the three target countries, different actor groups must adjust their current activities, perspectives and goals to successfully form an enabling environment. Specifically,

Adaptation SMEs must:

- Be aware of the market barriers and capitalise on existing opportunities by aligning their product and service portfolios to their customers' actual and imminent needs that are subject to change over time as climate change affects the region.
- Botswana, Malawian, or Zambian SMEs looking into adding to their product/service portfolio adaptation solutions should assess solution-specific and general adaptation opportunities and barriers before entering the market. They should also be aware of existing adaptation solutions in the market that could be adapted to the local context or replicated in a specific region.
- Actively engage in the discourse of adaptation policies and projects in order to advocate for a more conducive policy framework and their actual support needs.

National and international financial institutions must:

- Create financial mechanisms for adaptation solution providers. Climate finance for SMEs as such is already severely underfunded and insufficiently addressed whereas finance for adaptation SMEs is even less considered (SEED 2021) by financial institutions. While the lack of adaptation finance is relevant for all adaptation SMEs, this is particularly important for adaptation SMEs providing products that necessitate large upfront capital needs (e.g. eco briquette or greenhouse providers).
- Ensure alignment with local needs and contexts. To achieve this, national and international financial institutions need to collaborate in multi-actor consortia together with locally experienced intermediary institutions (such as SME incubators or accelerators). This will help enhance knowledge on local realities of adaptation SMEs and draft tailored financial products fitting the needs of adaptation SMEs.

Policy-makers must:

- Address climate adaptation more prominently in national policies and programmes. While Malawi and Zambia have formalised a series of policies to build climate change resilience, Botswana is lagging behind in advancing environmental and climate policies generally, and adaptation relevant topics specifically.¹⁴ While having (few) relevant policies in place, all three countries lack enforcement in terms of clear implementation plans and budgetary schemes.
- Expand their toolbox of policy-supported adaptation action with measures that reflect local needs. Policy-makers in Malawi and Zambia currently focus on politically fashionable but often non-contextual and poorly adopted adaptation measures (such as CSA) that are largely detached from local needs. The two countries' governments have been implementing a multitude of CSA projects, with a focus on conservation agriculture and agroforestry. These projects, however, suffer from extremely high levels of dis-adoption (CIAT 2017, 2018) due to a lack of clarity on the benefits of undertaken measures and lack of access to finance (ibid). Turning away from large project-based activities towards more sustainable market-based adaptation solutions provided by locally embedded enterprises knowing their clientele and context would raise the effectiveness of government efforts towards building local climate resilience.
- Craft structures that create and incentivise the demand for adaptation products or services in communities vulnerable to climate change. Adaptation SMEs predominantly cater their products and services to often rural and non-affluent communities, who frequently face difficulties in purchasing resilience-enhancing products and services. National policy makers must create the legal ground for support mechanisms such as subsidy schemes on adaptation products and services to enable and incentivise these purchases.
- More stringently assess national economic development programmes on their effects onto the private sector that provides climate action products or services to avoid negative side-effects such as with the Malawian and Zambian FISP (see organic fertiliser spotlight).

¹⁴ Malawi recently has made sizeable progress in including climate change adaptation measures into their policy landscape (CIAT 2018, Mwase et al. 2013). It is a signatory to a number of international policies and conventions on climate change and has put in place national policies and plans that address climate change issues. As for agriculture, the National Agriculture Policy, the Forest Policy and the National Irrigation Policy have seen revisions to involve climate change actions (CIAT 2018). The Climate Smart Agriculture Framework, the Strategic Program for Climate Change and the CSA Training manual are actions that were decidedly developed to support agricultural climate resilience (ibid). Similar to Malawi, Zambia has formalised a series of international and national adaptation policies. Its Nationally Determined Contributions (NDC) prominently feature CSA practices such as agroforestry and water management (CIAT 2017). Nationally, there is an array of policies and plans such as the National Programme of Action, the Policy on Environment, the National Agriculture Policy and the Second National Biodiversity Strategy and Action Plan – which all at least feature adaptation. Zambia's Seventh National Development Plan is centring on climate change and agricultural development (MNDP 2017). Compared to the other two countries, Botswana's climate change policies are in a nascent stage (CARIAA 2016). The country has yet to formalise a dedicated policy on climate change action, let alone adaptation (Mogomotsi et al. 2020).

