Eastern Africa Alliance
On Carbon Markets And
Climate Finance

STUDY ON CARBON MARKET OPPORTUNITIES AND TECHNOLOGIES FOR SEVEN EASTERN AFRICA COUNTRIES

NOVEMBER 2023

Acknowledgements

This study has been commissioned by the Eastern Africa Alliance on Carbon Markets and Climate Finance with the support of GIZ Global Carbon Market Project on behalf of the German Federal Ministry for Economic Affairs and Climate Action (BMWK), in collaboration with the Regional Collaboration Centre (RCC) Kampala - a joint initiative of the United Nations Framework Convention on Climate Change (UNFCCC) and the East African Development Bank (EADB). The study aims to support the Alliance member countries to identify and prioritise climate mitigation technologies to facilitate the implementation of Article 6. Activities.

Special thanks go to all the National focal points of the Eastern Africa Alliance on Carbon Markets and Climate Finance for their valuable input and coordination. We would also like to thank the Coordinator of the Alliance, all interviewees and contributors, and colleagues from the GIZ Energizing Development (ENDEV) Uganda program, for sharing important information and feedback.

The views expressed in this study are those of the authors and may not necessarily reflect those of GIZ, BMWK, RCC Kampala or EAA.

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Citation: Eastern Africa Alliance on Carbon Markets and Climate Finance (2023): Study on Carbon Market Opportunities and Technologies for Seven Eastern Africa Countries.

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Federal Ministry for Economic Affairs and Climate Action

RCC East and Southern Africa
Collaboration for Climate Action

Members:

Burundi, Ethiopia, Kenya, Rwanda
Sudan,Tanzania, Uganda

Executive Summary

The main objective of this study is to assist the seven member countries of the Eastern African Alliance on Carbon Markets and Climate Finance (EAA) in considering and prioritising mitigation technologies and project activities on the path to the operationalisation of Article 6 of the Paris Agreement. The study encompasses seven countries, namely Burundi, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, and Uganda. The prioritisation of mitigation technologies or activities could assist countries in developing technology "positive lists", which may be used in respective Article 6 Frameworks. Ultimately, the aim is to promote the adoption of sustainable and low-carbon technologies that can mitigate GHG emissions, support the transition to a green economy, and achieve the region's sustainable development objectives.

Priority Mitigation Technologies and Activities

Thirty-seven country-specific technologies and activities were identified through desktop reviews of available literature, namely Nationally Determined Contributions (NDCs); Technical Needs Assessments as well as relevant climate strategies, policies and plans. In addition, key country-level stakeholders were engaged through various means, including an electronic survey and virtual interviews.

The report underscores the critical importance of aligning climate measures with long-term strategies and decarbonization plans outlined in each country's NDCs. Prioritising activities and technologies that align with specific needs and objectives is crucial for effectively accessing carbon financing opportunities.

A multicriteria analysis framework was then employed to assess the identified GHG mitigation technologies and activities, considering the specific circumstances and priorities of each country. Multicriteria analysis is useful in developing informed decisions when faced with complex problems that involve multiple conflicting objectives. This is particularly relevant when considering the suitability of climate mitigation technologies and project activities, as some key benefits may appear contradictory to each other. For example, the implementation of largescale renewable energy projects may have large GHG mitigation impacts, however such projects may have limited co-benefits, compared to other project types or technologies, and may therefore face more barriers to accessing carbon finances.

Each technology, per relevant country, was assessed and scored according to nine different criteria:

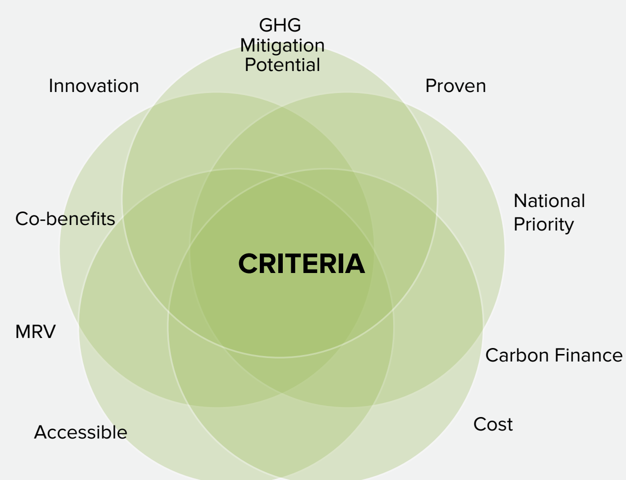


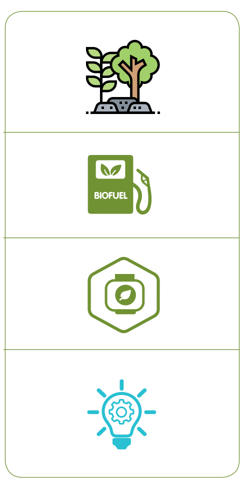
Figure 1: Criteria used in the analysis of mitigation technologies and activities

The scores, per criteria, were weighted according to different levels of priority. For example, the '*National Priority*' criterion was weighted higher than the '*Cost*' criterion.

The design of the scoring assessment reflects the objective to ensure that the 'technology-fit' with the respective countries was prioritised over the cost-effective characteristics of the identified technologies. The analyses resulted in a 'top-five list' of prioritised technologies and activities, per country, presented in the following table.

Top-five prioritised technologies and activities per country

COUNTRY	1	2	3	4	5
Burundi	Soil and water conservation	Composting	Small/micro-hydropower	Solar PV	Biogas production
Ethiopia	Industry fuel switches	Solar home systems	Landfill gas recovery and use or destruction	Sustainable forest management	E-cooking
Kenya	Biogas production	Solar home systems	Solar dryers	Afforestation and reforestation	Wind
Rwanda	Improved Cook Stoves	Small/micro-hydropower	Landfill gas recovery and use or destruction	E-cooking	Waste to energy
Sudan	Soil and water conservation	Solar PV	Composting	Smart irrigation technologies	Biogas production
Tanzania	Biofuel	Biomass to energy	Small/micro-hydropower	Sustainable charcoal production	Solar PV
Uganda	Improved livestock management	Biomass to energy	Improved Cook Stoves	Solar PV	Composting



The technologies and activities that feature in the country top-five rankings include:

- Afforestation and reforestation
- Biofuel
- Biogas production
- Biomass to energy
- Composting
- E-cooking
- Improved Cook Stoves
- Improved livestock management
- Industry fuel switches
- Landfill gas recovery and use or destruction
- Small/micro-hydropower
- Smart irrigation technologies
- Soil and water conservation
- Solar dryers
- Solar home systems
- Solar PV
- Sustainable charcoal production
- Sustainable forest management
- Waste to energy
- Wind

Most of the technologies in the top-five rankings may be considered as mature or proven technologies. The majority of the technologies are located either in the energy sector, or are technologies which result directly in carbon sequestration

Most of the technologies in the top-five rankings may be considered as mature or proven technologies. Notably, solar PV features in four countries' top-five rankings and was considered separately to solar home systems (features in two countries' top-five) and solar dryers (features in Kenya's top-five). Most of the technologies are GHG mitigation technologies, many of which are located in the energy sectors. These technologies include hydropower, wind power, biogas and biomass to energy and waste to energy. This distribution is to be expected, considering the abundant solar resources in East African, as well as the key socio-economic impacts related to the provision of clean, accessible and affordable energy.

There are four activities in the list above which result directly in carbon sequestration, namely afforestation and reforestation; improved livestock management (where this relates to improvements to the health of pastures and resulting in better soil carbon sequestration); soil conservation and sustainable forest management.

The only innovative or emerging technology in the top - five rankings is E-cooking, which features in the lists for Ethiopia and Rwanda. The three other innovative or emerging technologies considered in this assessment, namely BECCs, green hydrogen and E-mobility, did not feature in the top-five rankings. This is because they typically scored lower in the assessments relating to the accessibility, proven and cost criteria. These technologies will likely align with these criteria as they mature.

The following is a summary of the top-five technologies and activities specific to the seven East African countries in this study.

In Burundi, soil and water conservation practices were ranked highest, due to their effectiveness in mitigating GHG emissions when scaled, their potential to enhance agricultural productivity and to promote sustainable economic growth. Composting also ranked highly, due to the availability of organic feedstocks, which may ultimately provide valuable nutrients for local farming sectors, while simultaneously addressing socio and environmental issues associated with effective waste management practices. In addition, small/micro-hydropower was also ranked highly, due to its effectiveness in GHG emissions mitigation, aligned with climate change policies, which has the potential to stimulate economic growth through the provision of clean, accessible and affordable power. Solar PV technology also exhibits highly effective GHG mitigation potential due to solar resource availability, with co-benefits including job creation and support for local industries. Biogas production is considered a national priority, offering transformative changes in emissions reduction and co-benefits such as reducing methane emissions, improving waste management, and supporting local economic development.

In Ethiopia, industry fuel switches ranked highest, as they are seen as a promising solution to reducing emissions in the manufacturing sector. Notably, their scalability requires adequate support and infrastructure. Solar home systems were ranked second as they have the potential scale, especially in rural areas, where they may replace or reduce the use of non-renewable biomass and fossil fuels. Landfill gas recovery and use or destruction technologies also ranked highly because they are effective in reducing emissions and align well with waste sector priorities. Sustainable forest management practices featured as well, on account of their potential to help preserve ecosystems, create jobs, and remove GHG emissions on a long-term basis. E-cooking was included in the top-five, because the technology offers reasonable scalability with low initial costs, promoting sustainable cooking practices in Ethiopia.

In Kenya, biogas production, using abundant agricultural and organic waste resources, is considered a promising solution for emission reduction and can create job opportunities and drive economic growth. Solar home systems can achieve modest emission reductions, with potential for large-scale implementation in off-grid communities. Solar dryers are effective in significantly reducing emissions, particularly in manufacturing industries employing drying processes. Afforestation and reforestation measures hold potential for substantial emission reductions on a large scale. Furthermore, wind technology is recognised for its significant potential in achieving substantial emission reductions, aligning with Kenya's NDC.

In Rwanda, improved cookstoves ranked highest as they are widely recognised for their effectiveness in emission reduction, offering high scalability and co-benefits of reducing biodiversity loss and air pollutants that impair health. Small/micro-hydropower also ranked highly, due to Rwanda's abundant hydro resources. It was noted that scalability from a carbon markets perspective may be limited by the relatively low grid emission factor and concerns related to negative socio and environmental impacts from hydro projects. Landfill gas recovery and use or destruction technologies also featured, as they are effective in reducing emissions. It was also noted that the scalability of such technologies may be constrained by Rwanda's small population size and low grid emission factor. E-cooking ranked in the top-five on account of the technology's innovative nature and potential for large-scale implementation. Waste-to-energy technologies also feature, as they are effective in reducing GHG emissions and contribute to national sustainable development priorities.

In Sudan, soil and water conservation ranked highest, due to alignment with national climate change policies, their ability to promote agricultural productivity, food security, and water availability. Solar PV ranked second highest, due to Sudan's abundant solar radiation and ample space for large-scale implementation. Composting also features, on account of its co-benefits that include the potential to enhance air quality and reduce pollution, contributing to a healthier environment. Smart irrigation technologies also feature in the top-five on account of their potential to conserve water, improve energy efficiency, increase crop yields, and create employment opportunities in agriculture. Biogas production was included because it is effective in reducing emissions, with co-benefits of local employment, reliable energy supply, and potential to reduce deforestation and biodiversity loss.

In Tanzania, biofuel was ranked first on account of its potential to effectively reduce emissions, using the country's abundant biomass and agricultural resources. Biomass to energy technologies followed closely for similar reasons, aligning with Tanzania's climate goals and fostering co-benefits for sustainable development. Small/micro-hydropower featured in the top-five as it offers potential for significant emission reductions and co-benefits of economic growth. Potential challenges in accessing finance were noted, on account of the potential negative socio and environmental impacts that may arise from hydropower projects. Sustainable charcoal production was included in the top-five due to its effectiveness in reducing emissions while simultaneously reducing deforestation and biodiversity loss. Solar PV was included because of Tanzania's solar resources, and the potential co-benefits related to the provision of clean and affordable electricity.

In Uganda, improved livestock management ranked highest as it has significant potential for emission reductions and aligns with Uganda's NDC. Biomass to energy technologies followed, specifically sustainable charcoal production, due to their effectiveness in reducing GHG emissions while also providing environmental co-benefits. Improved cookstoves also featured, as they offer a cost-effective approach to emission reductions and aligning with Uganda's TNA and NDC. In addition, solar PV exhibits high emission reduction potential and cost-effectiveness, aligning with Uganda's TNA and NDC. Composting, including bio latrines, was also included, due to the potential to improve air quality, health and sanitation, aligning with Uganda's TNA and NDC.

The main objective of this study is to assist the seven member countries of the Eastern African Alliance on Carbon Markets and Climate Finance (EAA) in considering and prioritising mitigation technologies and project activities on the path to the operationalisation of Article 6 of the Paris Agreement

Carbon Markets

Country level prioritisation of mitigation technologies and activities is only one component of the puzzle. Understanding the fast-evolving rules and characteristics of the current carbon markets is another key component in the system. The carbon markets were considered in the study, and broadly categorised as either Paris Agreement or voluntary markets, even though there is increasing interplay between the carbon certification standards or programmes that underpin these markets.

Particular emphasis is given in the study to cooperative approaches and mechanisms under Article 6.2 and 6.4 of the Paris Agreement, where Internationally Transferable Mitigation Outcomes (ITMOs) and Article 6.4 Emission Reductions can be respectively traded. This focus is essential to understanding the opportunities available for the Eastern African countries to participate in international carbon markets and leverage global efforts to combat climate change effectively. Additionally, the report recognises the significance of non-market approaches as outlined in Article 6.8 of the Paris Agreement, including the Adaptation Benefit Mechanism, for enhancing resilience and facilitating adaptation finance.

Conclusion and Recommendations

The prioritised technologies present opportunities for the East African countries considered in this study to combat climate change and promote sustainable development through the implementation of their long-term strategies and decarbonization plans. Effective planning and stakeholder involvement are vital for the successful adoption of these technologies. The report highlights opportunities to scale mitigation efforts and reduce associated costs by underlining the pivotal role of these technologies in achieving a sustainable and low-carbon future. Strategic implementation of these technologies through carbon credit projects holds the potential to significantly impact global efforts to combat climate change.

The identified priority areas and technologies may offer investment and collaboration opportunities, fostering emission reduction goals while bolstering economic growth and livelihoods in the region. The study delivers crucial insights into prioritising GHG mitigation technologies and activities for Eastern African countries, while pinpointing opportunities for accessing carbon markets. These findings, however, are not intended to be conclusive in themselves. Rather, they are meant to serve as guides for further, comprehensive investigations by the respective countries. Adoption of sustainable and low-carbon technologies will drive emission reduction targets and sustainable development objectives in the region, as these proactive measures pave the way for informed decision - making and strategic planning.

The report recommends that this study may be used as the basis for further, detailed investigations into the viability of the prioritised technologies, at country-level. Furthermore, the report recommends exploring avenues for collaboration and knowledge sharing among the East African countries, monitoring and evaluating technology progress, considering Article 6 ‘positive lists’, proposing simplified approaches for demonstrating additionality, development of standardized baselines and evaluating the impacts of tax incentives on technologies and project activities. These proactive measures may propel the region’s transition to a green economy, ultimately achieving sustainable development objectives.

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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Glossary

Term	Definition or explanation of term
AFOLU (Agriculture Forestry Other Land Use)	AFOLU refers to one of the emissions sectors that comprise national greenhouse gas (GHG) inventories
Article 6 Mechanisms	Article 6 mechanisms refer to the cooperative approaches outlined in Article 6 of the Paris Agreement, which provide a framework for international cooperation in achieving climate mitigation and sustainable development goals. These mechanisms aim to facilitate the implementation of Nationally Determined Contributions (NDCs) by enabling countries to voluntarily cooperate in the implementation of their mitigation and adaptation actions.
BAU (Business-as-usual)	The regular operations of a company, entity or organisation
BAT (Best Available Technology)	Means the most effective and advanced stage in the development of technologies and their methods of operation, which indicates the practical suitability of techniques to mitigate the effects of climate change. Specifically, "best" means most effective in achieving a high general level of greenhouse gas mitigation or removal. "Available" means those technologies developed under economically and technically viable conditions, taking into consideration the costs and advantages, that are reasonably accessible to the operator.
Bioenergy Carbon Capture and Storage (BECCS)	Bioenergy with carbon capture and storage (BECCS) involves any energy pathway where CO2 is captured from a biogenic source and permanently stored
Carbon Market Mechanisms	Policy instruments that can be utilised to support climate action. There are two different approaches that lead to the creation of carbon markets: emissions trading schemes and crediting mechanisms
CCP (Core Carbon Principles)	The Integrity Council for the Voluntary Carbon Market (ICVCM) has introduced (CCPs) as a means to establish integrity in the voluntary carbon market. The need for integrity arises from the rapid expansion of the market, increased public interest and scrutiny, and negative media coverage of certain projects and carbon credit categories. This criticism has resulted in reduced investment in carbon reduction or removal projects, especially in emerging markets. The CCP standards aim to provide a market-wide benchmark for carbon credit quality and integrity. The CCPs are designed to give investors' confidence in buying high-quality voluntary carbon credits, which will facilitate the financing of nature-based solutions and emerging technologies that may otherwise struggle to attract funding.
CDM (Clean Development Mechanism)	The CDM was established by Article 12 of the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC). The CDM is a mechanism that provides for emissions reduction projects to earn certified emissions reductions (CERs) that may be traded in emissions trading schemes. Each CER is equivalent to one tonne of carbon dioxide reduced from the atmosphere.
CER (Certified Emission Reduction)	Means a carbon unit, equal to one metric tonne of carbon dioxide equivalent (tCO2e) of GHG emissions reduced, calculated in accordance with, and issued pursuant to, the rules of the CDM

Term	Definition or explanation of term
CO_2e (carbon dioxide equivalent)	Means a standard unit for measuring GHGs. For any quantity and type of GHG, CO_2e signifies the amount of CO_2 which would have the equivalent global warming impact
CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation)	CORSIA is a global market-based measure designed to offset international aviation CO_2 emissions to stabilise the levels of such emissions
Emerging technologies	New or innovative GHG mitigation technologies or processes. As such, the practical application of such technologies may still be in development. Emerging technologies are often disruptive in nature and may be capable of dramatically changing the status quo.
GHG (Greenhouse Gas)	Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include, but are not limited to, water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrochlorofluorocarbons (HCFCs), ozone (O_3), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6).
ITMO (Internationally Transferred Mitigation Outcomes)	ITMOs are real, additional, and verified emission reductions or removals, including mitigation co-benefits resulting from adaptation actions and/or economic diversification plans or the means to achieve them when internationally transferred. ITMOs are authorised by the host Party for use towards another Party's NDC, international mitigation purposes (e.g., the CORSIA scheme for international aviation) or other purposes (such as voluntary offsetting).
LULUCF (Land Use, land-Use Change and Forestry Activities)	LULUCF refers to one of the emissions sectors that comprise national GHG gas inventories
NDC (Nationally Determined Contribution)	A national climate action plan to cut emissions and adapt to climate impacts. Each Party to the Paris Agreement is required to establish an NDC and update it every five years
Paris Agreement	The Paris Agreement is a legally binding international treaty on climate change. It was adopted by 196 Parties at COP 21 in Paris, on 12 December 2015 and entered into force on 4 November 2016. Its goal is to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels.
TNA (Technical Needs Assessment)	To determine their climate technology priorities, countries undertake technology needs assessments (TNAs). These assessments typically support national sustainable development priorities in addition to GHG mitigation needs.
UNFCCC (The United Nations Framework Convention on Climate Change)	The UNFCCC was established in 1994 as an international environmental treaty to combat "dangerous human interference with the climate system", in part by stabilising GHG concentrations in the atmosphere
VCM (Voluntary Carbon Market)	The VCMs allow carbon emitters to offset their emissions by purchasing carbon credits emitted by projects targeted at removing or reducing GHGs from the atmosphere
VCS (Verified Carbon Standard)	The VCS is a carbon standard that allows certified projects to turn their GHG emission reductions and removals into tradable carbon credits. The VCS is managed by VERRA

Introduction

This report outlines outcomes of the assessments of different GHG mitigation technologies and activities, with the aim of establishing which of these may feasibly access carbon finances

The Eastern Africa Alliance on Carbon Markets and Climate Finance with the support of the GIZ Global Carbon Market Project (on behalf of BMWK) and the Regional Collaboration Centre (RCC Kampala), appointed Promethium Carbon to undertake a study on carbon market opportunities and applicable technologies for the Eastern Africa Region. The seven countries within the scope of the study are Burundi, Ethiopia, Kenya, Rwanda, Sudan, Tanzania and Uganda.