BIBLIOGRAPHY

In-text

- Acevedo, M. ; Pixley, K. ; Zinyengere, N. et al. (2020): A scoping review of adoption of climate-resilient crops by small-scale producers in low- and middle-income countries. *Nat. Plants* (6). Accessed via <https://www.nature.com/articles/s41477-020-00783-z>.
- Adaptation SME Accelerator Project (ASAP; 2020): Adaptation Solutions Taxonomy. July 2020. Accessed via <https://publications.iadb.org/en/adaptation-solutions-taxonomy#:~:text=The%20ASAP%20Adaptation%20Solutions%20Taxonomy,SMEs%20may%20require%20targeted%20support>.
- adelphi (2019): The Roles of the Private Sector in Climate Change Adaptation – an Introduction. Accessed via <https://www.adelphi.de/en/publication/roles-private-sector-climate-change-adaptation-introduction>.
- African Climate Policy Centre (ACPC; 2018): Economic growth and climate change in Africa. United Nations Economic Commission for Africa (UNECA). Accessed via https://archive.uneca.org/sites/default/files/uploaded-documents/ACPC/annex_21b_-_climate_change_impacts_on_africas_economic_growth_-_report.pdf.
- Alibhai, S.; Bell, S.; Conner, G. (2017): What's Happening in the Missing Middle? Lessons from Financing SMEs. World Bank. Retrieved from: <https://openknowledge.worldbank.org/handle/10986/26324>.
- AllAfrica (2020): Botswana: Energy Ministry Strives for Self-Reliance. Accessed via <https://allafrica.com/stories/202009020199.html>.
- Armstrong, M. (2019): The Titans of the Agrochemical Industry. Statista. Accessed via <https://www.statista.com/chart/17998/the-titans-of-the-agrochemical-industry/>.
- Asian Development Bank (ADB; 2013): Guidelines for Climate Proofing Investment in the Energy Sector. Accessed via <https://www.adb.org/sites/default/files/institutionaldocument/33896/files/guidelines-climate-proofing-investment-energy-sector.pdf>.
- Bisbis, M.B.; Gruda, N.; Blanke, M. (2018): Potential impacts of climate change on vegetable production and product quality – A review. *Journal of Cleaner Production* (170). Accessed via <https://www.sciencedirect.com/science/article/pii/S095965261732228X>.
- Borgen Project (2020): 3 Solar Energy Developments in Malawi. Accessed via <https://borgenproject.org/solar-energy-developments-in-malawi/>.
- Botswana Ministry of Minerals, Energy and Water Resources (MMEWR; 2009): Botswana Biomass Energy Strategy. Accessed via <https://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/laws/1090.pdf>.
- Burillo, D. (2018): Effects of Climate Change in Electric Power Infrastructures, Power System Stability. Accessed via <https://www.intechopen.com/chapters/64723>.
- BusinessBotswana (2020): COVID-19 Pandemic Recovery Plan for the Private Sector. Accessed via https://www.bb.org.bw/common_up/business-botswana/doc_1594713920.pdf.
- BusinessDay (2019): Blackouts hit Zambia and Zimbabwe as hydropower dams drain over drought. Accessed via <https://www.businesslive.co.za/bd/world/africa/2019-12-18-blackouts-hit-zambia-and-zimbabwe-as-hydropower-dams-drain-over-drought/>.
- CGTN Africa (2021): Zambia approves bill to legalize cannabis cultivation for research purposes. Accessed via <http://africa.cgtn.com/2021/03/02/zambia-approves-bill-to-legalize-cannabis-cultivation-for-research-purposes/>.
- Chidumayo, E.; Gumbo, D. J. (2013): the environmental impacts of charcoal production in tropical ecosystems of the world: A synthesis. *Energy for Sustainable Development* (17/2). Accessed via https://www.researchgate.net/publication/257434434_The_environmental_impacts_of_charcoal_production_in_tropical_ecosystems_of_the_world_A_synthesis.
- International Center for Tropical Agriculture (CIAT; 2017): Climate-Smart Agriculture in Zambia. CSA Country Profiles for Africa Series. World Bank. Accessed via <https://ccafs.cgiar.org/resources/publications/climate-smart-agriculture-zambia>.
- International Center for Tropical Agriculture (CIAT; 2018): Climate-Smart Agriculture in Malawi. CSA Country Profiles for Africa Series. World Bank. Accessed via <https://ccafs.cgiar.org/resources/publications/climate-smart-agriculture-malawi>.
- Climate ADAPT (2021): Adaptation options. Accessed via <https://climate-adapt.eea.europa.eu/knowledge/adaptation-information/adaptation-measures>.

- Climate Emergency Institute (2015): Africa Climate Change Policy: An adaptation and development challenge in a dangerous world. Accessed via http://assets.fsnforum.fao.org.s3-eu-west-1.amazonaws.com/public/discussions/contributions/AFRICA_CLIMATE_CHANGE_POLICY-CEI_3.pdf.
- Climate Policy Initiative (CPI, 2019): Global Landscape of Climate Finance 2019. Accessed via <https://www.climatepolicyinitiative.org/wp-content/uploads/2019/11/2019-Global-Landscape-of-Climate-Finance.pdf>.
- Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA; Crawford, A., 2016): Review of Current and Planned Adaptation Action in Botswana. CARIAA Working Paper #7. International Development Research Centre (IDRC). Accessed via <https://idl-bnc-idrc.dspacedirect.org/handle/10625/55863>.
- Development and Cooperation (D+C; 2020): Water over the dam. Accessed via <https://www.dandc.eu/en/article/zambias-dependence-hydropower-becoming-increasingly-problematic>.
- Dovie, B. D. ; Witkowski, E.T.; Shackleton, C. (2004): The Fuelwood Crisis in Southern Africa – Relating Fuelwood Use to Livelihoods in a Rural Village. *GeoJournal* (60/2). Accessed via https://www.researchgate.net/publication/226226659_The_Fuelwood_Crisis_in_Southern_Africa_-_Relating_Fuelwood_Use_to_Livelihoods_in_a_Rural_Village.
- Ebinger, J.; Vergara, W. (2011): Climate Impacts on Energy Systems: Key Issues for Energy Sector Adaptation. World Bank. Accessed via <http://documents.worldbank.org/curated/en/580481468331850839/Climate-impacts-on-energy-systems-key-issues-for-energy-sector-adaptation>.
- Elings, A.; Hemming, S.; Os, E.A. van; Campen, J. B., Bakker, J.C. (2015): The African Greenhouse: a toolbox. Wageningen UR Greenhouse Horticulture. Accessed via <https://library.wur.nl/WebQuery/wurpubs/fulltext/351439>.
- Famine Early Warning Systems Network (FEWS NET, 2014): Zambia livelihood zones and description. US AID. Accessed via https://fewsn.net/sites/default/files/documents/reports/ZM_LZ_descriptions_2014_0.pdf.
- Gamula, G.; Hui, L.; Peng, W. (2013) : An Overview of the Energy Sector in Malawi. *International Journal of Renewable Energy Technology Research* (2/2). Accessed via http://ijretr.org/IJRETR_Vol.%202.%20No.%202.%20February%202013/Development%20of%20Renewable%20Energy%20Technologies%20in%20Malawi.pdf.
- Get Invest (2019): Zambia : Solar PV and Hydro Mini-Grids. Model Business Case : Solar PV Mini-Grid for Rural Electrification. Accessed via https://www.get-invest.eu/wp-content/uploads/2020/10/GETinvest-Market-Insights_ZMB_Mini-grid_-MBC-Solar_2019-1.pdf.
- Global Forest Watch (GFW; 2021a): Dashboard Malawi. Accessed via <https://www.globalforestwatch.org/dashboards/country/MWI/?category>
- Global Forest Watch (GFW; 2021b): Dashboard Zambia. Accessed via <https://www.globalforestwatch.org/dashboards/country/ZMB/?category>
- Global Solar Atlas (2020): Global Photovoltaic Power Potential: Country Factsheet Malawi. World Bank Group. Accessed via <https://globalsolaratlas.info/global-pv-potential-study>.
- Government of Malawi (GoM; 2018): National Energy Policy. Accessed via https://rise.esmap.org/data/files/library/malawi/Renewable%20Energy/Supporting%20Documentation/Malawi_National%20Energy%20Policy%202018.pdf.
- GRID Arendal (GRIDA; 2013): Wood charcoal production in Africa. Accessed via <https://www.grida.no/resources/7497>.
- Heinrich Böll Stiftung (2011): Climate Governance in Africa. Adaptation Strategies and Institutions. Accessed via https://www.boell.de/sites/default/files/assets/boell.de/images/download_de/Climate_Governance_in_Africa.pdf.
- Ifegbesan, A. P.; Rampedi, I. T.; Annegarn, H. J. (2016): Nigerian households' cooking energy use, determinants of choice, and some implications for human health and environmental sustainability. *Habitat International* (55). Accessed via <https://www.cabdirect.org/cabdirect/abstract/20163209855>.
- Intergovernmental Panel on Climate Change (IPCC; 2014): Africa. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Accessed via https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap22_FINAL.pdf
- International Energy Agency (IEA; 2020): Climate Impacts on African Hydropower. Accessed via <https://www.iea.org/reports/climate-impacts-on-african-hydropower>.
- International Finance Corporation (IFC, 2012): Interpretation Note on small and medium enterprises and environmental and social risk management. Accessed via https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/publications/publications_policy_interpretationnote-sme.
- International Fund for Agricultural Development (IFAD; 2021): Change starts here. Small farmers with a big message for the world. Accessed via <https://www.ifad.org/thefieldreport/>.
- International Hydropower Association (IHA; 2017): Hydropower Status Report 2016. Accessed via https://www.hydropower.org/sites/default/files/publicationsdocs/2016%20Hydropower%20Status%20Report_1.pdf.