This report outlines outcomes of the assessments of different GHG mitigation technologies and activities, with the aim of establishing which of these may feasibly access carbon finances. These assessments were undertaken considering the national circumstances and mitigation priorities of each country assessed in the study. The identification of technologies was facilitated by desktop studies that included assessments of the respect countries' Nationally Determined Contributions (NDCs), major climate related policies, Technical Needs Assessments (TNAs) and engagements with key country-level stakeholders.

The study was initiated by identifying the best available technologies relevant to the seven East African countries. For the purposes of this study on climate change mitigation, best available technologies are those techniques or activities that are simultaneously the most advanced and the best suited to a country's circumstances for implementation. The focus on "available" means those technologies developed under economically and technically viable conditions, taking into consideration the costs and advantages, that are reasonably accessible to the operator. The study was subsequently expanded to include a focus on identifying and assessing the relevance of emerging or innovative greenhouse gas (GHG) mitigation technologies in the specified countries. As such, the practical application of these technologies may still be in development, however, they are relevant as emerging technologies are often disruptive in nature and may be capable of dramatically changing the status quo.

The identified technologies were ultimately assessed using a multicriteria analysis framework, which aimed to determine suitable mitigation technologies and project activities per country. The multicriteria analysis approach allowed for the systematic consideration and weighing of different criteria based on their relative importance, per country.

The main objective of this study is to assist the seven East African countries in considering and prioritising mitigation technologies and project activities. Such prioritisations could assist countries in developing technology "positive lists", which may be used in respective Article 6 Frameworks. Ultimately, the aim is to promote the adoption of sustainable and low-carbon technologies that can mitigate GHG emissions, support the transition to a green economy, and achieve the region's sustainable development objectives.

Accordingly, a carbon market assessment follows to provide context for the development of GHG mitigation technologies and activities that could feasibly access carbon finances.

02

Carbon Market Assessment

Carbon markets are systems that are designed to facilitate the buying and selling of carbon credits that can be used to measure and offset GHG emissions, particularly carbon dioxide. The main goal of the carbon market is to reduce the amount of GHG that is emitted into the atmosphere by creating an economic incentive for polluters to reduce their emissions. The assessment of carbon markets is done to determine how different markets and mechanisms can be used to commoditise emission reductions and removals in the seven Eastern African countries.

This assessment considers various carbon markets, broadly categorised as either Paris Agreement or voluntary markets. The Paris Agreement markets are characterised by the demand for carbon offsets at a country level. The voluntary markets are characterised by demand for carbon offsets by corporates or individuals. This distinction is necessary as there is increasing interplay between the carbon programmes that underpin these markets.

The Paris cooperative approaches and mechanisms considered in the study are related to Internationally Transferable Mitigation Outcomes (ITMOs) under Article 6.2, emission reductions under Article 6.4, and non-market mechanisms under Articles 6.8. The voluntary market is considered to have the same underlying features as the Article 6.2 and 6.4 markets, in terms of the need to demonstrate additionality and articulate real, credible and accurate baseline and project emissions.

The scope for growth in the carbon markets is well documented, on account of the growing global demand for low or zero emission products and services. In particular, study considered the potential applicability of mitigation technologies and activities in the Article 6.2 market, which is expected to be the dominant internal material market in the near future.

The following figure represents the ecosystem in which the technologies may contribute to meeting host country priorities.

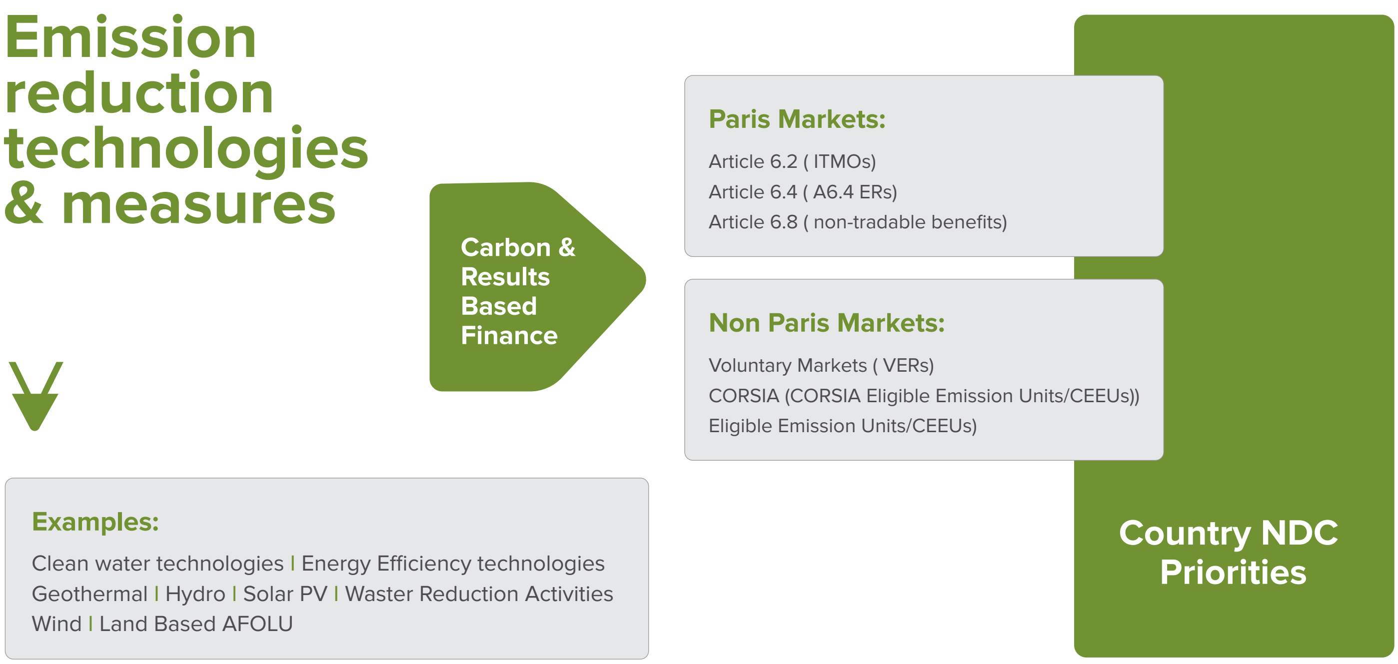

Figure 2: Carbon market ecosystem

This carbon assessment considers the opportunity of the identified technologies, applicable to the Eastern African countries in this study, to participate in international carbon mechanisms and markets.

This assessment therefore considers carbon from different perspectives. The first is the consideration of the different markets or mechanisms that may be used to commoditise carbon reductions and removals.

The second perspective relates to the country specific opportunities to develop carbon commodities, considering the possible reference or applicability of the identified technologies to meeting mitigation priorities in the respective country-NDCs.

2.1 Paris Agreement and Carbon Markets

The main aim of carbon markets and respective mechanisms is to facilitate economically efficient GHG reductions, which will enable more ambitious climate action.

Different mechanisms and markets may be appropriate for different technologies. This carbon assessment considers the opportunity of the identified technologies, applicable to the Eastern African countries in this study, to participate in international carbon mechanisms and markets. The markets considered in this study include those that will be developed within the ambition of the Paris Agreement, as well as the voluntary market.

The Paris cooperative approaches and mechanisms considered in this study are those related to ITMOs under Article 6.2, emission reductions under Article 6.4 and non-market mechanisms under Articles 6.8. The Paris Agreement mechanisms are significant because they aim, among other things, to develop a long-term future for international carbon markets that function in conjunction with domestic market - based policy instruments. These mechanisms are key levers that will assist countries in meeting their NDCs and other sustainable development commitments.

The guidance and Article 6 rulebook have been finalised, but the tools, procedures methodologies, texts, and conditions required for Article 6 implementation, are still being developed. The following is a summary of the established rules and frameworks relating to the different articles.

2.1.1 Article 6.2: Bilateral Carbon Trades

The cooperative approach under Article 6.2 provides the accounting framework required in the bilateral trade of GHG emission reductions or removals between countries. The bilaterally traded emission reductions are known as Internationally Transferred Mitigation Outcomes (ITMOs). [1]

The emission reductions are accounted for in both countries' national GHG inventories. This bilateral accounting process accordingly requires “corresponding adjustments”, to reflect a ‘credit' in the purchasing-country's emissions balance and a ‘debit' in the selling-country's emissions balance.

Importantly, for the Eastern African countries considered in this study, each State must decide on the criteria and frameworks in which emission reductions or removals are authorised as ITMOs under Article 6 of the Paris Agreement. ITMOs can be used to mitigate a bilateral country's NDC, or they may be used for “other international mitigation purposes”, as provided for in the latest Article 6.2 guidance.[2] These other international mitigation purposes could include markets such as the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) or REDD+ and Land Use, Land-Use Change and Forestry (LULUCF) activities, provided that such measures comply with the respective international and national rules.

1 Article 6.2: Decision 2/CMA 3, available at: https://unfccc.int/sites/default/files/resource/cma2021_10_add1_adv.pdf#page=11

2 UNFCCC. 2022. Guidance on cooperative approaches referred to in Article 6 of the Paris Agreement. Available at: https://unfccc.int/documents/310510

In the case of authorised use in a bilateral country's NDC or use in CORSIA, the host country commits to undertake a corresponding adjustment and fulfilling the participation and reporting requirements under the Article 6.2 guidance. These requirements include, among others, that ITMOs must have been verified, based on a robust methodology, by an accredited independent third-party auditor.

With regards to REDD+ and LULUCF opportunities, most of the Eastern African countries considered in this study outline opportunities for emission removals in land sector applications in their respective NDCs, such as those related to Afforestation and Other Land Use (AFOLU) and LULUCF activities.

The benefits of REDD+ and other land-based activities include their potential to remove significant carbon emissions from the atmosphere. Results-based finance mechanisms are increasingly used in implementing such measures, where funds are pledged and disbursed through multilateral and bilateral sources. These include, among others, the Green Climate Fund; the World Bank's Forest Carbon Partnership Facility and the Bio Carbon Fund; the German REDD Early Movers Program, and Norway's International Climate and Forest Initiative.

2.1.2 Article 6.4: International Carbon Market

Article 6.4 creates a new multilateral trading mechanism to replace the CDM which was applicable under the Kyoto Protocol and culminated at the end of 2020. Article 6.4 allows for the transition of some projects and credits that were successfully registered under the CDM. There are constraints however, with the aim of removing 'legacy' carbon credits that were generated prior to 2013 and which perhaps are not truly additional by the current standards.

Article 6.4 provides for a centralised approach to emissions accounting and reporting, with emission reduction units, or mitigation outcomes, to be created under the Supervisory Body. The Supervisory Body of the new Article 6.4 Mechanism will be responsible for approving all projects under the mechanism. Under Article 6.4, host country governments are also required to approve projects.

Accordingly, for the Eastern African countries considered in this study, each State must decide on the criteria and frameworks for approving Article 6.4 projects. The rules address the environmental integrity of the carbon credits developed under this mechanism, as well as matters related to proving sustainable development impacts. The rules for Article 6.4 also specify the crediting period of projects that are registered under the Article 6.4 mechanism. The crediting period must be either 5 years renewable, with the potential to be renewed twice, i.e., 15 years in total, or a maximum of 10 years with no option of renewal.[3]

Importantly, the additionality and baselines of project activities remain key focus areas of development under Article 6.4, however there is expected to be flexibility for countries to determine their own specific rules.

2.1.2.1 Baselines

With regards to baselines, work is ongoing to define more specific guidance for determining baselines according to four approaches: a performance based / best available approach, historic emissions, business-as-usual emissions and standardised baselines.[4]

In particular, Article 6.4 also provides for the development of standardised baselines "*by the Supervisory Body at the request of the host Party or may be developed by the host Party and approved by the Supervisory Body*."

This provision presents opportunities for the Eastern African countries considered in this study to define criteria used in the validity and determination of emissions reductions. The following is a list of recent CDM standardised baselines, some of which are no longer valid, related to the seven countries in question. This list of standardised baselines represents baselines that may feasibly be transitioned (for those that are valid) or updated under the Article 6.4 Mechanism:

3 UNFCCC. 2022. Guidance on cooperative approaches referred to in Article 6 of the Paris Agreement. Available at: https://unfccc.int/documents/310510

4 UNFCCC. 2022. Guidance on cooperative approaches referred to in Article 6 of the Paris Agreement. Paragraph 36-37 of the Rules, modalities and procedures for the mechanism established by Article 6, paragraph 4, of the Paris Agreement. Available at: https://unfccc.int/documents/310510

Table 1: Latest CDM standardised baselines[5]

Country	Technology	Code	Expired or Valid
Burundi	Domestic cookstoves	ASB0018	Expired on 26 Nov 2018
Ethiopia	Institutional cookstoves	ASB0044-2019	Expired on 21 Sep 2022
Kenya	Domestic cookstoves	ASB0035	Expired on 26 Feb 2020
	Renewable energy (GEF)	ASB0050-2020	Valid
Rwanda	Renewable energy (GEF)	ASB0017	Expired on 25 Oct 2018
	Waste: LFG projects	ASB0030	Expired on 23 Oct 2019
	Charcoal production	ASB0041-2018	Expired on 19 Dec 2021
Sudan	Waste: LFG projects	ASB0023	Expired on 10 Mar 2019
	Renewable energy (GEF)	ASB0024	Expired on 27 Mar 2019
Tanzania	-	-	-
Uganda	Charcoal production in communities	ASB0002-2017	Expired on 31 Oct 2020
	Institutional cookstoves	ASB0016	Expired on 15 Oct 2018
	Renewable energy (GEF)	ASB0054-2022	Valid

The standardised baselines in the above table can be grouped into three main themes of baselines:

1. Displacement of grid-based electricity (baseline for renewable energy projects)
2. Fraction of non-renewable biomass (baseline for energy efficiency cookstove, water purification and eco-charcoal projects)
3. Typical waste characterisations (baseline for landfill gas destruction/ utilisation projects)

These themes point to the national priorities of many of the Eastern African countries in this study. Namely, the prioritisation of providing access to clean and affordable energy, limiting deforestation and biodiversity loss and minimising pollution related to the release of landfill gas.

The use of standardised baselines assists project developers to register carbon credit projects by reducing the time, complexity and resources required to demonstrate certain baselines. This assertion is supported by an assessment of the successfully registered carbon credit projects in the Eastern African countries, discussed in the following section. This assessment reveals a trend in the registration of projects focussed on the provision of renewable energy, cookstoves, water purifiers and some eco-charcoal production and landfill related projects.

5 Available at: https://cdm.unfccc.int/methodologies/standard_base/2015/sb134.html and https://cdm.unfccc.int/methodologies/standard_base/2015/ sb4.html

6 Available at: CDM: Standardized baselines (unfccc.int)

Easing the barriers to registering carbon credit projects, through for example, the development of standardised baselines, will increase the ease of access to carbon and results-based finance. This may in turn increase or scale up the implementation of the related emission reduction technologies in the host country.

Similarly, it may be possible to simplify additionality requirements, particularly in least developed countries.

2.1.2.2 Additionality

Paragraph 39 of the Article 6.4 rules in the latest UNFCCC guidance[7] states that:

"The Supervisory Body may apply simplified approaches for demonstration of additionality for any least developed country or small island developing State at the request of that Party, in accordance with requirements developed by the Supervisory Body."

The latest guidance on Article 6 requires, however, that additionality be demonstrated using a robust assessment. Additionality must be demonstrated by showing that the activity would not have occurred in the absence of the incentives from the mechanism, considering all relevant national policies, including legislation, and mitigation measures that are required by law or regulation.

It is therefore expected that host countries may utilise the results of additionality tests as provided for under international crediting standards such as the CDM, Gold Standard and Verra, if they are considered to be robust.[8] For example, 'cost' and 'common practice' are typical indicators used to demonstrate additionality. Accordingly, technologies and activities that have higher associated costs, compared to a business-as-usual technology or activity, are likely to more easily demonstrate that they are additional. Furthermore, technologies or activities that are not commonplace or common practice, may also more easily demonstrate that they are additional.

Additionality is typically demonstrated at the project level, where each activity is subject to an additionality assessment. It is possible however to demonstrate additionality at a technology level, where it can be proven that such a technology is widely additional. The CDM's positive list is such an example, where specific technologies that are in a specific context, such as special underdeveloped zones quality for automatic additionality. It is further possible, considering the provisions of paragraphs 26(e), 27 and 39 of the Rules, Modalities and Procedures for the Mechanism Established by Article 6, Paragraph 4, of the Paris Agreement, that host Parties may be able to develop country-specific positive lists in terms of the additionality of certain project activities and technologies, provided that they meet the Article 6.4 rules.

There is speculation that the requirements pertaining to additionality and baselines of emission reductions and removals should be contained in host country NDCs. This discussion is continued in the following section 2.3. Many NDCs have emission reduction targets that are 'conditional' or 'unconditional'. Project and technologies associated with 'conditional' targets could be considered as additional. These rules and requirements are not yet finalised.

In addition to carbon trading opportunities in East Africa, the following section considers the opportunities presented by Article 6.8 of the Paris Agreement.

2.1.3 Article 6.8: Non-market Approaches and Benefits

Article 6.8 addresses non-market international cooperation

7 UNFCCC. 2022. Guidance on cooperative approaches referred to in Article 6 of the Paris Agreement. Available at: https://unfccc.int/documents/310510

8 West African Alliance on Carbon Markets and Climate Finance. 2022. Blueprint for Article 6 Readiness in Member Countries of the West African Alliance. Available at https://westafricaclimatealliance.org/2022/06/04/blueprint-for-article-6-readiness-in-member-countries-of-the-west-african-alliance/

among governments. Examples of non-market approaches include activities that facilitate social inclusivity, financial policies and measures, circular economy, blue carbon, just transition of the workforce and adaptation benefit mechanisms.

Non-market approaches are expected to gain multilateral support considering the increasing importance of enhancing resilience and delivering adaptation finance, particularly in developing country contexts. Non-market approaches are ultimately expected to contribute to the achievement of the adaptation commitments contained in host country NDCs.

A notable example of work in progress in this regard is the development by the African Development Bank of an Adaptation Benefit Mechanism, which is being piloted in several African countries including Ethiopia, Kenya and Uganda.[9] The Adaptation Benefit Mechanism aims to quantify, verify and certify the sustainable development benefits of adaptation action, using results-based finance.

The types of pilot methodologies and subsequent projects include renewable water pumping technologies, clean cooking, grid extension, watershed management and off-grid electrification sectors. Activities must be additional, i.e., would not be implemented in the selected sector/country without the incentive provided by the Adaptation Benefit Mechanism.