- Lobell, D. B., et al. (2008) : Prioritizing Climate Change Adaptation Needs for Food Security in 2030. *Science* (319/5863). Accessed via <https://www.science.org/doi/abs/10.1126/science.1152339>.
- London School of Economics (LSE; 2018): African electricity generation at risk from current and future climate. Accessed via <https://www.lse.ac.uk/granthaminstitute/news/african-electricity-generation-at-risk-from-current-and-future-climate/>.
- Ludi, E.; Jones, L.; Levine, S.: Changing Focus? How to take adaptive capacity seriously. Evidence from Africa shows that development interventions could do more. Overseas Development Institute, Briefing Paper 71. Accessed via https://www.researchgate.net/publication/317999780_Changing_Focus_How_to_Take_Adaptive_Capacity_Seriously.
- Makhado, R. A.; Potgieter, M. J.M Wessels, D. C. (2009): Colophospermum mopane wood utilisation in the Northeast of the Limpopo Province, South Africa. *Ethnobotanical Leaflets* (13). Accessed via <https://researchspace.csir.co.za/dspace/handle/10204/3536>.
- Malawi Ministry of Energy (2020): Malawi Rural Electrification Programme (MAREP). The Background of Malawi Rural Electrification Programme. Accessed via <https://www.energy.gov.mw/service/malawi-rural-electrification-programme/>.
- Market Data Forecast (2020a): Middle East And Africa Commercial Greenhouse Market By Equipment (Heating Systems, Cooling Systems, And Others), Type (Glass Greenhouse, Plastic Greenhouse And Others), Crop Type, & By Region - Industry Analysis, Size, Share, Growth, Trends, And Forecasts (2021-2026). Accessed via <https://www.marketdataforecast.com/market-reports/middle-east-and-africa-commercial-greenhouse-market>.
- Market Data Forecast (2020b): Middle-East And Africa Seed Market By Crop Type (Oilseed-soybean, Sunflower, Cotton, Canola; Grain Seed-corn, Wheat, Rice, Millet Crops; Fruit & Vegetable-tomato, Melon, Carrot, Onion, Pepper, Lettuce; Other Seed-alfalfa, Turf, Clover & Forage Plants, Flower Seed), By Seed Trait (Herbicide Tolerant, Insect Resistant, And Other Stacked Traits), And By Region- Industry Analysis, Size, Share, Growth, Trends, And Forecast | 2021 to 2026. Accessed via <https://www.marketdataforecast.com/market-reports/middle-east-and-africa-seed-market>.
- Ministry of National Development Planning (Ministry of National Development Planning; 2017): 7th National Development Plan. 2017-2021. Accessed via <https://www.mndp.gov.zm/wp-content/uploads/2018/05/7NDP.pdf>.
- Mogomotsi, P. K.; Sekelemani, A. ; Mogomotsi, G. E. (2020) : Climate change adaptation strategies of small-scale farmers in Ngamiland East, Botswana. *Transactions of the Royal Society of South Africa* (20/2). Accessed via <https://link.springer.com/article/10.1007/s10584-019-02645-w>.