The resulting 'Certified Adaptation Benefits' are not intended to be internationally tradable and will instead be delivered directly to the end-users, such as governments, climate funds, philanthropists, the private sector and individuals. The results-based finance principle enshrined in the Adaptation Benefit Mechanism entails agreed payment to project developers upon delivery of the Certified Adaptation Benefits. The aim is therefore to catalyse investments in priority measures that credibly demonstrate that they are able to deliver the required impacts and results.

9 https://www.afdb.org/en/topics-and-sectors/initiatives-partnerships/adaptation-benefit-mechanism-abm.

Accordingly, for the Eastern African countries in this study, the benefits of pursuing activities and technologies related to Article 6.8 include the opportunities to mobilise public and private sector finance to enhance adaptation action. Local communities are the intended beneficiaries of non-market approaches, as non-market approaches are particularly suitable for adaptation activities in rural or low-income areas where climate impacts are usually more significant compared to more developed areas. It is therefore important that host country NDCs be developed and updated with the aim of addressing the specific in-country needs and priorities.

2.2 Voluntary Carbon Markets

The voluntary carbon market is widely recognised as being an important component in the suite of measures that are required for global decarbonisation. There are numerous voluntary carbon certification bodies which cater for different customer needs and standards, as by definition this market is unregulated. As such, there are criticisms about the integrity of some carbon certifications in the market.

Accordingly, there are increasing measures underway to strengthen the integrity of the voluntary carbon markets, such as those being undertaken by the Taskforce on Scaling Voluntary Carbon Markets.[10] This association is a private sector-led initiative working to scale an effective and efficient voluntary carbon market to help meet the goals of the Paris Agreement. The framework for interaction between the voluntary markets and the Paris Agreement mechanisms and instruments is currently in development.

The Voluntary Carbon Market Initiative (VCMI)[11] is another example of measures taken to strengthen the integrity of the carbon markets. The VCMI is a non-profit organisation working to establish trustworthy voluntary carbon markets aligned with the Paris Agreement. The VCMI collaborates with stakeholders to create markets that contribute to climate goals and promote

10 https://www.iif.com/tsvcm.
11 VCMI - Delivering high-integrity carbon markets (vcmintegrity.org)

sustainability. It provides guidelines for companies to use carbon credits credibly (VCMI Claims Code of Practice) and helps countries engage in high-integrity markets (VCM Access Strategy Toolkit). The VCMI is independent and has received support from various organisations, including the UK Department for Business, Energy and Industrial Strategy.

In addition, the Integrity Council for the Voluntary Carbon Market (ICVCM) has introduced the Core Carbon Principles (CCPs) as a means to establish integrity in the voluntary carbon market. The need for integrity arises from the rapid expansion of the market, increased public interest and scrutiny, and negative media coverage of certain projects and carbon credit categories. This criticism has resulted in reduced investment in carbon reduction or removal projects, especially in emerging markets.

The ICVCM, an independent governance body for the voluntary carbon market, published the final version of the CCPs in late March 2023.[12] These standards aim to provide a market-wide benchmark for carbon credit quality and integrity. The CCPs are designed to give investors confidence in buying high-quality voluntary carbon credits, which will facilitate the financing of nature-based solutions and emerging technologies that may otherwise struggle to attract funding.

To operationalise the CCPs, the ICVCM also launched the Program-level Assessment Framework, which assesses carbon credit issuing programs or standards for CCP approval, providing criteria and decision tools for each principle.

Carbon credits will receive the CCP label only if both the carbon-crediting program that issued them and the credit category are assessed by the Integrity Council and meet its criteria for high-integrity (climate, environmental, and social) as set out in the CCPs. The Assessment Procedure aims to embed the CCPs into the voluntary carbon market, outlining the process for assessing CCP-eligibility, tagging eligible carbon credits, and ensuring ongoing oversight and enforcement of the CCPs. This enables investors to align with well-governed programs and allows project developers to choose appropriate programs for their projects.

In the context of the Eastern African countries in this study, the market dynamics and customer preferences, such as those that may be underpinned by the CCP, are key determinants in the ability to access carbon finances. There are undoubtedly opportunities for accessing private sector markets and engaging with players focused on achieving emission reductions and net-zero targets. The voluntary carbon market, in particular, is regarded as a significant lever with the potential to scale up climate action through investments in emissions reduction and removal projects, without the constraints and bureaucracy associated with operationalising the Paris Agreement mechanisms and instruments.

2.3 Alignment of Climate Measures with Long-term Strategies and Plans

This carbon assessment also considers the potential contribution of the technologies in terms of each country's long-term strategies and decarbonisation plans, as articulated in the respective NDCs. A summary of the long-term strategies and NDCs follows.

2.3.1 Long-term Climate Strategies

The table below sets out the published long-term strategies for each east African country forming part of this assessment.

12 A Boost to Integrity in the Voluntary Carbon Market | Global law firm | Norton Rose Fulbright

Table 2: Summary of Long-term Strategies

Country	Long-term Strategies
Burundi	Burundi has developed a range of long-term strategies and action plans to address various aspects of sustainable development, including climate change mitigation, biodiversity conservation, agriculture, water resources, energy, and soil degradation. • REDD+ National Strategy and Action Plan 2019, aims to transform Burundi into a country with a forest carbon stock by 2027. The strategy envisions using forest resources to boost the national economy and enhance the well-being of the population. The updated NDC emphasises the approval of a revised National Forestry Strategy, although this document could not be located. • The National Agriculture Strategy for 2018-2027 focuses on ensuring environmental sustainability, food security, and improved income for those engaged in the agricultural sector. It aims to enhance the sector's resilience to climate change impacts and promote sustainable farming practices. • National Plan for the Development of Burundi for 2018-2027 outlines the government's vision for economic transformation and emphasises strategic goals such as promoting growth-oriented sectors, developing human capital, sustainable environmental management, climate change mitigation, and strengthening governance and security. • The Decentralised Rural Electrification Strategy 2015, in collaboration with UNICEF, promotes off-grid renewable energy production and usage, with a strong emphasis on environmental sustainability. • National Strategy and Action Plan on Climate Change 2013, serves as a comprehensive framework for integrating climate change considerations across all sectors of the country's socio-economic life. The strategy envisions a state that fosters development resilient to the harmful effects of climate change. • The National Strategy and Action Plan on Biodiversity 2013, aims to protect and conserve biodiversity, particularly in the face of climate change's adverse impacts. • National Water Strategy 2012 allocates resources for monitoring and evaluating the impact of climate change on water resources. • The National Strategy and Action Plan to Combat Soil Degradation 2011, provides a framework for soil conservation efforts, aligning with the country's Poverty Reduction Strategy Paper (PRSP II). • Energy Strategy and Action Plan 2011, prioritises hydropower and other renewable resources for capacity additions. The strategy emphasises electrification of social infrastructure in remote, off-grid areas and highlights the importance of investing in renewable energy sources. • Vision Burundi 2025, developed in 2011, sets the government's development vision, focusing on sustainability, including objectives related to climate change adaptation planning, the development of hydroelectric power stations and investment in renewable energies, and intensive reforestation for ecosystem restoration.

Country	Long-term Strategies
Ethiopia	Ethiopia has established a range of long-term strategies and plans to address climate change adaptation, sustainable development, disaster risk management, and environmental conservation. These strategies demonstrate the country's commitment to building a climate-resilient and green economy while ensuring the well-being of its population. • The 10-year development plan for 2020/21-2029/30 sets Ethiopia's development vision for the next decade, with one of its pillars focused on building a climate-resilient, green economy. This plan aims to combat land degradation, reduce pollution, increase productivity, lower GHG practices. • The National Adaptation Plan Implementation Roadmap identifies key activities and milestones necessary for achieving the country's National Adaptation Plan. This roadmap promotes collaboration among stakeholders responsible for implementation to enhance adaptation efforts. • The National Disaster Risk Management Commission Establishment Council of Ministers Regulation establishes the National Disaster Risk Management Commission as the primary federal agency for disaster prevention and response coordination. This regulation defines the commission's functions and powers to facilitate comprehensive disaster risk management. • The Climate Resilience Strategy for Water and Energy outlines the government's strategy to ensure sustainable water and energy supplies across the country. • The Climate Resilient Transport Sector Strategy aims to modernise Ethiopia's transport sector, enhance coordination, improve public transport accessibility and safety, reduce transport-related pollution, and promote non-motorised transportation options. • The National Policy and Strategy on Disaster Risk Management focuses on comprehensive disaster risk management in the context of sustainable development. It includes directives related to disaster risk management systems, early warning systems, and official disaster response coordination. • The Climate-Resilient Green Economy (CRGE) Strategy envisions Ethiopia achieving middle-income status by 2025 through a climate-resilient green economy. The strategy encompasses pillars such as agriculture, deforestation reduction, renewable energy, and climate-conscious urban planning. • The Ethiopian Programme of Adaptation to Climate Change (EPACC) emphasises mainstreaming climate change into national decision-making processes and highlights key climate change risks in areas such as health, agriculture, land degradation, water scarcity, biodiversity, and displacement.

Country	Long-term Strategies
Kenya	Kenya has developed a comprehensive set of long-term strategies and policies to address climate change, wildlife conservation, sustainable agriculture, disaster management, and environmental governance. • In 2021, the Central Bank of Kenya issued guidance on climate-related risk management, recognising climate change as a substantial risk and an opportunity for the financial sector. This guidance aims to maintain a stable and efficient banking and financial system in the face of climate challenges. • The National Wildlife Strategy 2030 focuses on resilient ecosystems, engagement by all Kenyans, evidence-based decision making, and sustainability and governance. This strategy acknowledges that climate change poses risks to Kenya's wildlife but also recognises the role of ecosystem conservation in enhancing climate resilience. • The Kenya Climate Smart Agriculture Strategy 2017-2026 aims to enhance the adaptive capacity and resilience of farmers, pastoralists, and fisherfolk. This strategy seeks to minimise emissions, promote sustainable agricultural practices, and improve food security and livelihoods. • The National Policy on Climate Finance outlines Kenya's legal and policy framework for climate financing and identifies the role of climate finance in key economic sectors. It aims to support climate actions in sectors such as agriculture, forestry, energy, transport, trade, and tourism. • The Forest Conservation and Management Act 2016 aims to conserve Kenya's forests and manage them sustainably, including combatting deforestation and promoting carbon sequestration. • The National Adaptation Plan 2015-2030 identifies Kenya's vulnerabilities to climate change and outlines adaptation actions and implementation strategies for addressing these challenges. • The Climate Risk Management Framework for Kenya seeks to harmonise climate change and disaster risk policies. It identifies priority areas for government intervention and outlines strategies for program coordination and implementation. • The Environmental Management and Coordination (Air Quality) Regulations set emissions standards, including GHG emissions, and require certain facilities to apply for emissions licenses. These regulations contribute to reducing air pollution and GHG emissions. • The National Environment Policy 2013 provides a framework for integrated and sustainable management of Kenya's environment and natural resources. It aims to strengthen the legal and institutional framework, integrate environmental management with economic growth, promote research and capacity development, and encourage sustainable practices. • The National Disaster Response Plan outlines principles, procedures, roles, and responsibilities for disaster response in Kenya. It addresses various hazards, including droughts, floods, landslides, and fires, and provides guidance for effective disaster management. • The National Policy for Disaster Management recognises the role of climate change in increasing Kenya's vulnerability to disasters. It aims to institutionalise mechanisms for addressing disasters and associated vulnerabilities, with a focus on climate change resilience. • The Kenya Vision 2030 is a long-term development blueprint that emphasises sustainable development across various sectors, including social, economic, and environmental dimensions. This vision provides a framework for Kenya's development efforts toward achieving its long-term goals.

Country	Long-term Strategies
Rwanda	Rwanda has undertaken an array of long-term strategies and plans to steer its sustainable development, bolster economic growth, and enhance its resilience to climate change and disasters. With the aim of fulfilling its conditional commitment, Rwanda envisions using climate finance and international market mechanisms as needed, drawing from the expertise gained through initiatives like the CDM and other established market systems. This encompasses a potential engagement in international collaborative endeavours, as outlined in Article 6 of the Paris Agreement. • Vision 2050 aspires Rwanda to be an upper middle-income country by 2035 and a high-income country by 2050, Rwanda adopts a sustainable approach to natural resources use and management while building resilience to climate change impacts. • Green Growth and Climate Resilience Strategy (GGCRS) was revised and approved in 2023, this strategy aims to transform Rwanda into a developed, climate-resilient, and low-carbon economy by 2050. • National Environment and Climate Change Policy (2019) sets the guiding principles and objectives for addressing environmental and climate change challenges in Rwanda. • National Strategy for Transformation (NST1) aligns with the 7 Years Government Programme (2017-2024) to achieve economic development visions by 2020 and 2050, recognising climate change as a priority cross-cutting area. • Environment and Natural Resources Strategic Plan (2018-2024) contributes to the revised targets of Vision 2020 and focuses on achieving environmental sustainability while maximising the sector's contribution to economic growth. This Strategic Plan aligns with environmental and climate change policies and strategies such as the NST1, GGCRS and Rwanda's NDC. • National Strategy for Disaster Risk Reduction (2020-2025) serves as a guiding document for disaster risk management in Rwanda, aiming to enhance disaster resilience and protect vulnerable communities. • Strategic Plan for Agriculture Transformation 2018-2024 (PSTA4) aims to transform Rwanda's agriculture sector through sustainable practices and climate-resilient approaches. • National Land Use and Development Master Plan outlines the sustainable use and management of land resources in Rwanda

Country	Long-term Strategies
Sudan	Sudan has developed a series of long-term strategies to address its energy needs, promote renewable energy, and protect its forests and natural resources. • The Electricity Strategy 2019-2035 aims to significantly increase electricity coverage in Sudan, from 32% to 100% by 2035. The strategy focuses on reducing operational costs and emphasises the development of renewable energy projects, particularly solar and wind energy, as well as the expansion of distribution networks. By prioritising renewable energy sources, Sudan aims to enhance energy accessibility, sustainability, and affordability. • In 2020, Sudan launched the Solar Transformation Programme (STP) as part of its efforts to expand electricity access to rural communities. The STP leverages decentralised renewable energy solutions to provide alternatives for energy expansion. By harnessing solar power and promoting the use of renewable energy technologies, Sudan seeks to improve electricity access, particularly in remote areas, while reducing dependence on traditional energy sources. • The Sudan National Forestry Policy Statement 2019 aims to address deforestation, forest degradation, and environmental challenges. The policy seeks to combat deforestation caused by illegal cutting, mismanagement of cutting permits, agricultural expansion, and fuel energy demand. It envisions creating a “greener Sudan” by implementing programs aligned with national development and investment plans. Sudan intends to reverse the trend of forest cover loss and counter desertification and environmental degradation through detailed analysis, formulation, and implementation of sustainable forestry practices.
Tanzania	Tanzania has implemented various long-term strategies to address the challenges posed by climate change and promote sustainable development. • The National Five-Year Development Plan 2016/17 - 2020/21 acknowledges climate change as a challenge and sets mitigation and adaptation goals. The plan emphasises the promotion of renewable energy technologies such as solar, biomass, wind, and geothermal, as well as the reduction of charcoal consumption in urban areas. It also targets increasing natural forest cover, planting trees, and integrating climate change and disaster risk reduction strategies into districts. • The National Energy Policy 2015 aims to provide sustainable, reliable, and affordable energy to its citizens. It promotes the use of renewable energy sources like solar, biomass, wind, small-scale hydro, and geothermal. The policy also encourages the establishment of feed-in tariffs, the integration of renewable energy into the national grid, and the reduction of wood consumption for cooking. • The Agriculture Climate Resilience Plan 2014 focuses on addressing climate change impacts through improved land and water management, the adoption of climate-smart agriculture, enhanced risk management, and strengthening knowledge and systems for climate action. The plan also emphasises the importance of organic agriculture, biofuel crop production, and sustainable use of natural resources. • Tanzania has formulated strategies to reduce emissions from deforestation and forest degradation (REDD+). The National Strategy for Reduced Emissions from Deforestation and Forest Degradation (REDD) aims to establish monitoring systems, engage stakeholders, build capacity, promote awareness, and address the drivers of deforestation.

Country	Long-term Strategies
Uganda	Uganda has developed a series of long-term strategies and policies aimed at achieving sustainable development and addressing the challenges posed by climate change and environmental degradation. • The Uganda Climate Change Act 2021 establishes a legal framework to align Uganda with global climate agreements, including the United Nations Framework Convention on Climate Change, the Kyoto Protocol, and the Paris Agreement. The Act enables the implementation of climate change mitigation and adaptation measures, participation in international climate mechanisms, accurate emission measurement and reporting, institutional coordination for effective response, and mechanisms for financing climate initiatives, all aimed at addressing climate challenges and promoting sustainability. • The Third National Development Plan (NDPIII) for the period 2020-2025. NDPIII emphasises the importance of natural resource and climate change management in reducing disaster losses, improving household incomes, and enhancing the quality of life for the population. • The Ugandan government has allocated resources through the National Budget to provide relief aid in response to climate-induced disasters such as floods and landslides. The budget framework paper also sets targets for forest cover, integration of climate change into development plans, and reduction of GHG emissions. • The Green Growth Development Strategy, aligned with Vision 2040, aims to foster economic growth while promoting resource use efficiency, climate resilience, and the optimal use of natural capital. The strategy seeks to create new opportunities for decent employment, enhance food security, and establish an enabling institutional and governance framework for green growth. • The National Climate Change Policy aims to ensure a harmonised and coordinated approach toward climate-resilient and low-carbon development. The policy focuses on priority concerns such as adaptation, mitigation, monitoring, research, education, increased awareness, gender issues, and institutional capacity building. It emphasises the adoption and implementation of strategies across various sectors including, agriculture, livestock, fisheries, water management, forestry, biodiversity, ecosystem services, and tourism. • The National Policy for Disaster Preparedness and Management serves as a framework for effective disaster risk management and preparedness. This policy recognises climate change and environmental degradation as increasing vulnerabilities and highlights the importance of cross-sectoral collaboration, behavioural change, institutional frameworks, and information management in disaster management. • Uganda has also prioritised renewable energy as a means to address energy challenges, environmental degradation, and climate change. The Renewable Energy Policy for Uganda aims to increase the use of modern renewable energy sources, such as hydropower, solar, biofuels, and waste-to-energy. The policy includes objectives related to legal and institutional frameworks, financing, public awareness, research and development, biomass energy use, and energy efficiency.


Good Stove - Better Cooking
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Many developing countries differentiate between NDC targets that are ‘conditional’ and those that are ‘unconditional’. Conditional targets are those that are expected to be achieved upon receiving financial or technical and capacity building support.

2.3.2 Decarbonisation Plans in NDCs and TNAs

In the context of this study, the respective country NDCs are relevant for two main reasons. Firstly, emission reductions within each country should be aligned with the principles and focus areas for achievement of the NDC commitments. Secondly, it is possible that the national decisions related to additionality may be defined or articulated in the country NDCs.

Many developing countries differentiate between NDC targets that are ‘conditional’ and those that are ‘unconditional’. Conditional targets are those that are expected to be achieved upon receiving financial or technical and capacity building support. Unconditional targets are those that the country expects to meet through its own domestic means. Host countries will need to decide whether or not to link the relationship of an Article 6 transaction to their conditional or unconditional NDC targets.

Table 3 below summarises the country-specific NDC targets, indicating whether the targets are conditional and/or unconditional. The conditional component has often been linked to international financial support, including through Article 6 carbon markets. Conversely, the unconditional component is therefore linked to a country’s intention to implement its NDC using its own resources. However, there is no clear guidance on what NDC (un)conditionality means and how to apply it.