- Mordor Intelligence (2020): Africa Organic Fertilizers Market – Growth, Trends, COVID-19 impact, and forecasts (2021-2026). Accessed via <https://www.mordorintelligence.com/industry-reports/africa-biological-organic-fertilizers-market>.
- Moseley, W. G. (2016) : Agriculture on the Brink: Climate Change, Labor and Smallholder Farming in Botswana. *Water* 2016 (5/21). MDPI. Accessed via <https://www.mdpi.com/2073-445X/5/3/21>.
- Mwampamba, T. H.; Owen, M.; Pigaht, M. (2013): Opportunities, challenges and way forward for the charcoal briquette industry in Sub-Saharan Africa. *Energy for Sustainable Development* (17/2). Accessed via <https://www.sciencedirect.com/science/article/pii/S0973082612000750>.
- Naik, P. S. ; Sing, M.; Ranjan, J. K. (2017): Impact of Climate Change on Vegetable Production and Adaptation measures. In: Minhas P, Rane J., Pasala R. (eds): *Abiotic Stress Management for Resilient Agriculture*. Springer. Accessed via https://link.springer.com/chapter/10.1007/978-981-10-5744-1_19#:~:text=Vegetable%20crops%20are%20more%20sensitive,further%20magnified%20by%20climate%20change.
- NBC News (2015): Drought-Caused Blackouts Batter Zambia, Zimbabwe Economies. Accessed via <https://www.nbcnews.com/business/energy/drought-caused-blackouts-batter-zambia-zimbabwe-economies-n454581>.
- New York Times (2016): Climate Change Hits Hard in Zambia, an African Success Story. Accessed via <https://www.nytimes.com/2016/04/13/world/africa/zambia-drought-climate-change-economy.html>.
- Nhemachena, C.; Nhamo, L.; Matchaya, G. et al. (2020): Climate Change Impacts on Water and Agriculture Sectors in Southern Africa: Threats and Opportunities for Sustainable Development. *Water* 2020. MDPI. Accessed via <https://www.mdpi.com/2073-4441/12/10/2673>.
- Oakland Institute (2020): The Failure of Input Subsidies and a New Path Forward to Fight Hunger in Malawi. Accessed via <https://www.oaklandinstitute.org/blog/malawi-failure-input-subsidies-new-path-forward-fight-hunger>.
- Owen, M.; Plas, R. van der; Sepp, S. (2013): Can there be energy policy in Sub-Saharan Africa without biomass? *Energy for Sustainable Development* (17). Accessed via <https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.1047.3490&rep=rep1&type=pdf>.
- Pauw, W. P.; M. Chan (2018): Multistakeholder partnerships for adaptation: the role of micro, small and medium enterprises. 98-109. In: *Private-sector action in adaptation: Perspectives on the role of micro, small and medium size enterprises* (2018). 3BPublisher: UNEP DTU PartnershipEditors: Caroline Schaer, Natasha Kuruppu. Accessed