Importantly, the assessment of the country NDCs (and TNAs) facilitated the identification of a list of mitigation technologies required to achieve each country’s decarbonisation targets. The respective technologies, and in some cases their specific applications, are summarised in the following table.

Table 3: Summary of Technologies prioritised in NDCs and TNAs

Country	NDC Target	Conditional / Unconditional	NDC and TNA Priority Technologies
Burundi[13]	Unconditional scenario is to reduce national emissions by 1.58% compared with the BAU scenario by 2025 and 3.04% by 2030.	**Unconditional** – reduce emissions by 3.04% by 2030. **Conditional** - reduce emissions by 12.61% with international support.	**Energy and Transport:** 1. Improved Cook Stoves 2. Household Solar PV 3. Solar PV plants 4. Wind 5. Large Hydroelectric power 6. Micro-hydroelectric power 7. Biogas in schools and detention facilities 8. E-mobility **Waste sector:** 1. Methanation for biogas production 2. Optimisation of biomass briquette capacities 3. Composting 4. Anaerobic digestion for biogas production 5. Wastewater treatment by lagooning 6. Methane recovery from landfill 7. Recycling of wastewater for irrigation and soil fertilization **AFOLU:** 1. Development of Forestry industry 2. Development of Bamboo sector **IPPU:** 1. Emissions from IPPU sector – negligible. The 2020 NDC does not include actions to mitigate emissions from the IPPU sector, but it is accounted for in the BAU.

13 CDN Burundi ANNEXE 1.pdf (unfccc.int) (NDC) and bdi-rapport-ebt-etape-1-attenuation-layout-version-finale2-1.pdf (unepccc.org) (TNA)

Country	NDC Target	Conditional / Unconditional	NDC and TNA Priority Technologies
Ethiopia[14]	Carbon Neutrality, but Ethiopia does not specify the year.	**Unconditional** - absolute emission levels of 347.3 MtCO2e in 2030 equal to a 14% (-56 MtCO2e) reduction below BAU in 2030. **Conditional** - absolute emission levels to 125.8 MtCO2e in 2030 equal to a 68.8% (-277.7 MtCO2e) reduction below BAU in 2030 MtCO2e) reduction below BAU in 2030	Ethiopia started on its TNA process in 2020 as part of the TNA IV project from 2020 to 2023, where the country needs to decide its priority sectors and technologies for both mitigation and adaptation. **Energy and Transport:** 1. Cookstove efficiency improvement 2. Solar lanterns 3. Solar home systems 4. Micro and pico-hydropower electricity generation 5. Wind 6. E-cooking 7. E-mobility **Waste sector:** 1. Composting 2. Landfill gas use **AFOLU:** 1. Solar powered water irrigation 2. Use of Efficient Carbon Sink Crops and Energy Cropping **IPPU:** 1. Replacing energy source in the production of clinker in cement with adequate and available materials without compromising cement properties 2. Industry fuel switches a. Fuel switch 1 – shift from industrial petroleum demand to electricity b. Fuel switch 2 - shift from industrial petroleum demand to sustainable bio

14 unfccc.int/sites/default/files/NDC/2022-06/Ethiopia%27s updated NDC JULY 2021 Submission_.pdf (NDC)

Country	NDC Target	Conditional / Unconditional	NDC and TNA Priority Technologies
Kenya[15]	Reduce emissions by 32% by 2030	Unconditional - abate GHG emissions by 32% by 2030 relative to the BAU scenario of 143 MtCO2e - 21% of the mitigation cost from domestic sources. Conditional - abate GHG emissions by 32% by 2030 relative to the BAU scenario of 143 MtCO2e - 79% of the mitigation cost is subject to international support	**Energy and Transport:** 1. Geothermal 2. Solar home systems 3. Solar dryers 4. Small hydropower 5. Large hydropower 6. Biomass to energy 7. Biofuel 8. E-mobility 9. Wind **Waste sector:** 1. Bio-methane capture from biodigester 2. Waste re-use / recycling 3. Waste composting **AFOLU:** 1. Afforestation and Reforestation 2. Enhance REDD+ projects **IPPU:** None
Rwanda[16]	Unconditional + Conditional = 38% reduction in GHG emissions compared to BAU in 2030, equivalent to an estimated mitigation level of up to 4.6 million CO2e in 2030	**Unconditional** - reduce emissions by 16% by 2030. **Conditional** - reduce emissions by 22% by 2030.	**Energy and Transport:** 1. Improved Cook Stoves 2. Solar PV 3. Wind 4. Biofuel 5. Small and micro hydropower 6. Geothermal 7. Improved charcoal and peat technology 8. Rail Transport 9. E-cooking 10. E-mobility **Waste sector:** 1. Waste to energy 2. Aerobic composting 3. Waste-water treatment 4. Landfill gas destruction **AFOLU:** 1. Soil and water conservation (crop rotation, terracing, multi cropping) 2. Improved livestock husbandry 3. Improved manure management 4. Solar irrigation 5. Conservation tillage 6. BECCS **IPPU:** 1. Increased pozzolana use in cement 1. Fluorinated gases substitution

15 unfccc.int/sites/default/files/NDC/2022-06/Kenya%27s First NDC %28updated version%29.pdf and technologyneedsassessmentreport-mitigation-kenya-13.pdf (unepccc.org) (TNA)
16 undp-ndcsp-rwanda-ndc2-2020.pdf (NDC) and tech-action.unepccc.org/wp-content/uploads/sites/2/2013/12/technologyneedsassessmentreport-rwanda-13.pdf (TNA)

Country	NDC Target	Conditional / Unconditional	NDC and TNA Priority Technologies
Sudan[17]	Absolute targets specified at sectoral levels	Conditional – reduce GHG emissions by 38% in the energy sector (12.4 Mt CO2e), 45% in the forestry sector (13.4 Mt CO2e), and 20% in the waste sector (1.3 Mt CO2e) by 2030 compared to business-as-usual.	**Energy and Transport:** 1. Improved Cook Stoves 2. Solar PV 3. Wind Turbines 4. Geothermal 5. Compact Fluorescent Lights 6. Solar Home Systems **Waste sector:** 1. Composting and recycling of waste 2. Sludge to Biogas **AFOLU:** 1. Water harvesting 2. Smart irrigation technologies - Solar pumps, precision irrigation 3. Fermentation technology - Biogas units **IPPU:** 1. Energy Efficient Boilers using tyres, bio-diesel, LPG or through the introduction of renewable energy technologies 2. Pozzolans Substitute for clinker Formation in Cement industry
Tanzania[18]	Reduce emissions by 30-35% by 2030	Conditional – reduce 30-35% of emissions by 2030 Breakdown not specified, however noted that Tanzania's "NDC implementation plan depends largely on climate finance mechanism under UNFCCC, bilateral and multilateral Climate Financing sources".	**Energy and Transport:** 1. Improved Cook Stoves 2. Hydroelectric power 3. Hydroelectric power 4. Solar PV 5. Wind 6. Geothermal 7. Bioenergy 8. E-cooking 9. E-mobility **Waste sector:** 1. Biofuel 2. Biomass energy 3. waste recycling and re-use; 4. Landfill gas recovery. **AFOLU:** 1. Agroforestry 2. Mangrove ecosystems conservation, Rehabilitation and restoration. 3. Sustainable forest management 4. Sustainable charcoal production models and appropriate techniques **IPPU:** None

17 Microsoft Word - Sudan Updated First NDC-12102021.docx (unfccc.int) (NDC) and hn (unepccc.org) (TNA)
18 TANZANIA_NDC_SUBMISSION_30%20JULY%202021.pdf (NDC) and Technology Needs Assessment Report (unepccc.org) (TNA)

Country	NDC Target	Conditional / Unconditional	NDC and TNA Priority Technologies
Uganda[19]	Reduce emissions by 24.7% by 2030.	**Unconditional** – reduce emissions by 5.9% by 2030. **Conditional** – reduce emissions by 18.8% by 2030.	**Energy and Transport:** 1. Micro-hydroelectric power 2. Geothermal 3. Solar PV 4. Wind 5. Improved Cook Stoves (ICS) 6. Bus Rapid Transport (BRT) 7. Rail Transport 8. E-cooking 9. E-mobility 10. Biofuel **Waste sector:** 1. Bio-latrines **AFOLU:** 1. Agroforestry 2. Rainwater harvesting and irrigation 3. Improved charcoal kilns linked to bioenergy woodlots 4. Livestock management in the cattle corridor 5. Wetland and Peatland management **IPPU:** 1. Substitute clinker in the cement production process; 2. Manage refrigerant use in a circular economy

It is evident that all the countries assessed are only able to implement their NDC targets with international financial support (conditionality of NDC). Therefore, it is likely that additionality of emission reduction projects in these countries will be feasibly demonstrated, on the basis that there is not enough access to finance at a national level to implement such measures. These finance gaps present opportunities for the use of results-based finance mechanisms.

The NDC assessments also highlight priority areas for the respective countries. Renewable energy and energy efficiency measures predominate and there are also key focus points on AFOLU-related opportunities, particularly measures that reduce deforestation, and waste minimisation projects. These focus areas are aligned with the developmental priorities in these countries, which aim to increase clean energy provision and security, protect natural resources, ecosystems and livelihoods associated with agropastoral practices, and increase the health and safety of communities.

The assessment of carbon markets and consideration of country specific climate policies, strategies and objectives facilitated the identification of a suite of applicable technologies and project activities, per country considered in this assessment. These technologies are described in the following chapter of this report.

19 Updated%20NDC%20_Uganda_2022%20Final.pdf (NDC) and Technology Needs Assessments – Mitigation Report (unepccc.org) (TNA)


03

Applicable Technologies

Various technologies and project activities were considered in this assessment, which could feasibly be implemented as carbon credit projects in one or more of the carbon markets described in the preceding chapters of this report. The technologies were identified by assessing each country's NDC and TNA, supported by engagements with key country-stakeholders.

In addition, innovative and emerging technologies were identified and included in each country-assessment due to increasing interest and recognition in the carbon market space, as identified by key stakeholders. These technologies represent potential opportunities to achieve decarbonisation and sustainable development that have not been considered in the past. These types of disruptive technologies and practices often have the potential to scale mitigation efforts and reduce the associated costs.

The following table provides a consolidated and standardised list of 37 technologies or activities considered in this study. Standardisation of technology terms was needed because the countries in the assessment use different terminologies to refer to technologies and project activities (see Table 3). The table below describes each technology, its potential environmental and social benefits, and its limitations and challenges. In addition, the technologies are further categorised as being either best available technologies or as being innovative/ emerging technologies, using the following icons:

Best available technology / activity

Innovative technology / emerging activity

The report highlights that the adoption of these technologies requires comprehensive planning, careful consideration of their environmental and social impacts, and the involvement of communities and stakeholders. Ultimately, the report argues that these technologies can play a vital role in the transition to a more sustainable and low-carbon future.

Table 4: Description of identified technologies

Assessed Technologies	Description	Co-Benefits	Potential Associated Risks
1. Afforestation and reforestation	**Afforestation and reforestation** involve the planting of trees and the restoration of forests in areas that have experienced deforestation or forest degradation. These activities help sequester carbon dioxide from the atmosphere, enhance biodiversity, restore ecosystems, and provide various ecosystem services such as water regulation and soil conservation.	**Afforestation and reforestation** projects in East Africa can contribute to climate change mitigation, wildlife conservation, and sustainable land management practices, leading to improved air and water quality, enhanced resilience to climate change impacts, and socio-economic benefits for local communities, including job creation and income generation.	Risks may include inadequate monitoring and management leading to deforestation, loss of biodiversity, and potential displacement of local communities if not carried out sustainably. There could also be challenges related to invasive species, disease outbreaks, and changing climate conditions affecting the success of afforestation and reforestation efforts.
2. Agroforestry	**Agroforestry** is a land management system that integrates trees with crops or livestock, providing multiple benefits such as increased agricultural productivity, soil conservation, water management, and carbon sequestration.	**Agroforestry** practices can enhance soil fertility, reduce erosion, improve water retention, diversify income sources for farmers, and provide shade and shelter for livestock. It also contributes to climate change mitigation by sequestering carbon dioxide from the atmosphere and reducing GHG emissions.	Risks may involve challenges in maintaining proper agroforestry practices, potential conflicts between agricultural and forestry objectives, and complexities in managing mixed land use systems. Poor planning could lead to reduced crop yields or insufficient benefits for farmers.

Assessed Technologies	Description	Co-Benefits	Potential Associated Risks
3. BECCs	**BECCS** is a technology that captures CO2 from biogenic sources and stores it in geological formations to reduce global warming while delivering energy needs. Africa has large biomass availability and substantial CO2 storage capacities, making it an ideal location for BECCS. However, introducing expensive technology like BECCS in developing countries, such as Eastern Africa, presents challenges due to prioritisation of socio-economic needs over GHG mitigation. The feasibility of BECCS is dependent on various factors such as national politics, land characteristics, and social relations. The BECCS CO2 global emission reduction target is 3.3 gigatonnes stored per year, with 300-700 hectares required to meet such targets. The cost of BECCS varies between $15-$400 depending on the sector, and there are currently five facilities actively using BECCS systems worldwide, capturing approximately 1.5 million tonnes per year of CO2. No demonstration or pilot facilities have been deployed in Africa yet.	**BECCS** technology offers multiple co-benefits for climate change mitigation and sustainable development. Firstly, it enables the removal of carbon dioxide from the atmosphere, reducing GHG concentrations and stabilising global temperatures. Secondly, it uses renewable biomass feedstocks for energy generation, providing an alternative to fossil fuels, which diversification enhances energy security and independence. BECCS also contributes to sustainable waste management by converting organic waste streams into energy, reducing the need for landfilling or incineration. BECCS projects can foster rural development and job creation through biomass. cultivation and processing, supporting local economies, which in turn can also contribute to ecosystem restoration, improving biodiversity, soil health, and ecosystem services. Additionally, replacing fossil fuels with biomass-based energy generation through BECCS can improve air quality due to fewer emissions. However, the specific co-benefits of BECCS can vary depending on project implementation and sustainability factors. Proper management of biomass feedstocks, land use, and carbon storage is crucial to ensure the overall sustainability and effectiveness of BECCS in achieving climate goals while minimising potential negative impacts on ecosystems and food security.	Implementation challenges could also arise from political, social, and economic factors that affect project feasibility and acceptance.

Assessed Technologies	Description	Co-Benefits	Potential Associated Risks
4. Biofuel	**Biofuel** is a type of renewable fuel produced from organic matter such as plants, crops, or organic waste. It can be used as an alternative to fossil fuels in transportation and energy generation.	The production and use of **biofuels** offer several co-benefits, including reduced GHG emissions compared to fossil fuels, improved air quality, and decreased dependence on imported oil. Biofuel production can also contribute to rural development by creating jobs and promoting sustainable agriculture.	Increased use of biofuels can lead to food insecurity, particularly relevant in the region. Some biofuels are made from agricultural products mainly dedicated to food and feed purposes (animals). If not harnessed carefully, biofuels could negatively impact food security, especially when food crops (soy, maize, beans, ground nuts, etc.) are used as feedstock, which may result in competition over land use and potential conflicts with food production. Moreover, expanding biofuel crop cultivation could lead to deforestation, habitat destruction, and loss of biodiversity. The resource intensiveness of large-scale biofuel production might strain vital resources such as water, fertilizer, and energy, leading to environmental degradation. Additionally, biofuel production can have social impacts, including the displacement of communities, changes in traditional land use practices, and even potential labour exploitation.
5. Biogas production	**Biogas production** involves the anaerobic digestion of organic waste materials such as agricultural residues, animal manure, or food waste to produce biogas, a renewable energy source.	**Biogas production** offers multiple co-benefits, including reducing methane emissions from organic waste, improving waste management practices, and providing a source of clean energy for cooking, heating, and electricity generation. It also contributes to sustainable agriculture by using agricultural residues and manure, reducing reliance on chemical fertilisers, and promoting nutrient cycling.	Possible challenges encompass issues with waste collection and the accessibility of feedstock, along with the necessity for skilful control of anaerobic digestion procedures to prevent odours and the escape of methane. Moreover, potential impediments of a technical and financial nature could arise when establishing biogas facilities, particularly in rural regions.

Assessed Technologies	Description	Co-Benefits	Potential Associated Risks
6. Biomass to energy	**Biomass to energy** refers to the conversion of biomass materials, such as agricultural residues, wood, or dedicated energy crops, into heat, electricity, or biofuels.	**Biomass to energy** projects provide co-benefits such as renewable energy generation, reducing reliance on fossil fuels, and reducing GHG emissions. They also contribute to waste management by using organic waste materials and promote sustainable agriculture by using agricultural residues and energy crops.	Potential risks include competition for biomass feedstock with food production, potential land-use conflicts, and environmental impacts from biomass harvesting. There may also be technical challenges in ensuring efficient and sustainable biomass conversion processes.
7. Bus rapid transport	**Bus rapid transit (BRT)** systems are high-capacity public transportation systems that use dedicated bus lanes, off-board fare collection, and other features to provide fast, efficient, and reliable service.	**BRT** systems offer several co-benefits, including reduced traffic congestion, improved air quality by reducing the number of private vehicles on the road, and increased accessibility to public transportation. They also promote sustainable urban development by providing an efficient and affordable transportation option.	Possible challenges involve the complex creation of BRT systems, requiring careful planning for routes, vehicle integration, and infrastructure upkeep. Continued success depends on maintaining the BRT infrastructure to prevent disruptions, higher costs, and reduced quality. To prevent inequalities or displacement, proactive management is crucial. Solving these issues requires technical know-how, consistent infrastructure care, and community involvement to balance BRT benefits and community welfare.
8. Cleaner boilers	**Cleaner boilers** refer to the use of high-efficiency boilers or the retrofitting of existing boilers with emissions control technologies to reduce the emissions of pollutants such as nitrogen oxides (NOx), sulphur oxides (SOx), and particulate matter.	**Cleaner boilers** help improve air quality by reducing emissions of pollutants, which can have positive impacts on human health and the environment. They also contribute to energy efficiency and reduce fuel consumption, resulting in cost savings and lower GHG emissions.	Possible concerns include technical obstacles when retrofitting current boilers, expenses linked to equipment upgrades or replacements, and potential compromises between reducing emissions and maintaining energy efficiency. Additionally, ensuring ongoing advantages necessitates appropriate maintenance and operation of cleaner boilers.

Assessed Technologies	Description	Co-Benefits	Potential Associated Risks
9. Compact fluorescent lights	**Compact fluorescent lights (CFLs)** are energy-efficient lightbulbs that use up to 80% less energy than traditional incandescent bulbs and have a longer lifespan.	**CFLs** offer co-benefits such as reduced energy consumption, lower electricity bills for consumers, and reduced GHG emissions. They also contribute to energy conservation and reduce the demand for electricity, leading to lower environmental impacts associated with electricity generation.	Potential risks extend beyond proper CFL disposal and recycling due to low mercury content. Other associated risks include potential low-level electromagnetic field emissions during operation, which, while generally considered safe, have sparked discussions. Additionally, variations in CFL light composition could affect individuals sensitive to light or prone to health conditions like migraines. Attentive handling, disposal, and awareness remain pivotal in mitigating these risks and maximising energy-efficient lighting benefits.
10. Composting	**Composting** is a waste reduction activity that helps reduce emissions released by waste material in landfills. Composting projects can use human and animal waste, organic food waste, or sludge stream waste to create compost. Composting projects have far-reaching environmental and co-benefits, including enhancing soil quality for forestry conservation, land restoration, afforestation, or restorative farming. Composting can be done on a large or small scale, and can include community food gardens, school gardens for educational and skills development, or for sale purposes.	A co-benefit of **composting** is that it reduces the emissions that would have been released in a landfill, which benefits people's health, well-being and the environment. Composting is a project type that, with a bit of training, can be implemented by anyone and can also increase employment opportunity. Co-benefits of composting include job creation, possible lower costs to transport waste (if onsite) to landfills and the cost is less expensive than landfill or incineration.	Risks include potential odour issues, inadequate waste collection, improper feedstock management leading to suboptimal compost quality, and challenges in scaling up operations. Incomplete composting may result in the persistence of pathogens or weed seeds. Additionally, lack of proper training, infrastructure, and community involvement could hinder successful implementation and undermine the potential co-benefits of composting.

Assessed Technologies	Description	Co-Benefits	Potential Associated Risks
11. E-cooking	The use of **e-cooking** can help countries transition from biomass fuel sources to renewable sources, reducing harmful emissions and air pollutants. However, countries like Kenya, Rwanda, and Uganda, where biomass is still the primary fuel source for cooking, need to develop cost-effective electric cooking methods. Studies show that using electric cooking methods is cheaper than traditional fuel sources like wood, charcoal, kerosene, and LPG. In Ethiopia, 4% of the population already uses electric cooking as their primary method, and there are local manufacturers producing tailored appliances for local cuisine. However, the cost of electric cooking appliances and access to electricity overall is still a barrier, especially for low-income households.	**E-cooking** technology offers multiple co-benefits in terms of sustainability, health, and convenience. It reduces indoor air pollution by eliminating the need for burning solid fuels, leading to improved respiratory health, particularly for women and children. E-cooking also contributes to climate change mitigation by relying on clean electricity from renewable sources, reducing GHG emissions and dependence on fossil fuels. Furthermore, it enhances safety by eliminating the risks associated with open flames and flammable fuels, reducing the chances of fires and cooking-related injuries and it provides time and convenience advantages with faster and more efficient cooking processes, allowing households to engage in other activities. E-cooking helps reduce deforestation and environmental degradation by decreasing the demand for biomass fuels, preserving forests, and protecting ecosystems and it aligns with modernisation trends and promotes productivity in the kitchen. Overall, transitioning to e-cooking enhances indoor air quality, mitigates climate change, improves safety, saves time, promotes modernisation, and contributes to environmental conservation.	Risks include challenges in providing affordable electric cooking appliances and ensuring reliable access to electricity, particularly in remote or low-income areas. Technical issues, maintenance, and repair could also impact adoption.

Assessed Technologies	Description	Co-Benefits	Potential Associated Risks
12. E-mobility	**E-mobility** is the use of electric vehicles (EVs) and supporting infrastructure for transportation. This includes rechargeable batteries, fuel cells, charging stations, and energy storage systems. In East Africa, the applicability of e-mobility depends on the cost of EVs and infrastructure, the state of the electrical infrastructure, and the availability of renewable energy sources. Despite challenges, e-mobility could be a good fit for the region due to the potential for renewable energy sources and reducing reliance on imported fossil fuels. Specific technologies include battery electric vehicles, plug-in hybrid electric vehicles, and fuel cell electric vehicles. If challenges can be overcome, e-mobility could play an important role in transitioning to cleaner, more sustainable transportation systems in East Africa.	**E-mobility** technology offers significant co-benefits in terms of sustainability, health, and economic development. Some key co-benefits include the reduction of GHG emissions and improved air quality, as electric vehicles produce zero tailpipe emissions and eliminate pollutants harmful to human health. Electric mobility also promotes energy efficiency, noise reduction, and the diversification of energy sources, leading to lower fuel consumption and enhanced energy security. Additionally, the transition to electric mobility creates economic opportunities and jobs, drives technological innovation, and contributes to sustainable urban development. It is important to consider factors such as clean electricity generation, e-waste (batteries) solutions and holistic approaches to maximise these co-benefits.	Limited charging infrastructure availability and accessibility needs to be addressed to ease range concerns for potential EV users. High upfront costs of EVs deter adoption, necessitating incentives or financing options. EVs' driving range limitations require battery technology advancements and charging network expansion.
13. Energy efficient boilers	**Energy efficient** boilers refer to boilers that are designed to operate with higher efficiency, using less energy to produce the same amount of heat compared to conventional boilers.	**Energy efficient** boilers offer co-benefits such as reduced energy consumption, lower operating costs, and decreased GHG emissions. They contribute to energy conservation, improve energy efficiency, and support sustainable practices in heating systems.	Upgrading existing boilers for enhanced energy efficiency can present technical obstacles, such as integrating new components and adjusting heating systems. These challenges may lead to higher implementation costs. Replacing conventional boilers with energy-efficient models may involve substantial upfront expenses, encompassing equipment costs, installation, and infrastructure modifications. Proper maintenance is necessary to sustain the benefits of energy-efficient boilers. Inadequate servicing could result in reduced efficiency over time, negating anticipated savings and benefits.

Assessed Technologies	Description	Co-Benefits	Potential Associated Risks
14. Geothermal	Underground geothermal reservoirs for the generation of steam and heated water can be used for electricity generation and other heating and cooling applications. Wells of up to a mile deep or more are drilled into underground reservoirs to tap into the geothermal resources. Geothermal energy could be a baseload renewable energy source, but production is limited to areas near tectonic plate boundaries. Drilling and exploration can be quite expensive and further exploitation of the earth's resources may cause a further unknown negative change.	The co-benefits of geothermal electricity generation to communities are the access to clean electricity, positively impacting people's health and well-being. In addition, environmental co-benefits would be the prevention of emissions from fossil-fuel based electricity. The stable and reliable supply of energy can enable industrial development and support the growth of local businesses, leading to job creation and economic growth. This can have important positive impacts on local communities, improving livelihoods and reducing poverty.	The initial costs of drilling deep wells into underground geothermal reservoirs for exploration and energy production can be substantial where these high upfront costs may pose financial challenges to project developers, especially in regions with limited financial resources. The availability and quality of geothermal resources can vary significantly based on geological conditions. This variability may impact the viability and efficiency of geothermal power generation, making careful site selection and resource assessment critical. Moreover, the extraction of geothermal fluids from reservoirs can lead to subsurface changes and potential environmental impacts, including land subsidence or induced seismicity. Overexploitation of geothermal reservoirs can lead to resource depletion, reducing the long-term sustainability of geothermal energy generation. Careful management and sustainable extraction practices are necessary to avoid prematurely depleting the resource.

Assessed Technologies	Description	Co-Benefits	Potential Associated Risks
15. Green hydrogen 	Green hydrogen is a clean energy source produced from renewable-based methods like water electrolysis and biomass conversion. It can be stored, transported, and used across various sectors. Transitioning to green hydrogen is feasible and vital for achieving decarbonisation goals by 2050. It is currently in demand for ammonia production and hydrofracking, but its future applications could extend to electricity production, fuel for transportation, and more. Green hydrogen is projected to account for 6-18% of global final energy consumption by 2050. Electrolysis is the most accessible method, but water and electricity shortages pose challenges in Africa. The production cost ranges from 2.5 to 7 USD/kg, but favourable wind conditions and affordable electrolysers can lower it to around 1.5 USD/kg, making it competitive with grey hydrogen. Transporting small quantities of green hydrogen can use existing gas pipelines and salt caverns for storage. Local green hydrogen economies can be developed near seaports, railways, and roads to enable regional usage. Six potential landing zones for green hydrogen production have been identified in Africa. Leveraging Africa's renewable resources for green hydrogen presents an opportunity to drive the hydrogen economy, foster economic development, and enhance resilience in the region.	Green hydrogen offers co-benefits in terms of sustainability, energy security, and economic development. It enables carbon neutrality by using renewable energy sources, reducing GHG emissions. Adopting green hydrogen improves air quality, especially in densely populated areas and it provides energy storage and flexibility, addressing the intermittent nature of renewables. Using green hydrogen enhances energy independence and security, reducing reliance on imported fossil fuels. The development of green hydrogen creates jobs, stimulates economic growth, and promotes sustainable industrial processes. It drives technological advancements and research in hydrogen production and utilisation. It is important to note that the co-benefits of green hydrogen can vary depending on factors such as the renewable energy source used, the efficiency of electrolysis processes, and the integration with other energy systems. Ensuring sustainable production, distribution, and use of green hydrogen is crucial to maximising these co-benefits and achieving a sustainable and low-carbon energy future.	The production of green hydrogen can be cost-intensive, particularly in the early stages of technology deployment. High production costs could limit its widespread adoption and competitiveness. Its production relies on abundant renewable energy sources, such as wind or solar power and in regions with limited access to these resources, ensuring a consistent and reliable supply of clean energy can be challenging. Electrolysis, the process used to produce green hydrogen, requires efficient and scalable technology. Additionally, storing and distributing hydrogen safely and efficiently presents technical challenges due to its low energy density by volume. While green hydrogen is a clean energy carrier, its production processes may have potential environmental impacts, such as water usage for electrolysis or the environmental footprint of biomass feedstocks.

Assessed Technologies	Description	Co-Benefits	Potential Associated Risks
16. Improved cookstoves	**Improved cookstoves** burn biomass fuel more efficiently, reducing fuel consumption and smoke emissions. These cookstoves can help reduce GHG emissions by using less fuel and projects aimed at replacing traditional biomass fuel sources with sustainably sourced alternatives can help reduce deforestation. However, it is important to avoid double-counting emissions reductions by ensuring carbon credits are not claimed for both the reduction in deforestation and the use of the cooking devices. There is increasing scrutiny on the evaluation of baseline emissions from such projects, to ensure that resulting carbon credits are accurate and credible. These cooking devices can generate carbon credits, but more efforts, such as subsidies and loan guarantees, are needed to make them more widely available and increase adoption.	**Improved cookstoves** Improved cookstoves provide significant social, economic, and environmental benefits. Socially, these cookstoves alleviate the burden on women and girls in low-income communities by reducing the time and effort required for cooking and fuel collection. This enables them to engage in education and income-generating activities. Moreover, improved cookstoves improve indoor air quality, leading to better health and sanitation outcomes. Environmentally, they contribute to reducing GHG emissions, deforestation, and air pollution, while also supporting local biodiversity. Economically, these cookstoves offer cost advantages through low-cost manufacturing, distribution, and usage. Users can also save on cooking fuel expenses, resulting in economic benefits for households.	There is a risk of double-counting carbon credits, as some projects might claim reductions for both emissions and deforestation resulting from reduced fuel consumption. Proper accounting and rigorous evaluation are crucial to avoid double-counting. Additionally, accurately establishing a baseline for emissions reduction presents challenges due to variations in cooking practices, fuel types, and local conditions, all of which can impact the calculation of emissions reductions. Addressing these challenges is essential to maximise the effectiveness of improved cookstove initiatives.
17. Improved livestock management	**Improved livestock management** practices involve sustainable and efficient techniques for livestock rearing, including better feeding practices, waste management, and animal health management.	Co-benefits of **improved livestock management** include reduced GHG emissions from livestock, improved soil fertility through better manure management, enhanced animal health and productivity, and reduced deforestation by minimising the need for grazing land expansion. It also supports sustainable livelihoods for farmers and promotes food security.	Convincing farmers to embrace new practices may encounter resistance due to established routines, lack of awareness, or concerns about potential risks. Moreover, the deeply ingrained cultural and behavioural aspects of traditional livestock management practices create hurdles in introducing and implementing novel methods. Implementing sustainable techniques requires comprehensive training and capacity building, which can be operationally intricate and resource intensive.

Assessed Technologies	Description	Co-Benefits	Potential Associated Risks
18. Industry fuel switches (IFS)	**Industry fuel switches** involve transitioning from high-emission fossil fuels to cleaner and more sustainable alternatives, such as natural gas or renewable energy sources.	Co-benefits of **industry fuel switches** include reduced GHG emissions and air pollution, improved energy efficiency, cost savings through lower fuel consumption, and enhanced energy security by diversifying energy sources. It also stimulates innovation and job creation in the renewable energy sector.	The shift to cleaner fuels necessitates substantial adjustments to equipment, infrastructure, and supply chains, which could trigger compatibility challenges and technological limitations. Additionally, the high initial investment costs associated with adopting new fuels or technologies, coupled with potential retrofitting expenses for existing equipment, could pose barriers that discourage industries from embracing the switch.
19. Landfill gas recovery and use or destruction	**Landfill gas** recovery involves capturing and using or destroying methane gas emitted from landfills, which is a potent GHG.	Co-benefits of **landfill gas** recovery include reduced methane emissions and odours from landfills, prevention of groundwater contamination, generation of renewable energy, and revenue generation through the sale of recovered gas or electricity. It also contributes to sustainable waste management practices and climate change mitigation.	The process of capturing and effectively using landfill gas is marked by intricate engineering intricacies, spanning the development of efficient gas collection systems, the secure storage of collected gas, and the meticulous treatment to ensure the gas meets quality standards for safe use. Furthermore, the pursuit of landfill gas recovery ventures could potentially intersect with existing waste management practices, presenting a further challenge. This intersection may necessitate modifications to established waste disposal methods and systems, which might run counter to the priorities and frameworks of current waste management operations. Balancing the objectives of methane emission reduction and efficient waste disposal while navigating potential conflicts between landfill gas recovery and waste management practices underscores the importance of comprehensive planning and collaboration among stakeholders.

Assessed Technologies	Description	Co-Benefits	Potential Associated Risks
20. Large hydropower	**Large Hydropower** are power plants that produce electrical energy by driving turbines and generators from the gravitational force of falling or flowing water. The head height and flow of available water determines the amount of power that can be generated. When planning a hydropower plant attention needs to be paid to the seasonal and yearly differences in water availability. For run-of the river power plants, the flow of water needs to be above a certain minimum all year round to be able to produce electricity all year round.[20] In addition, during the planning phase it is necessary to identify and mitigate environmental impacts, such as impact to fisheries and related livelihoods.	**Large Hydropower** provides social and environmental benefits but are costly to build and maintain at any scale. They rely on available flowing water sources, which limits their implementation. Co-benefits include displacing emission-intensive energy sources, reducing pollution, and improving community health and access to electricity. However, hydropower development can negatively impact local communities and the environment, causing displacement, ecosystem disruption, and downstream water user conflicts. Careful consideration and mitigation are essential for any hydropower project to address these potential harms.	The construction and operation of large hydropower facilities can lead to significant environmental disturbances, impacting aquatic ecosystems, wildlife habitats, and water flow dynamics. Additionally, the potential displacement of communities creates social and cultural complexities. Altering natural river systems can trigger broader ecosystem disruptions, affecting local habitats and water-dependent livelihoods, potentially leading to conflicts over water use. Addressing these challenges requires a comprehensive approach, including careful environmental management, community involvement, and negotiation of water use agreements.
21. Mangrove ecosystems conservations rehabilitation and restoration	**Mangrove ecosystems conservation, rehabilitation, and restoration** involve protecting existing mangrove forests, restoring degraded areas, and planting new mangrove trees.	Co-benefits of **mangrove conservation and restoration** include carbon sequestration, improved coastal protection against storms and erosion, enhanced biodiversity and fisheries, and livelihood support for local communities. Mangroves also act as nursery grounds for various marine species and contribute to water filtration and purification.	The restoration of mangrove habitats may have difficulties from establishing optimal planting conditions, selecting appropriate species, and ensuring resilience to shifting environmental conditions. Sustaining the health and survival of rehabilitated mangrove areas necessitates ongoing management efforts, including safeguarding against human activities and adapting to evolving coastal dynamics. Additionally, conflicts may emerge as mangrove preservation intersects with alternative land uses, such as aquaculture, agriculture, and urban development, particularly in densely populated coastal regions.

20 Run-of-river hydropower | Climate Technology Centre & Network | Tue, 11/08/2016 (ctc-n.org)

Assessed Technologies	Description	Co-Benefits	Potential Associated Risks
22. Rail transport	**Rail transport** refers to the use of trains for the transportation of passengers and goods, offering an energy-efficient and low-emission alternative to road and air transport.	Co-benefits of **rail transport** include reduced GHG emissions, improved air quality, reduced traffic congestion, enhanced safety, and energy savings compared to other modes of transportation. It also supports sustainable urban development, trade facilitation, and improved accessibility.	A key concern is the substantial costs associated with constructing, maintaining, and updating rail networks, potentially creating obstacles in regions with limited financial resources or competing priorities. Ongoing maintenance and upgrades demand significant resources and technical expertise to ensure safe and efficient operations. Additionally, the accessibility of rail networks may be hindered by geographical, logistical, or economic factors, limiting widespread coverage and the realisation of rail's benefits in certain areas.
23. Refrigerant Replacement 21	**Refrigerant** replacement involves phasing out ozone-depleting substances and high-global-warming-potential refrigerants and transitioning to more environmentally friendly alternatives.	Co-benefits of **refrigerant replacement** include ozone layer protection, reduced GHG emissions, improved air quality, and energy efficiency gains in refrigeration and air conditioning systems. It also supports compliance with international agreements.	The intricate retrofitting of systems for new refrigerants requires meticulous compatibility assessment to ensure safety and performance, potentially involving modifications to accommodate variations in operating conditions. Proper disposal of old refrigerants is necessary to prevent potent greenhouse gas release, demanding specialised handling.

24. Small/micro hydropower	**Micro hydro** is a form of renewable energy that requires a source of running water for energy production. Micro hydro systems usually generate up to 100kW electricity.[21] Hydropower is a clean, renewable source of energy that may be used to displace or reduce the need for fossil fuels such as coal or diesel, resulting in emission reductions. However, micro hydro systems can be cost-intensive, both to build and to maintain.[22]	**Small/micro hydropower** provides a clean and renewable source of energy, reducing the reliance on fossil fuels and associated emissions. It offers co-benefits such as increased access to electricity in rural areas, job creation, and improved energy security. However, small/micro hydropower systems can be cost-intensive to build and maintain.	Challenges include high construction and maintenance costs, potential environmental disruptions to water bodies, and navigating regulatory hurdles and permitting complexities. Strategies encompass careful cost-benefit assessments, thorough environmental evaluations, community engagement, and streamlined regulatory processes to ensure responsible and effective small/micro hydropower implementation.
	Pico hydro produces a maximum electrical output of 5 kWh installed capacity [23] which works without battery storage. Like micro hydro, running water, such as a stream or river, needs to be located close to the community that the facility is supplying energy to.[24]		
25. Smart irrigation technologies – Solar pumps, precision irrigation	**Solar water pumps** can be used to irrigate crops or provide potable drinking water. A solar water pump system is essentially an electrical pump system in which the electricity is provided by PV panels, with efficiency of the pump being measured in the amount of water pumped per watt of electricity used.	**Solar water pumps** benefit communities and the environment through less pollution being produced from the requirement to boil water to make it drinkable.	Solar pump efficiency refinement is essential for consistent performance across diverse conditions, involving improvements in photovoltaic panels, motor efficiency, and energy storage. Effective training is vital for precision irrigation, offering farmers the expertise needed for proper system installation, operation, and maintenance. Tackling affordability issues, particularly for small-scale farmers, requires cost reduction through innovation, collaboration for subsidy programs or financing options, and financial literacy training.