via https://www.researchgate.net/publication/324747626_Multistakeholder_partnerships_for_adaptation_the_role_of_micro_small_and_medium_enterprises.

- Peschard, K.; Randeria, S. (2020): 'Keeping seeds in our hands': the rise of seed activism. *The Journal of Peasant Studies* (47/4). Accessed via <https://www.tandfonline.com/doi/epub/10.1080/03066150.2020.1753705?needAccess=true>.
- Polity (2014): Doing business in SADC: Still a long way to go. Accessed via <https://www.polity.org.za/article/doing-business-in-sadc-still-a-long-way-to-go-2014-10-14>.
- Reliefweb (2019): Becoming Drought Resilient: Why African Farmers Must Consider Drought Tolerant Crops. Accessed via <https://reliefweb.int/report/world/becoming-drought-resilient-why-african-farmers-must-consider-drought-tolerant-crops>.
- Remigios, M. V. (2014): The Significance of Culture as a Household Energy Determinant: The Case of Chiwundura Communal Area, Zimbabwe. Accessed via <https://www.tandfonline.com/doi/abs/10.1080/09709274.2014.11906732>.
- Renewable Energy and Energy Efficiency Partnership (REEEP; 2012): Zambia. Accessed via <https://www.reeep.org/zambia-2012>.
- Reuters (2020): Malawi ready to produce cannabis for industrial and medicinal use. Accessed via <https://www.reuters.com/article/malawi-cannabis-idUSL8N2IA4VV>.
- Schaer, C.; Kuruppu, N. D. (Eds., 2018): Private-sector action in adaptation: Perspectives on the role of micro, small and medium size enterprises. UNEP DTU Partnership. Accessed via <https://unepdtu.org/publications/private-sector-action-in-adaptation-perspectives-on-the-role-of-micro-small-and-medium-size-enterprises/>.
- SEED (2021): Translating Climate Finance into Climate Action on the Ground. Leveraging the Potential for Small and Medium-sized Enterprises (SMEs). Accessed via <https://seed.uno/articles/reports/seed-climate-finance-for-smes-report>.
- Semenya, K.; Machate, M. (2019): Factors that influence firewood use among electrified Bapedi households of Senwabarwana Villages, South Africa. *African Journal of Science Technology Innovation and Development*. https://www.researchgate.net/publication/332118847_Factors_that_influence_firewood_use_among_electrified_Bapedi_households_of_Senwabarwana_Villages_South_Africa.
- Sunday Standard (2019): Government approved the production of cannabis in 2018. Accessed via <https://www.sundaystandard.info/government-approved-the-production-of-cannabis-in-2018/>.
- Tauro, J.; Gondwe, K. J.; Sebitosi, A. B. (2015): Energy supply in Malawi: Options and issues. *Journal of Energy in Southern Africa* (26/2). Accessed via http://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S1021-447X2015000200003.
- The Guardian (2017): Malawi suffers blackouts as drought exposes 98% reliance on hydro power. Accessed via <https://www.theguardian.com/world/2017/dec/08/malawi-blackouts-drought-hydro-power>.
- The White House (2021): Report on the Impact of Climate Change on Migration. October 2021. Accessed via <https://www.whitehouse.gov/wp-content/uploads/2021/10/Report-on-the-Impact-of-Climate-Change-on-Migration.pdf>.
- U.S. Department of Agriculture (USDA; 2015): Botswana: Agricultural Economic Fact Sheet. Accessed via <https://www.fas.usda.gov/data/botswana-agricultural-economic-fact-sheet>.
- U.S. Department of Agriculture (USDA; 2019): International Agricultural Productivity. Accessed via <https://www.ers.usda.gov/data-products/international-agricultural-productivity/>.
- U.S. Department of Agriculture (USDA; 2021): World Agricultural Production. Accessed via <https://apps.fas.usda.gov/psdonline/circulars/production.pdf>.
- U.S. Energy Information Administration (EIA; 2019): Hydropower explained. Accessed via <https://www.eia.gov/energyexplained/hydropower/hydropower-and-theenvironment.php>.
- United Nations Environment Programme (UNEP; 2015b) : Energy Profile Botswana. Accessed via https://wedocs.unep.org/bitstream/handle/20.500.11822/20482/Energy_profile_Botswana.pdf?sequence=1&%3BisAllowed.
- United Nations Environment Programme (UNEP; 2017): Energy Profile : Botswana. Accessed via <https://www.unep.org/resources/report/energy-profile-botswana>.
- United Nations Environment Programme (UNEP; 2015a): Business Unusual: Why the climate is changing the rules for our cities and SMEs. Retrieved from: https://www.unepfi.org/fileadmin/documents/business_unusual.pdf.
- United Nations Environment Programme (UNEP, 2021): What does COP26 mean for adaptation? Accessed via <https://www.unep.org/news-and-stories/story/what-does-cop26-mean-adaptation>.
- United Nations Framework Convention on climate Change (UNFCCC, 2020): Climate Change Is an Increasing Threat to Africa. Accessed via <https://unfccc.int/news/climate-change-is-an-increasing-threat-to-africa>.
- Upstream (2020): Botswana in renewables drive, but coalbed methane and coal still in the mix. Accessed via

<https://www.upstreamonline.com/energy-transition/botswana-in-renewables-drive-but-coalbed-methane-and-coal-still-in-the-mix/2-1-933944>.