22 Micro Hydro Power – Pros and Cons (alternative-energy-news.info)

23 EPREWA64.pdf (wseas.us)

24 Pico hydropower | Faculty of Engineering | University of Bristol

Assessed Technologies	Description	Co-Benefits	Potential Associated Risks
	Precision irrigation involves the application of water and nutrients to crops in a precise and targeted manner, based on factors such as soil moisture levels, weather conditions, and crop requirements. This approach optimises water usage and reduces water wastage, improving crop yields and water efficiency.	**Precision irrigation** minimises water waste, improves crop productivity, and conserves water resources. By using advanced technologies and techniques, farmers can optimise the use of water and nutrients, resulting in reduced water consumption and improved agricultural sustainability.	
26. Soil and water conservation	**Soil and water conservation** refers to various practices and techniques aimed at preventing soil erosion, improving soil fertility, and conserving water resources in agricultural, forestry, or land management systems.	**Soil and water conservation** practices offer co-benefits such as improved soil health and fertility, enhanced water availability and quality, reduced soil erosion, and increased resilience to climate change impacts. They also contribute to sustainable agriculture and land management, promoting long-term productivity and ecosystem stability.	Encouraging behavioural change among farmers, overcoming implementation and maintenance costs, and potential conflicts with existing land use practices are key risks. Solutions entail targeted education, innovative financing options, and inclusive stakeholder engagement to ensure the successful adoption of these practices and their contributions to sustainable agriculture, improved soil health, and water resource preservation.
27. Solar dryers	**Solar dryers** use solar energy to dry agricultural produce, reducing post-harvest losses and improving food preservation.	Co-benefits of **solar dryers** include reduced reliance on fossil fuels, improved food security through reduced post-harvest losses, and increased income for farmers by preserving the quality and value of their produce as well as increasing value addition Solar dryers also promote sustainable agricultural practices and support rural development.	The initial setup cost presents a challenge, particularly for rural, resource-constrained farmers, requiring financial accessibility solutions like microfinancing or subsidies. Solar dryers' effectiveness is weather-dependent, necessitating strategies such as energy storage or hybrid drying methods to ensure consistent operation. Maintenance challenges require technical skills and support networks for upkeep, impacting long-term performance.

Assessed Technologies	Description	Co-Benefits	Potential Associated Risks
28. Solar home Systems	**Solar home systems** provide electricity to off-grid households using solar panels and battery storage.	Solar home systems offer co-benefits such as improved access to electricity, enhanced education and productivity, reduced reliance on harmful and costly energy sources (e.g., kerosene lamps), and reduced GHG emissions. They contribute to poverty alleviation, health and well-being, and sustainable development in rural areas.	Potential risks include upfront costs, maintenance expenses, regulatory issues, and weather-dependent operation. These risks require solutions such as financing options, reliable maintenance services, supportive regulations, and backup energy strategies to ensure effective and sustainable implementation.
29. Solar PV	**Solar PV** technologies can be used for community and residential purposes. Community solar PV installations are typically small-scale and shared among residents, providing power for basic electrical appliances, often including battery storage. Residential solar PV technologies include small panels that can be used to power small devices such as mobile phones or lights, with power ranging from 5 to 100 watts. The decreasing costs of solar PV technology make these projects more feasible and attractive to consumers. These solar applications provide not only a reduction in GHG emissions, but also other co-benefits such as increasing access to clean energy, which is a driver of socio-economic development.	Solar PV offers social, environmental, and economic co-benefits. It provides clean and affordable energy, enabling access to communication, refrigeration, and security lighting. Solar PV reduces air pollution and conserves water compared to fossil fuel-based electricity. The decreasing costs of solar PV make it attractive for large-scale deployments, and innovative financing models increase accessibility. By saving on operational expenses, communities can allocate funds to other development priorities, fostering socio-economic activities and meeting basic needs	The initial investment cost of solar PV can be a barrier, requiring financial mechanisms to make adoption feasible. Intermittency challenges, particularly for grid-tied systems, may impact energy availability during cloudy periods. Additionally, the technology's lifespan and potential conflicts over land use must be managed.
30. Substitute clinker in the cement production process	**Substituting clinker**, a key component in cement production, with alternative materials such as fly ash, blast furnace slag, or calcined clay reduces the carbon intensity of cement.	Co-benefits of **substituting clinker** in cement production include reduced GHG emissions, energy savings, and conservation of natural resources. It also promotes circular economy principles by using industrial by-products and waste materials.	Potential risks include technical complexities in material substitution and quality control challenges and the maintenance of cement's structural and performance qualities. Ensuring market acceptance of alternative materials is crucial for successful adoption, and potential impacts on concrete properties need careful consideration.

Assessed Technologies	Description	Co-Benefits	Potential Associated Risks
31. Sustainable charcoal production	**Sustainable charcoal** production is the development and use of more efficient and sustainable methods for charcoal production, such as improved kilns or briquetting techniques, to reduce deforestation and improve air quality.	**Sustainable charcoal** production offers co-benefits such as reduced deforestation, improved air quality by reducing emissions from traditional charcoal production methods, and potential economic benefits through job creation and local charcoal production. It also contributes to sustainable land management and supports efforts to combat climate change.	Sustainable charcoal production presents certain risks that warrant careful consideration, such as the complexities associated with the adoption and expansion of enhanced production techniques, the potential reluctance to embrace change within conventional charcoal production communities, and the imperative of establishing continuous oversight and rigorous enforcement mechanisms to uphold sustainable practices.
32. Sustainable Forest Management	**Sustainable forest management** encompasses practices that promote the responsible use, conservation, and restoration of forests, ensuring their ecological, economic, and social values.	**Sustainable forest management** offers co-benefits such as carbon sequestration, biodiversity conservation, watershed protection, and sustainable livelihoods for forest-dependent communities. It also supports sustainable timber production, recreation, and tourism while reducing deforestation and forest degradation.	Potential risks revolve around the intricate balance between ecological preservation, economic viability, and social considerations. Challenges may emerge from potential conflicts between conservation goals and the necessity for resource extraction to support local livelihoods. Effective governance mechanisms and comprehensive stakeholder engagement become paramount to navigate these complexities and ensure the long-term viability of forests.
33. Waste re-use/ recycling	**Waste re-use/recycling** involves diverting waste materials from disposal and using them for secondary purposes or recycling them into new products.	Co-benefits of **waste re-use/ recycling** include reduced waste generation, conservation of resources, energy savings, reduced pollution and landfill emissions, and job creation in the recycling industry. It supports the transition to a circular economy and contributes to sustainable waste management practices.	The successful implementation of waste re-use/recycling faces challenges, including logistical complexities in waste collection and processing, potential resistance to behaviour change, quality control concerns, and uncertainties related to market demand for recycled materials.

Assessed Technologies	Description	Co-Benefits	Potential Associated Risks
34. Waste to energy	**Waste to energy** technologies convert waste materials into heat, electricity, or fuel through processes such as incineration, anaerobic digestion, or gasification.	Co-benefits of **waste to energy** include the generation of renewable energy, reduced GHG emissions from waste disposal, landfill space savings, and resource recovery from waste materials. It supports sustainable waste management and contributes to climate change mitigation.	Technical and environmental risks include air emissions containing pollutants from incineration processes. Proper pollution control measures and rigorous monitoring are essential to prevent adverse air quality impacts. Additionally, there might be public concerns regarding potential health risks and negative environmental impacts associated with waste incineration, necessitating transparent communication and robust regulatory oversight. Economic viability and fluctuating energy markets can also impact the financial feasibility of waste to energy projects.
35. Waste-water treatment	**Waste-water treatment** involves removing contaminants from wastewater before it is discharged into the environment or reused.	Co-benefits of **waste-water treatment** include improved water quality, protection of aquatic ecosystems, reduced pollution of water bodies, and enhanced public health through safe water supply and sanitation. It also supports water resource management and sustainable development.	The complexity of treatment processes presents technical and operational challenges that require advanced engineering expertise for design, construction, and maintenance. Inadequate treatment could lead to the discharge of untreated wastewater, impacting downstream water bodies and ecosystems. Proper waste disposal, efficient sludge management, and reliable treatment facilities are essential to prevent contamination. Financial barriers, regulatory compliance issues, and lack of community engagement can also affect waste-water treatment projects.

Assessed Technologies	Description	Co-Benefits	Potential Associated Risks
36. Wetland and peatland management	**Wetland and peatland** management focuses on the conservation, restoration, and sustainable use of wetland and peatland ecosystems.	Co-benefits of **wetland and peatland** management include carbon sequestration, water purification, flood control, enhanced biodiversity, and support for livelihoods of local communities. It also contributes to climate change adaptation, ecosystem services, and sustainable land use practices.	Balancing conservation objectives with the need for sustainable resource use can be complex, requiring careful planning and coordination among various stakeholders. Improper land use practices or excessive exploitation can lead to degradation, loss of biodiversity, and disruption of vital ecosystem functions. There's a potential for conflicts between traditional land uses, such as agriculture or development, and wetland and peatland conservation goals. Furthermore, the restoration of degraded wetlands and peatlands may encounter difficulties in terms of ecological recovery and long-term success.
37. Wind power	**Wind** power or energy is generated by wind turbines, which collect and convert the captured energy, produced by the wind, into electricity.[25] Wind turbines need very little water inputs and are therefore applicable in arid areas that have high wind speeds. Grid scale application are typically large-scale installations that feed power into the grid. Wind is a clean, renewable source of energy that may be used to displace emissions intensive energy or electricity sources, such as coal or diesel.	**Wind** technology producing renewable energy has both environmental and social co-benefits. This technology provides for safe and clean access to energy, which displaces emissions intensive energy or electricity sources, such as coal or diesel, preventing damage and harm to the health and well-being of communities, as well as to the environment.	Visual and noise impacts on local communities and landscapes are notable risks, requiring strategic siting and community engagement efforts to minimise such disturbances. The intermittent nature of wind availability poses challenges for maintaining a stable and reliable electricity supply, emphasising the need for energy storage solutions and advanced grid management techniques. The manufacturing, transportation, and installation processes associated with wind turbines can carry their own environmental footprint, requiring effective mitigation strategies to ensure overall sustainability.

Thirty-three of the above technologies or activities listed above are considered proven or mature.

Four technologies were highlighted as being emerging or innovative, namely BECCs, green hydrogen, E-cooking and E-mobility.

The technologies and project activities in the table above have different relevance to different countries. The methodology for assessing these technologies is summarised in the following chapter.

04

Methodology

The aim of this study is to assist countries and climate mitigation project developers in overcoming project implementation barriers, thereby enhancing accessibility for communities and stakeholders to carbon finances and the benefits of climate mitigation measures. The following overall methodology was used to develop the findings of this assessment.

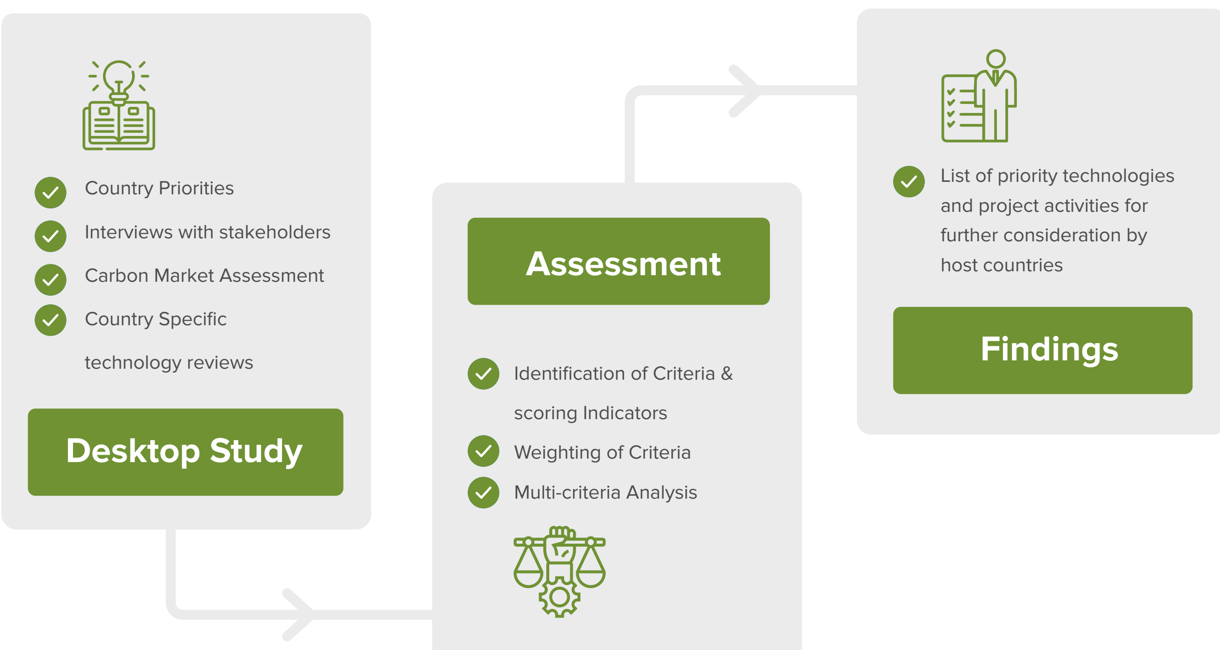

Figure 3: Overall methodological approach

The identification of appropriate technologies and project activities resulted from a research component of the overall study, which considered the national priorities of the respective countries, country specific technology reviews, interviews with key stakeholders and an overall assessment of the current carbon markets. These technologies and project activities were subsequently assessed and ranked in terms of their suitability for implementation in the host countries.

The evaluation and ranking of suitable technologies for the seven East African countries required the use of a multifaceted and robust set of criteria. Multicriteria analyses provide a decision-making technique that may be used to evaluate and compare alternatives based on multiple criteria or objectives. It can assist in developing informed decisions when faced with complex problems that involve multiple conflicting objectives. This is particularly relevant when considering the suitability of climate mitigation technologies and project activities, as some key benefits may appear contradictory to each other.
For example, the implementation of largescale renewable energy projects may have large GHG mitigation impacts, however such projects may have limited co-benefits, compared to other project types or technologies, and may therefore face more barriers to accessing carbon finances.

The framework for the multicriteria analysis, which aimed to determine suitable mitigation technologies and project activities per country, allowed for the systematic consideration and weighing of different criteria based on their relative importance, per country.

The process involved defining the criteria, establishing their importance or weights, and evaluating the criteria against each technology/project activity identified for each respective country. The final step entailed aggregating the scores/results to obtain an overall ranking or preference for each alternative mitigation technology or project activity, at each country level.

The multicriteria analysis techniques therefore provide systematic approaches for decision-makers to assess the trade-offs and preferences among different criteria, applied to mitigation technologies and project activities. The aim is to assist decision makers reach informed and transparent decisions about prioritising suitable climate technologies or project activities.

4.1 Criteria Descriptions

A set of criteria was selected to evaluate the suitability of technologies in East African countries, **illustrated in Figure 4.**

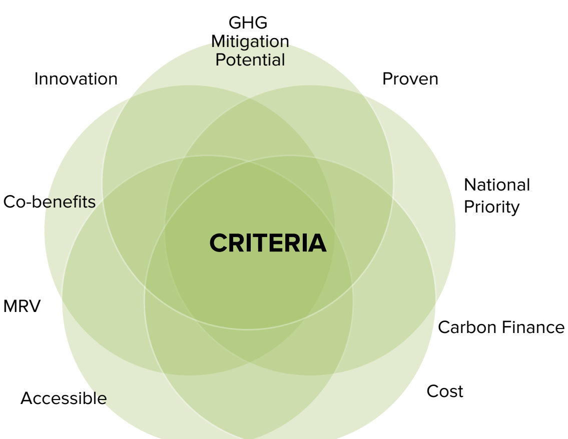

Figure 4: Criteria for assessing technologies.

The selection was informed by priorities given in the NDCs, TNAs, stakeholder questionnaires and interviews. Each criterion is described below, including indicators used to determine whether the technology in question meets the relevant criterion. The indicators were used to score each technology in terms of the respective overall criteria.

4.1.1 GHG mitigation potential

GHG mitigation potential refers to the ability of a technology or project to reduce GHG emissions or remove carbon from the atmosphere, which is a key criterion used to evaluate the suitability of different technologies for implementation in the respective countries. Technologies that have a high GHG mitigation potential are given greater consideration as they have the potential to make a significant impact on reducing carbon emissions and mitigating climate change. The assessment of GHG mitigation potential is based on a variety of factors, including the type of technology, its efficiency, and the extent to which it can be scaled up and implemented in the region. By identifying technologies with high GHG mitigation potential, the aim is to promote the adoption of sustainable and low-carbon technologies that can contribute to achieving the region's climate goals and support the transition to a green economy.

Scoring Indicators

1) Effectiveness - The technology's ability to achieve significant GHG emissions reductions.
2) Scalability - The potential for the technology to be implemented on a large scale and contribute to substantial GHG mitigation.
3) Baseline evaluation - impact of the baseline situation on amount of emission reductions/ removals. For example, renewable energy in countries with relatively high grid emission intensities will have bigger GHG reduction impacts compared to countries where the grid emission factor is relatively low.

4.1.2 National Priority

The term "national priority" is identified within the context of policy, NDCs and TNAs. National priority is the level of importance or urgency assigned to a particular technology or set of technologies by the government or relevant authorities. It signifies the recognition that the development, adoption, or advancement of certain technologies is crucial for the overall progress, competitiveness, and well-being of the nation. These priorities are typically determined based on factors such as economic, social, environmental, and security considerations, as well as the potential impact of the technologies on various sectors and the overall national development agenda.

Scoring Indicators

1) Policy alignment - The degree to which the technology aligns with the national climate change policies, targets, and strategies of the East African countries, especially NDCs and long-term strategies.
2) Economic growth potential - The applicability and relevance of the technology to stimulate economic growth and development.
3) Capacity Building - The potential for the technology to contribute to the development of local capacities, knowledge, and skills in the region.

4.1.3 Cost

In evaluating technologies for the seven Eastern Africa countries, the term cost is linked to the term “relatively economical” and refers to the cost-effectiveness of a particular technology in comparison to other available options. A technology that is considered relatively economical is one that has a reasonable upfront cost and a low cost of maintenance. It is important to note that what may be considered relatively economical in one country may not be the same in another country, as various factors such as the availability of resources, labour costs, and market conditions can vary significantly. However, it is important to note that high-cost technologies may be indicators that the technology in questions is in addition to the business-as-usual scenario. Hence, a high-cost technology is not necessarily a negative indicator.

Scoring Indicators

1) Capital cost and operational costs - The initial investment required to implement the technology. The ongoing expenses associated with operating and maintaining the technology.
2) Cost-effectiveness - The relationship between the costs incurred and the GHG emissions reductions achieved.
3) Additionality – Assumed that the higher-cost technology is a fair indicator of additionality.

4.1.4 Accessible

The term “accessible” refers to the extent to which the identified technologies are easily obtainable by communities and stakeholders in the seven Eastern African countries. This encompasses the availability of financing options, infrastructure, and technical capabilities necessary to implement and expand these technologies. To be effective in mitigating GHG emissions and achieving sustainable development goals, technologies must be accessible and to the communities they aim to benefit. This is especially critical for small-scale distributed units such as cookstoves or clean water filters, which have the potential to directly enhance the lives and well-being of communities. The assessment of each technology’s cost-effectiveness in each country is a crucial factor that determines whether it is accessible. Ideally, technologies that can reduce obstacles to their implementation, will be more accessible to the region’s communities and stakeholders. However, technologies that are not common-place are likely to be considered additional to the business-as-usual scenario. Hence, technologies that currently have a low penetration rate are likely to demonstrate additionality.

Scoring Indicators

1) Affordability - The cost-effectiveness and affordability of the technology, including considerations of upfront costs, operational expenses, and maintenance requirements. This sub-criterion examines whether the technology is economically accessible to a wide range of users.

2) Availability/accessibility and acceptable - The availability/accessibility of the technology is evaluated by considering factors such as its market availability, supply chain logistics, and distribution channels. It assesses whether the technology is easily accessible to potential users and considers aspects such as the ease of access to the technology, its usability, and compatibility with existing systems. It examines physical accessibility, user

interface design, inclusiveness, and compatibility with other technologies. The goal is to determine if the technology is designed to be readily available to users with diverse needs, seamlessly integrates with existing systems, and offers a user-friendly interface that can adapt to different devices and platforms. Acceptance by communities is also key and will impact the uptake of the technologies.

3) Additionality – Assumed that technologies that currently have a low penetration rate are likely to demonstrate additionality.

Social Co-benefits

Social benefits are the positive outcomes for indigenous people and local communities within which a mitigation project is located. This includes generating employment opportunities, capacity building, improving health and education, and providing access to clean and affordable energy. Some additional examples of social co-benefits include gender equality; improvement of skills/livelihoods/opportunities to reduce dependency on national infrastructure and environmental education initiatives in local communities.

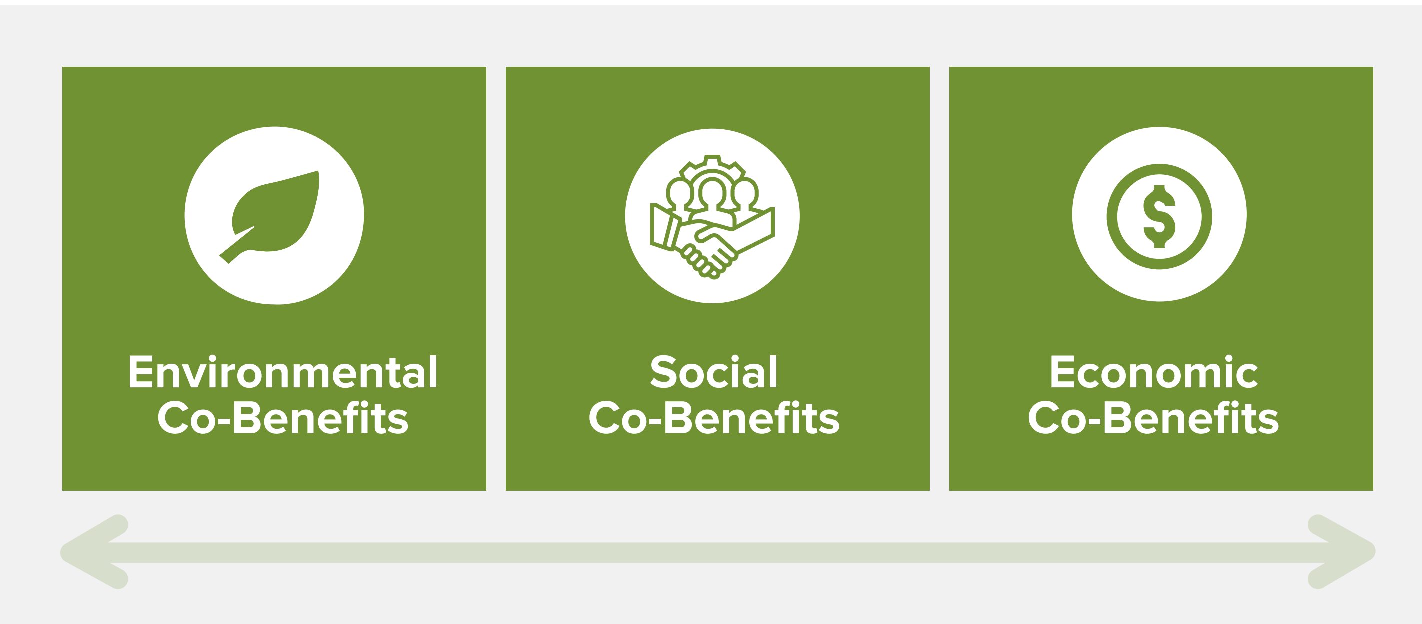

Figure 5: Project Co-benefits

Environmental Co-benefits

Environmental benefits from carbon mitigation projects relate to increasing local biodiversity, maintaining habitat for native species, improving local air and water quality, avoiding vegetation clearance, re-establishing vegetation on previously cleared areas, and improving environmental management. Some emission reduction projects may also address regional air pollution by reducing GHG pollutants.

Economic Co-benefits

Economic benefits occur when income from the sale of carbon credits is directed to the indigenous people and local community where a project is located. This often translates into employment and community support (through skills development), improved infrastructure, technology transfer, and increased economic activity. Specific examples of economic co-benefits include, creating an inclusive economy through carbon credits, job creation and livelihood improvement. Economic co-benefits may therefore be seen as comprising of components such as education and skills development, employment, health and well-being, food security and finance.

Scoring Indicators

1) Sustainable development – The technology's potential to contribute to social, economic, and environmental co-benefits, such as job creation, improved air quality, energy access, or biodiversity conservation.
2) Adaptation – The extent to which the technology enhances the resilience and adaptive capacity of communities and ecosystems to climate change impacts.
3) Local value addition – The potential for the technology to stimulate local industries, create local value chains, and promote technology transfer.

4.1.6 Innovation

Innovation has the potential to drive greater emissions reductions and promote sustainable development. Therefore, many countries and carbon funders prioritise the development and adoption of new and emerging technologies. This may involve supporting research and development efforts, fostering innovation ecosystems, and promoting collaboration between governments, academia, and the private sector.

In the context of climate change, innovative technologies refer to novel and advanced solutions that are designed to address the challenges of reducing GHG emissions and mitigating the impacts of climate change. These technologies are characterized by their ability to offer new approaches, methods, or systems that are more efficient, sustainable, cost effective or environmentally friendly than existing technologies.

Innovative technologies are however likely to have a higher price and lower penetration rate than mature or developed technologies. A higher price and lower penetration rate are positive indicators of additionality.

Scoring Indicators

1) Technological advancement and potential disruption - The level of innovation and novel features that differentiate the technology from existing solutions. The ability of the technology to disrupt conventional practices and enable transformative changes in GHG emissions reduction.
2) Market readiness - The extent to which the technology is ready for deployment in real-world settings and can be integrated into existing systems and processes.
3) Additionality – Assumed that a higher price and lower penetration rate are positive indicators of additionality.

4.1.7 Proven

In the context of carbon projects, "proven" refers to those technologies that have been successfully registered under established carbon standards such as the CDM, VCS, Gold Standard, and Plan Vivo. These projects have undergone rigorous assessment and verification processes to demonstrate that they meet the required criteria for generating carbon credits. By identifying and analysing these proven projects, insights can be gained into the carbon focus areas of different countries and potential market opportunities in the future. It is important to note that "proven" does not necessarily mean that a carbon project is sustainable or meets the strict sustainability criteria required by the EU green taxonomy or other sustainability frameworks.

Scoring Indicators

1) Technical maturity - The stage of development and commercialisation of the technology, including its demonstrated performance and reliability.
2) Performance records - Evidence of successful implementation and operation of the technology in similar contexts.
3) Demonstrated replicability - The ability of the technology to be replicated and implemented in different locations within the region. This also refers to the potential scalability of a technology or project activity.

4.1.8 Monitoring Reporting and Verification (MRV)

The Monitoring, Reporting and Verification of the roll-out of climate change technologies in developing countries is vital as it ensures transparency, accountability, and effectiveness of the measures. This aids in international cooperation and trust, and incentivising further investments in green technologies. It is important to note that different technologies and activities will have different monitoring requirements. E.g., traditional AFOLU projects and account methodologies have typically complicated and onerous monitoring requirements. These are increasingly being simplified by use of satellite data and other measures. MRV is however likely to remain more complicated and onerous compared to monitoring a renewable energy project.

Scoring Indicators

1) Ease of monitoring – Consideration of the monitoring requirements of different technologies and the current or imminent opportunities for digital monitoring.
2) Cost of monitoring – Complex projects are likely to have increased monitoring costs, as are projects involving high levels of distributed units, which may require sample surveys.
3) Baseline evaluation – impact of the baseline situation on amount of emission reductions/removals. For example, renewable energy in countries with relatively high grid emission intensities will have bigger GHG reduction impacts compared to countries where the grid emission factor is relatively low.

4.1.9 Carbon finance

The implementation of GHG mitigation technologies can be significantly enhanced through access to funding through the international carbon markets. In this respect both the Article 6.2 market for ITMOs, as well as the non-Paris, voluntary, markets are important. Carbon finance that comes in through the trading of ITMOs under Article 6.2 is subject to corresponding adjustments.

Scoring Indicators

1) Accessibility – Market preferences can determine flows of carbon finances to particular technologies or project activities. For example, current preference for projects that result in co-benefits or can demonstrate no significant harm.
2) Alignment with NDC – Conditional technologies or project activities may be likely to have greater access to carbon finances.
3) Coverage of finance – Larger capital projects may need different sources of funding, in addition to carbon finances. Smaller projects likely to cover more expenses through carbon finance.
4) Visibility within the National GHG Inventory - ease with which the granularity of the national inventory can be improved to the level of the proposed technology. As countries move towards economic-wide NDCs, they are progressively working towards improving the granularity of GHG inventories. Visibility within the national inventory could have a bearing on the attractiveness of the technology for ITMO transfer. Therefore, technologies that are easier to disaggregate under the sectors of country GHG inventories will score higher than those that are more difficult to specify as sector-specific.

The criteria above were further considered against identified scoring indicators, to provide a more comprehensive evaluation. Descriptions of the criteria and their respective scoring indicators are provided in the following section of this report.

4.2 Scoring System

In order to conduct a thorough evaluation, a scoring system has been implemented, which involves an initial consideration of established criteria followed by a detailed examination using specific scoring indicators. This comprehensive assessment allows for a more in-depth analysis of the identified technologies within each country.

Each technology was scored against the utilised criteria. A technology was scored on a scale of 3-0 as follows:

- **A score of 3**: reflects compliance with all 3 scoring indicators.
- **A score of 2**: reflects compliance with 2 out of 3 indicators.
- **A score of 1**: reflects compliance with 1 out of 3 indicators.
- **A score of 0**: reflects compliance with 0 out of 3 indicators.

The only exception was related to the carbon finance criterion, which was ranked on a scale of 4-1 as there were 4 scoring indicators. Once the technologies were assessed in accordance with the criteria and their respective scoring indicators, a country-context weighting of the criteria was further applied. The different criteria weightings were designed to prioritise which technologies should be well suited to the carbon market of each country context, while also being forward-looking.

Furthermore, different weightings were applied per county, to reflect different levels of country access to carbon markets. For example, Burundi and Sudan has slightly different weighting of criteria compared to the other five countries in the assessment, on the basis that Burundi and Sudan have historically had less access to the markets than the other countries.

Table 5: Weighting by country and criteria

	Weighting per Criteria (%)									
Country	GHG Mitigation Potential	National Priority	Cost	Accessible	Co-benefits	Innovation	Proven	MRV	Carbon finance	Total
Burundi	12	22	7	12	11	7	14	3	12	100
Ethiopia	16	22	5	9	10	10	14	3	11	100
Kenya	16	22	5	9	10	10	14	3	11	100
Rwanda	16	22	5	9	10	10	14	3	11	100
Sudan	12	22	7	12	11	7	14	3	12	100
Tanzania	16	22	5	9	10	10	14	3	11	100
Uganda	16	22	5	9	10	10	14	3	11	100

The weighted scores were aggregated, per technology, and then summed to determine a final score. The summaries of these assessments and scores are provided in the following chapter

All Users
Jul 16 - Jul 22
Jul 23 - Jul 29
Jul 30 - Aug 5
Aug 6 - Aug 12
Aug 13 - Aug 19
Aug 20 - Aug 26
Last 6 weeks
Where are your users?
Sessions by country
Czechia
85.2%
Slovakia
10.8%

05

Results of Multicriteria Analysis

This section presents the results of the multicriteria analysis conducted to evaluate and rank the suitability of different climate mitigation technologies and project activities in the seven East African countries. The aim of the analysis is to provide decision-makers with a systematic approach for assessing and comparing alternatives based on multiple criteria and objectives. The criteria were evaluated using specific scoring indicators, and the results were aggregated to obtain an overall ranking or preference for each technology or project activity in each country. The analysis takes into account the unique context of each country, adjusting the weights of the criteria based on their specific priorities. The findings of this analysis provide actionable insights to reduce barriers to implementation and enhance accessibility to climate mitigation measures, facilitating the transition to a low-carbon and sustainable future for the region's communities and stakeholders.

The following sections for each country present a summary of the results obtained from the multicriteria analysis conducted for each relevant technology in that specific country. For the more comprehensive analysis, including detailed information, please refer to Annex 1.

5.1 Burundi

Seventeen GHG reduction or removal technologies / activities were considered in Burundi's multicriteria analysis.
The following table outlines the five technologies/ activities that ranked the highest in the multicriteria assessment, with the weighted scores for each criterion.

Table 6: Top five technologies/ activities that contribute to Burundi's carbon reduction goals

	Burundi				
	Soil and water conservation	Composting	Small/micro-hydropower	Solar PV	Biogas production
GHG mitigation potential	8	4	8	8	4
National priority	22	22	22	22	22
Cost	5	2	5	5	5
Accessible	8	12	8	8	4
Co-benefits	11	7	11	11	11
Innovation	2	5	2	5	5
Proven	14	14	14	9	14
MRV	1	1	3	3	2
Carbon finance	9	12	6	6	9
Grand Total	**80**	**79**	**79**	**77**	**75**

The assessment for Burundi ranked technologies/activites based on their potential to contribute to carbon reduction or removal efforts. Soil and water conservation, composting and small scale hydro power emerged as the top-scoring measures, with excellent alignment with the criteria and indicators related to national priority, co-benefits, maturity and likelihood of accessing carbon finances. These activities effectively remove or reduce carbon emissions and hold promise for widespread implementation. Prioritising these technologies and activities can contribute to meeting climate goals, enhancing ecological resilience, and promoting Burundi's sustainable development.

Table 20 in Annexure 2 provides insights into the assessments of the top-five ranking technologies or activities for Burundi.

The spider graph below visually represents the top five ranking technologies in the multicriteria assessment for Burundi. The figure graphically illustrates the alignment, or non-alignment, of the five top-ranking technologies in terms of the nine criteria used in the assessment. This tool helps stakeholders and decision-makers quickly understand each technology's essential characteristics, enabling well-informed decisions on their integration into Burundi's sustainable development trajectory.

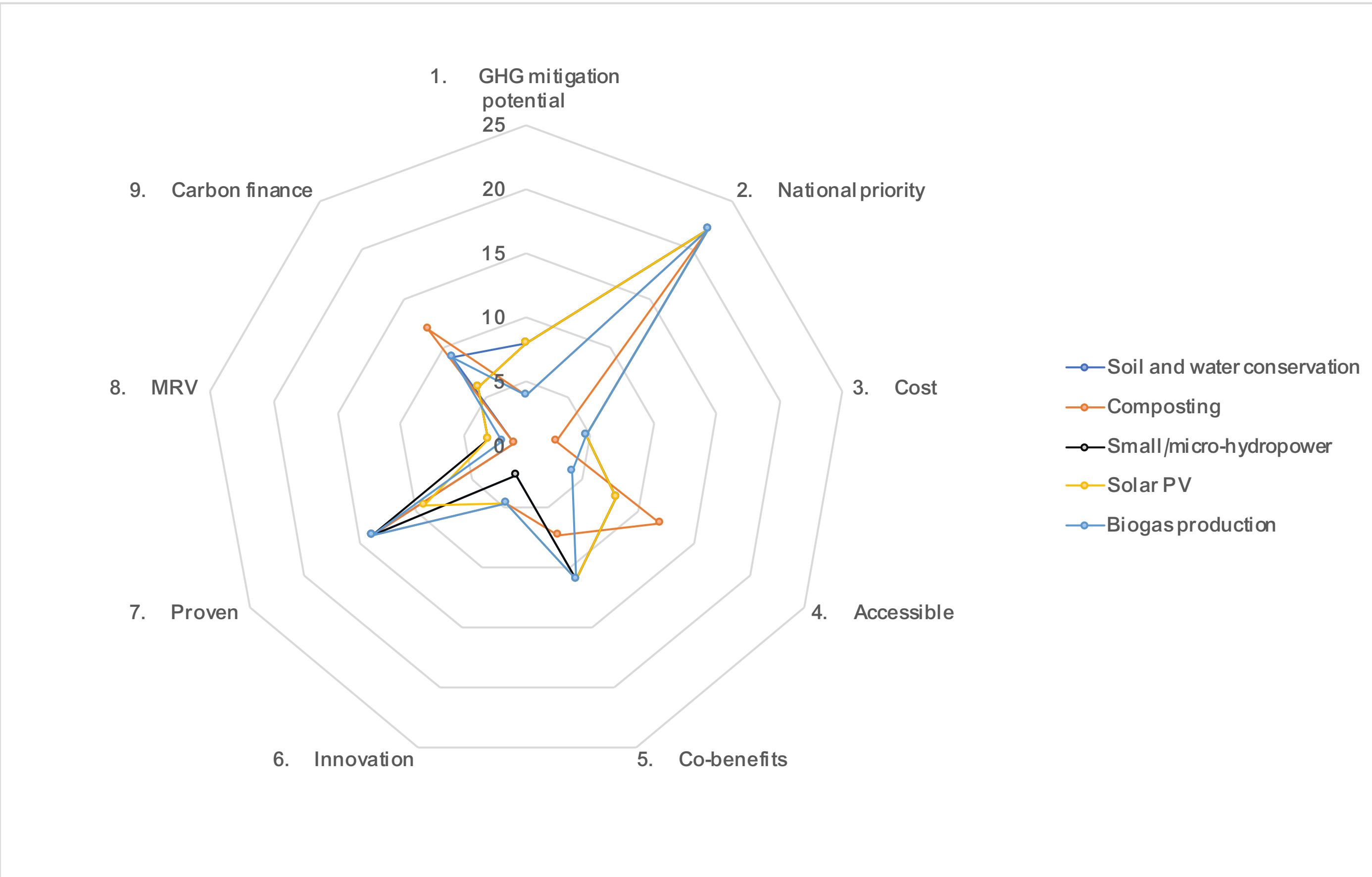

Figure 6: Spider diagram of Burundi's five top-ranking technologies

The following table outlines the outcomes (weighted scores) of all the technologies/ activities in the assessment for Burundi. The technologies/activities are presented from highest to lowest weighted scores. Additionally, the table indicates whether each technology is classified as innovative (blue lightbulb icon) or recognised as the best available option (green rosette icon). This comprehensive overview allows for a convenient comparison of the total scores, offering valuable insights into the relative strengths and weaknesses of the technologies related to their current carbon market potential.

Table 7: Outcomes of all technologies assessed for Burundi

		Technologies	Weighted scores
1.		Soil and water conservation	80,0
2.		Composting	79,3
3.		Small/micro-hydropower	79,0
4.		Solar PV	76,7
5.		Biogas production	75,3
6.		Biomass to energy	74,7
7.		E-cooking	72,0
8.		Improved Cook Stoves	72,0
9.		Solar home systems	69,3
10.		Agroforestry	68,3
11.		Large hydropower	65,0
12.		Landfill gas recovery and use or destruction	63,0
13.		E-mobility	59,7
14.		Wind	49,0
15.		Waste-water treatment	42,7
16.		Green Hydrogen	40,0
17.		BECCS	36,7

Technologies such as BECCS, green hydrogen, and waste-water treatment received lower scores due to factors such as limited potential, high costs, limited expected access to carbon finances and difficulty in apportioning emission reductions to a single sector in the national GHG inventory.