- US AID (2020a): Zambia Power Africa Fact Sheet. Accessed via <https://www.usaid.gov/powerafrica/zambia>.
- US AID (2020b): Malawi Power Africa Fact Sheet. Accessed via <https://www.usaid.gov/powerafrica/malawi>.
- USAID (2016): Climate Change Risk Profile Southern Africa. Regional Fact Sheet. Accessed via <https://www.climatelinks.org/resources/climate-risk-profile-southern-africa>.
- World Bank Group (2021): Power outages in firms in a typical month (number) – Malawi, Zambia, Botswana. Accessed via <https://data.worldbank.org/indicator/IC.ELC.OUTG?locations=MW-ZM-BW>.
- World Meteorological Organization (WMO; 2017): Energy Exemplar to the User Interface Platform of the Global Framework for Climate Services. Global Framework for Climate Services. Accessed via https://gfcs.wmo.int/sites/default/files/PriorityAreas/Energy/GFCS_Energy%20Exemplar_JN17453.pdf.
- Your Botswana (2020): Business Botswana proposes probe into cannabis as a cash crop. Accessed via <https://yourbotswana.com/2020/08/24/business-botswana-proposes-probe-into-cannabis-as-a-cash-crop/>.
- Zambia Ministry of Energy (MoE; 2019): National Energy Policy 2019. Accessed via https://www.moe.gov.zm/?wfb_dl=51.
- Zinyengere, N., Crespo, O., & Hachigonta, S. (2013). Crop response to climate change in southern Africa: A comprehensive review. *Global and Planetary Change*, 111, 118-126. Accessed via https://hal.archives-ouvertes.fr/file/index/docid/1062788/filename/2013sub_Crop_response_to_climate_change_in_southern_Africa_-_A_comprehensive_review.pdf.

Country Dashboards

Botswana

- [1] <https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?locations=BW>
- [2] <http://hdr.undp.org/sites/default/files/Country-Profiles/BWA.pdf>
- [3] <https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=BW>
- [4] https://apps.fas.usda.gov/newgainapi/api/report/downloadreportbyfilename?filename=Agricultural%20Economic%20Fact%20Sheet_Pretoria_Botswana_6-9-2015.pdf
- [5] <https://atlas.cid.harvard.edu/countries/37/export-basket>
- [6] <https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS?locations=BW>
- [7] <https://data.worldbank.org/indicator/AG.LND.ARBL.ZS?locations=BW>
- [8] http://earthwise.bgs.ac.uk/index.php/Hydrogeology_of_Botswana
- [9] <https://atlas.cid.harvard.edu/explore?country=37&product=undefined&year=2019&tradeDirection=import&productClass=HS&target=Product>
- [10] https://apps.fas.usda.gov/newgainapi/api/report/downloadreportbyfilename?filename=Agricultural%20Economic%20Fact%20Sheet_Pretoria_Botswana_6-9-2015.pdf
- [11] <http://www.fao.org/faostat/en/#data/QL>
- [12] <https://www.trade.gov/country-commercial-guides/botswana-energy>
- [13] <https://www.worlddata.info/africa/botswana/energy-consumption.php>
- [14] https://wedocs.unep.org/bitstream/handle/20.500.11822/20482/Energy_profile_Botswana.pdf?sequence=1&%3BisAllowed
- [15] https://wedocs.unep.org/bitstream/handle/20.500.11822/20482/Energy_profile_Botswana.pdf?sequence=1&%3BisAllowed
- [16] <https://data.worldbank.org/indicator/EG.ELC.ACCS.RU.ZS?locations=BW>
- [17] <https://databank.worldbank.org/reports.aspx?source=2&series=EG.ELC.ACCS.ZS&country=BWA>

Malawi

- [1] <https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?locations=MW>
- [2] <http://hdr.undp.org/en/content/latest-human-development-index-ranking>
- [3] <https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=MW>
- [4] <https://data.worldbank.org/country/malawi>
- [5] <https://atlas.cid.harvard.edu/explore?country=152&product=undefined&year=2019&productClass=HS&target=Product>
- [6] <https://www.worldbank.org/en/country/malawi/overview#1>
- [7] https://climateknowledgeportal.worldbank.org/sites/default/files/2019-06/CSA%20_Profile_Malawi.pdf
- [8] https://climateknowledgeportal.worldbank.org/sites/default/files/2019-06/CSA%20_Profile_Malawi.pdf
- [9] https://climateknowledgeportal.worldbank.org/sites/default/files/2019-06/CSA%20_Profile_Malawi.pdf
- [10] https://climateknowledgeportal.worldbank.org/sites/default/files/2019-06/CSA%20_Profile_Malawi.pdf
- [11] <http://www.fao.org/faostat/en/#data/QL>
- [12] <https://www.usaid.gov/powerafrica/malawi#:~:text=The%20country%20has%20the%20capacity,drought%20and%20low%20water%20levels>
- [13] <https://www.worlddata.info/africa/malawi/energy-consumption.php>
- [14] https://wedocs.unep.org/bitstream/handle/20.500.11822/20501/Energy_profile_Malawi.pdf?sequence=1&isAllowed=y
- [15] https://wedocs.unep.org/bitstream/handle/20.500.11822/20501/Energy_profile_Malawi.pdf?sequence=1&isAllowed=y
- [16] <https://databank.worldbank.org/reports.aspx?source=2&series=EG.ELC.ACCS.ZS&country=MWI#>

Zambia

- [1] <https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?locations=ZM>
- [2] <https://zambia.un.org/en/114983-zambia-launches-2020-human-development-report>
- [3] <https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=ZM-MW-BW>
- [4] <https://assets.kpmg/content/dam/kpmg/za/pdf/2017/12/Zambia-2017H2.pdf>
- [5] <https://pubs.usgs.gov/periodicals/mcs2021/mcs2021-copper.pdf>
- [6] <https://www.mdpi.com/2071-1050/12/11/4559>
- [7] <https://openknowledge.worldbank.org/handle/10986/25746>
- [8] <https://openknowledge.worldbank.org/handle/10986/25746>
- [9] <https://www.sciencedirect.com/science/article/pii/S1573521417300040>
- [10] <http://www.fao.org/faostat/en/#data/QL>
- [11] <https://www.usaid.gov/powerafrica/zambia#:~:text=Zambia%20has%20%2C800%20MW%20of,population%20having%20access%20to%20power.>
- [12] <https://www.worlddata.info/africa/zambia/energy-consumption.php>
- [13] https://www.moe.gov.zm/?wpfb_dl=51
- [14] <https://databank.worldbank.org/reports.aspx?source=2&series=EG.ELC.ACCS.ZS&country=ZMB#>
- [15] <https://databank.worldbank.org/reports.aspx?source=2&series=EG.ELC.ACCS.ZS&country=ZMB#>

ANNEX

Interviewed Enterprises

Enterprise	Interviewee	Email	Website
BIO-WATT	Obuile Morewane	info@biowatt.co.bw	https://www.bio-wattbotswana.com/
Chaca Rice Processing	Canaan Banda	chacaprocessing@gmail.com	
Green Ventures	Marko Chiumia	markochiumia2017@gmail.com	https://gvmalawi.wixsite.com/greenventures
Hydroponics BW	Olebo Mongalo	oleboholdings@gmail.com	
InteWaste	Emmanuel Chisamba	bobchisamba@gmail.com	
Kukula Solar	Francis Mbewe	info@kukulasolar.com ceo@kukulasolar.com	https://kukulasolar.com/
Mooto Cashew Suppliers	Mwala Mooto	mwala@mootoholdings.com	
Noble Agriculture Technologies	John Njoka	johnnjoka3@gmail.com	https://nobleagritech.com/
Organic Fertilizer Manufacturers Botswana (OFMB)	Mike Hallam	organicfmb@gmail.com	https://www.organicfmb.com/
RECAPO	Elube Matengula	info@recapo.org	http://www.recaposolar.com/
Smart Energy Enterprise (SEE)	Gift Mwangairo	gmwangairo@gmail.com	



www.seed.uno