5.2 Ethiopia

Fourteen GHG reduction or removal technologies/ activities were considered in Ethiopia's multicriteria analysis. The following table outlines the five technologies / activities that ranked the highest in the multicriteria assessment, with the weighted scores for each criterion

Table 8: Top five technologies that contribute to Ethiopia's carbon reduction goals

	Ethiopia				
	Industry fuel switches	Solar home systems	Landfill gas recovery and use or destruction	Sustainable forest management	E-cooking
GHG mitigation potential	16	16	11	16	11
National priority	22	22	22	15	15
Cost	3	3	3	3	5
Accessible	6	6	9	6	6
Co-benefits	10	10	7	10	10
Innovation	7	7	3	7	10
Proven	9	5	14	14	9
MRV	3	2	2	-	2
Carbon finance	6	11	8	8	11
Grand Total	**82**	**82**	**79**	**79**	**79**

In the assessment for Ethiopia, technologies and activities were evaluated based on their potential to contribute to carbon reduction or removal. Among the top-ranking options, industry fuel switches stood out for their effectiveness in GHG mitigation potential, national priority, and the ease and affordability of monitoring, reporting, and verification costs. Solar energy and landfill gas recovery also performed well, despite the challenges faced by solar home systems, such as the lack of local manufacturing, limited awareness of their operation, frequent system failures, insufficient maintenance expertise, and affordability constraints.

Table 21 in Annexure 2 provides insights into the assessments of the top-five ranking technologies or activities for Ethiopia.

The spider graph below provides a visual representation of the top five ranked technologies in the multicriteria assessment for Ethiopia. This graph demonstrates the degree of alignment or non-alignment of these technologies with the nine criteria considered in the assessment. By using this tool, stakeholders and decision-makers can easily grasp the key characteristics of each technology, facilitating informed decisions regarding their integration into Ethiopia's sustainable development pathway.

KEY TAKEAWAY

Among the top-ranking options, industry fuel switches stood out for their effectiveness in GHG mitigation potential, national priority, and the ease and affordability of monitoring, reporting, and verification costs

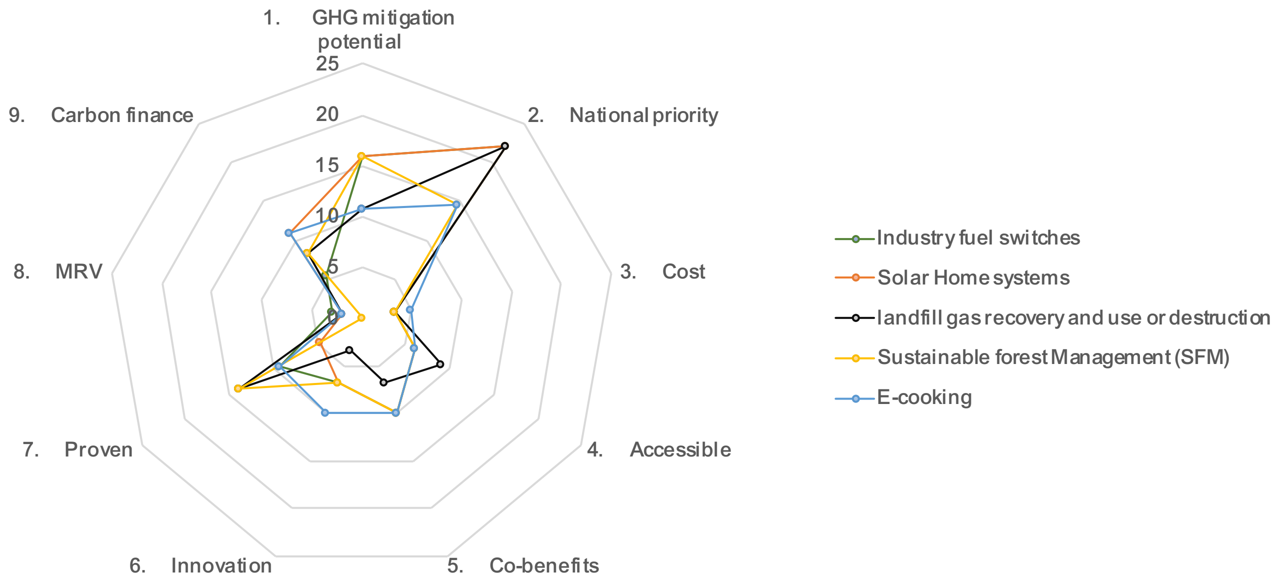

Figure 7: Spider diagram of Ethiopia's top five-ranking technologies

The following table outlines the outcomes (weighted scores) of all the technologies/ activities in the assessment for Ethiopia. The technologies/ activities are presented from highest to lowest weighted scores. Additionally, the table indicates whether each technology is classified as innovative or recognised as the best available option. This comprehensive overview allows for a convenient comparison of the total scores, offering valuable insights into the relative strengths and weaknesses of the technologies related to their current carbon market potential.

Table 9: Overall technologies assessed for Ethiopia, using multicriteria analysis framework

	Technologies	Weighted scores
1.	Industry fuel switches	81,8
2.	Solar home systems	81,7
3.	landfill gas recovery and use or destruction	79,3
4.	Sustainable forest management	78,9
5.	E-cooking	78,7
6.	Composting	76,3
7.	Smart irrigation technologies - Solar pumps, precision irrigation	73,8
8.	E-mobility	71,6
9.	Improved Cook Stoves	70,6
10.	Wind	66,1
11.	Substitute clinker in the cement production process	62,9
12.	Green Hydrogen	47,1
13.	Small/micro-hydropower	46,8
14.	BECCS	45,1

While technologies like small-scale hydropower, green hydrogen, and BECCS show potential and offer various co-benefits, their lower rankings in Ethiopia are primarily attributed to factors such as high implementation costs, limited accessibility and a relatively limited track record of performance within the Ethiopian context. Challenges for green hydrogen and BECCS could be accurately attributing emission reductions to specific sectors in the national GHG inventory,

KEY TAKEAWAY

While technologies like small-scale hydropower, green hydrogen, and BECCS show potential and offer various co-benefits, their lower rankings in Ethiopia are primarily attributed to factors such as high implementation costs, limited accessibility and a relatively limited track record of performance within the Ethiopian context.

5.3 Kenya

Seventeen GHG reduction or removal technologies/ activities were considered in Kenya's multicriteria analysis. The following table outlines the five technologies/ activities that ranked the highest in the multicriteria assessment, with the weighted scores for each criterion.

Table 10: Top five technologies/ activities that contribute to Kenya's carbon reduction goals

	Kenya				
	Biogas production	Solar home systems	Solar dryers	Afforestation and reforestation	Wind
GHG mitigation potential	16	11	11	11	11
National priority	22	22	22	22	22
Cost	3	2	2	3	3
Accessible	6	6	6	6	9
Co-benefits	10	10	10	10	3
Innovation	10	10	10	7	7
Proven	9	14	14	14	14
MRV	3	2	3	-	3
Carbon finance	8	8	6	8	8
Grand Total	**88**	**85**	**83**	**81**	**80**

The assessment for Kenya ranked technologies/activites based on their potential to contribute to carbon reduction or removal efforts. Biogas production, solar home systems and solar dryers emerged as the highest-scoring technologies due to their effectiveness in reducing GHG emissions in an innovative manner while also being successfully proven in Kenya. Such technologies also provide numerous high levels of co-benefits.

Afforestation and reforestation follow just after with the ability to effectively reduce GHG emissions, being a national priority and having been successfully proven in Kenya.

Afforestation and reforestation activities also ranked in the top-five, due to similar characteristics. These activities have the potential to contribute to carbon sequestration, biodiversity

KEY TAKEAWAY

Biogas production, solar home systems and solar dryers emerged as the highest-scoring technologies due to their effectiveness in reducing GHG emissions in an innovative manner while also being successfully proven in Kenya conservation, and sustainable development, earning them a place in the top five.

Table 22 in Annexure 2 provides insights into the assessments of the top-five ranking technologies or activities for Kenya.

The spider graph below visually represents the top five ranking technologies in the multicriteria assessment for Kenya. The figure graphically illustrates the alignment, or non-alignment, of the five top-ranking technologies in terms of the nine criteria used in the assessment. This tool helps stakeholders and decision-makers quickly understand each technology's essential characteristics, enabling well-informed decisions on their integration into Kenya's sustainable development trajectory.

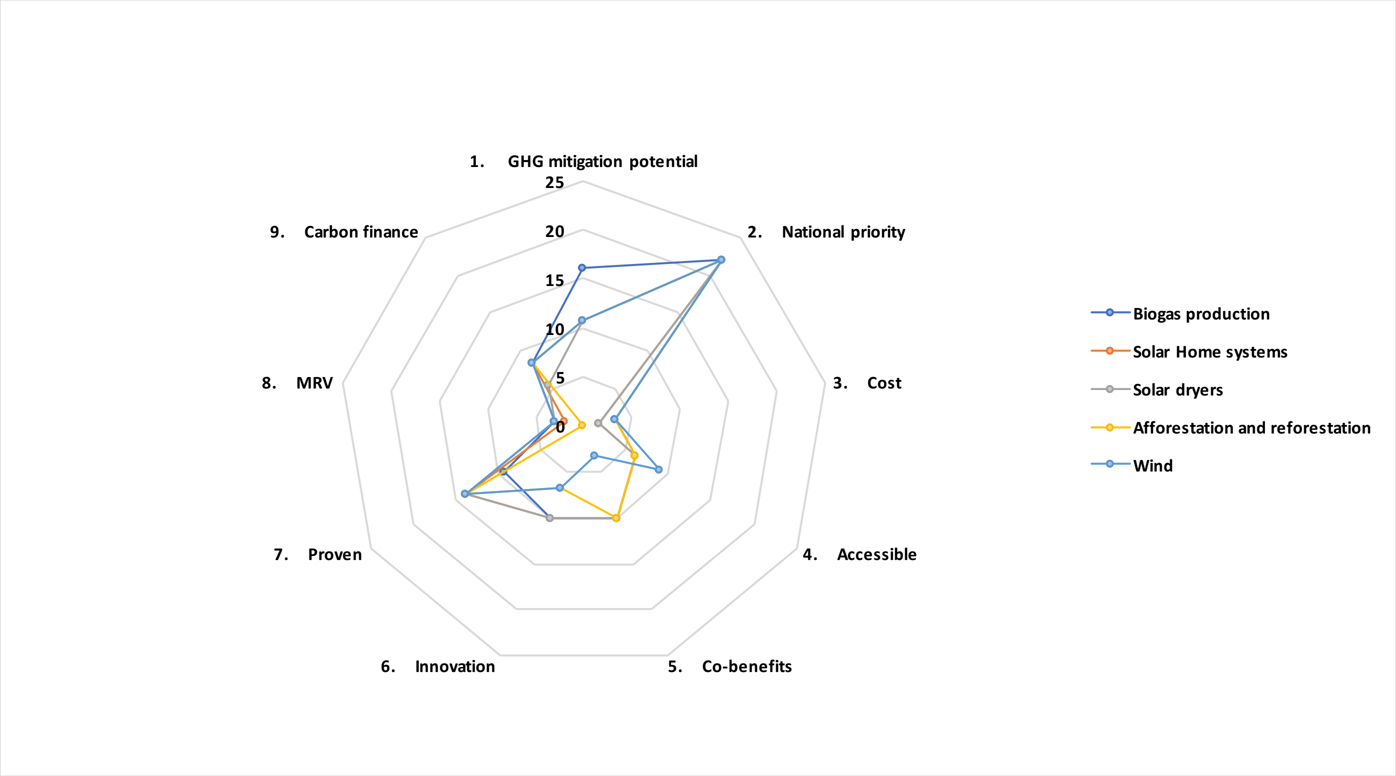

Figure 8: Spider diagram of Kenya's top five-ranking technologies

The following table outlines the outcomes (weighted scores) of all the technologies/ activities in the assessment for Kenya. The technologies/ activities are presented from highest to lowest weighted scores. Additionally, the table indicates whether each technology is classified as innovative (blue lightbulb icon) or recognised as the best available option (green rosette icon). This comprehensive overview allows for a convenient comparison of the total scores, offering valuable insights into the relative strengths and weaknesses of the technologies related to their current carbon market potential.

Table 11: Outcomes of all technologies assessed for Kenya

	Technologies	Weighted scores
1.	Biogas production	87,9
2.	Solar home systems	84,6
3.	Solar dryers	82,8
4.	Afforestation and reforestation	80,9
5.	Wind	80,3
6.	Geothermal	77,3
7.	Sustainable forest management	76,9
8.	Biomass to energy	75,5
9.	Waste re-use / recycling	74,9
10.	Composting	73,3
11.	Small/micro-hydropower	73,2
12.	E-mobility	72,3
13.	Biofuel	69,8
14.	Large hydropower	69,8
15.	E-cooking	63,2
16.	Green Hydrogen	53,4
17.	BECCS	50,7

KEY TAKEAWAY

While technologies, such as e-cooking, green hydrogen, and BECCS are innovative and offer various co-benefits, their lower rankings are largely due to factors such as high costs, limited accessibility, difficulty in apportioning emission reductions to a single sector in the national GHG inventory

5.4 Rwanda

Twenty GHG reduction or removal technologies / activities were considered in Rwanda's multicriteria analysis. The following table outlines the five technologies/ activities that ranked the highest in the multicriteria assessment, with the weighted scores for each criterion.

Table 12: Top five technologies/ activities that contribute to Rwanda's carbon reduction goals

	Rwanda				
	Improved Cook Stoves	Small/micro-hydropower	Landfill gas recovery and use or destruction	E-cooking	Waste to energy
GHG mitigation potential	16	11	5	11	5
National priority	22	22	22	15	22
Cost	3	3	3	3	3
Accessible	6	6	9	6	9
Co-benefits	10	10	10	10	10
Innovation	3	3	7	10	3
Proven	14	14	9	9	9
MRV	-	3	1	2	3
Carbon finance	8	8	8	8	8
Grand Total	**83**	**81**	**75**	**74**	**74**

The assessment for Rwanda ranked technologies/activites based on their potential to contribute to carbon reduction or removal efforts. Improved cookstoves, small scale hydro and landfill gas destruction and use emerge as the highest-scoring technologies due to their effectiveness and reducing GHG emissions, their associated co-benefits and their maturity. E-cooking is a notable entry, as it is considered an innovative or emerging technology.

KEY TAKEAWAY

Improved cookstoves, small scale hydro and landfill gas destruction and use emerge as the highest-scoring technologies due to their effectiveness and reducing GHG emissions, their associated co-benefits and their maturity

Table 23 in Annexure 2 provides insights into the assessments of the top-five ranking technologies or activities for Rwanda.

The spider graph below visually represents the top five ranking technologies in the multicriteria assessment for Rwanda. The figure graphically illustrates the alignment, or non-alignment, of the five top-ranking technologies in terms of the nine criteria used in the assessment. This tool helps stakeholders and decision-makers quickly understand each technology's essential characteristics, enabling well-informed decisions on their integration into Rwanda's sustainable development trajectory.

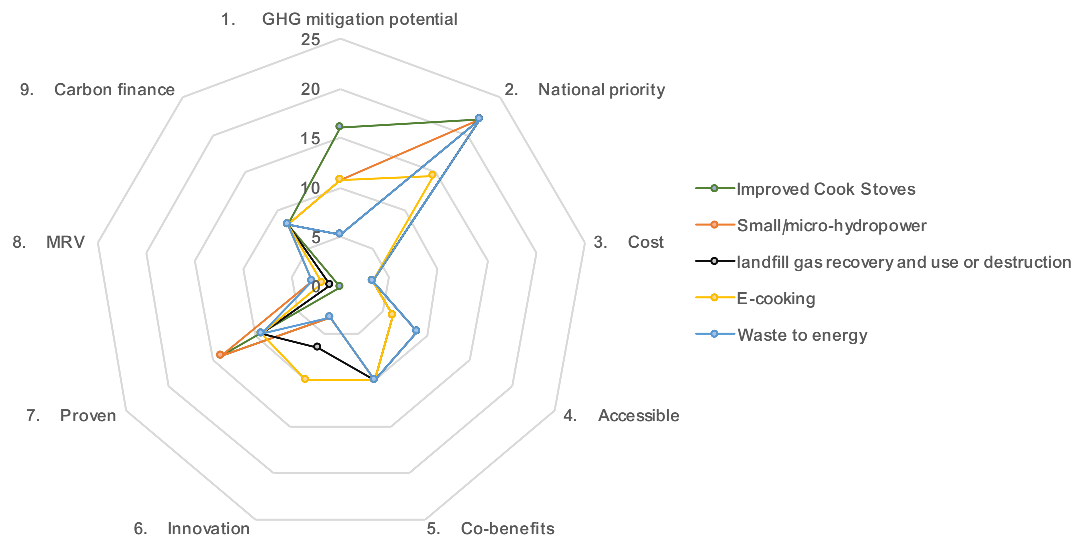

Figure 9: Spider diagram of Rwanda's top five-ranking technologies

The following table outlines the outcomes (weighted scores) of all the technologies/activities in the assessment for Rwanda. The technologies/activities are presented from highest to lowest weighted scores. Additionally, the table indicates whether each technology is classified as innovative (blue lightbulb icon) or recognised as the best available option (green rosette icon). This comprehensive overview allows for a convenient comparison of the total scores, offering valuable insights into the relative strengths and weaknesses of the technologies related to their current carbon market potential.

Table 13: Outcomes of all technologies assessed for Rwanda

	Technologies	Weighted scores
1.	Improved Cook Stoves	82,9
2.	Small/micro-hydropower	80,6
3.	landfill gas recovery and use or destruction	74,9
4.	E-cooking	74,3
5.	Waste to energy	73,6
6.	Geothermal	73,6
7.	Solar PV	70,5
8.	Smart irrigation technologies - Solar pumps, precision irrigation	68,5
9.	Biofuel	68,2
10.	Soil and water conservation	67,7
11.	Sustainable charcoal production	67,2
12.	Composting	66,7
13.	E-mobility	66,5
14.	Improved livestock management	66,0
15.	Refrigerant replacement	63,9
16.	Substitute clinker in the cement production process	59,3
17.	Green Hydrogen	52,8
18.	Rail Transport	51,8
19.	BECCS	47,3
20.	Wind	47,2

KEY TAKEAWAY

E-cooking is a notable entry in Rwanda's top five technologies/activities, as it is considered an innovative or emerging technology

5.5 Sudan

Sixteen GHG reduction or removal technologies / activities were considered in Sudan's multicriteria analysis.
The following table outlines the five technologies/ activities that ranked the highest in the multicriteria assessment, with the weighted scores for each criterion.

Table 14: Top five technologies/ activities that contribute to Sudan's carbon reduction goals

	Sudan				
	Soil and water conservation	Solar PV	Composting	Smart irrigation technologies	Biogas production
GHG mitigation potential	8	12	8	8	4
National priority	22	22	22	22	22
Cost	5	2	2	7	5
Accessible	8	8	8	8	4
Co-benefits	11	7	11	11	11
Innovation	2	5	2	2	5
Proven	14	9	5	5	9
MRV	1	3	2	3	3
Carbon finance	9	6	12	6	9
Grand Total	**80**	**75**	**72**	**72**	**72**

The assessment for Sudan ranked technologies/activities based on their potential to contribute to carbon reduction or removal efforts. Soil and water conservation, solar PV and composting emerge as the highest-scoring technologies due to the need for soil and water conservation in Sudan, as well as their associated co-benefits, their maturity and national priority. It is notable that four of the top five technologies/ activities are directly or indirectly related to the AFOLU sector.

Table 24 in Annexure 2 provides insights into the assessments of the top-five ranking technologies or activities for Sudan.

The spider graph below visually represents the top five ranking technologies in the multicriteria assessment for Sudan. The figure graphically illustrates the alignment, or non-alignment, of the five top-ranking technologies in terms of the nine criteria used in the assessment. This tool helps stakeholders and decision-makers quickly understand each technology's essential characteristics, enabling well-informed decisions on their integration into Sudan's sustainable development trajectory.

KEY TAKEAWAY

Soil and water conservation, solar PV and composting emerge as the highest-scoring technologies due to the need for soil and water conservation in Sudan, as well as their associated co-benefits, their maturity and national priority.

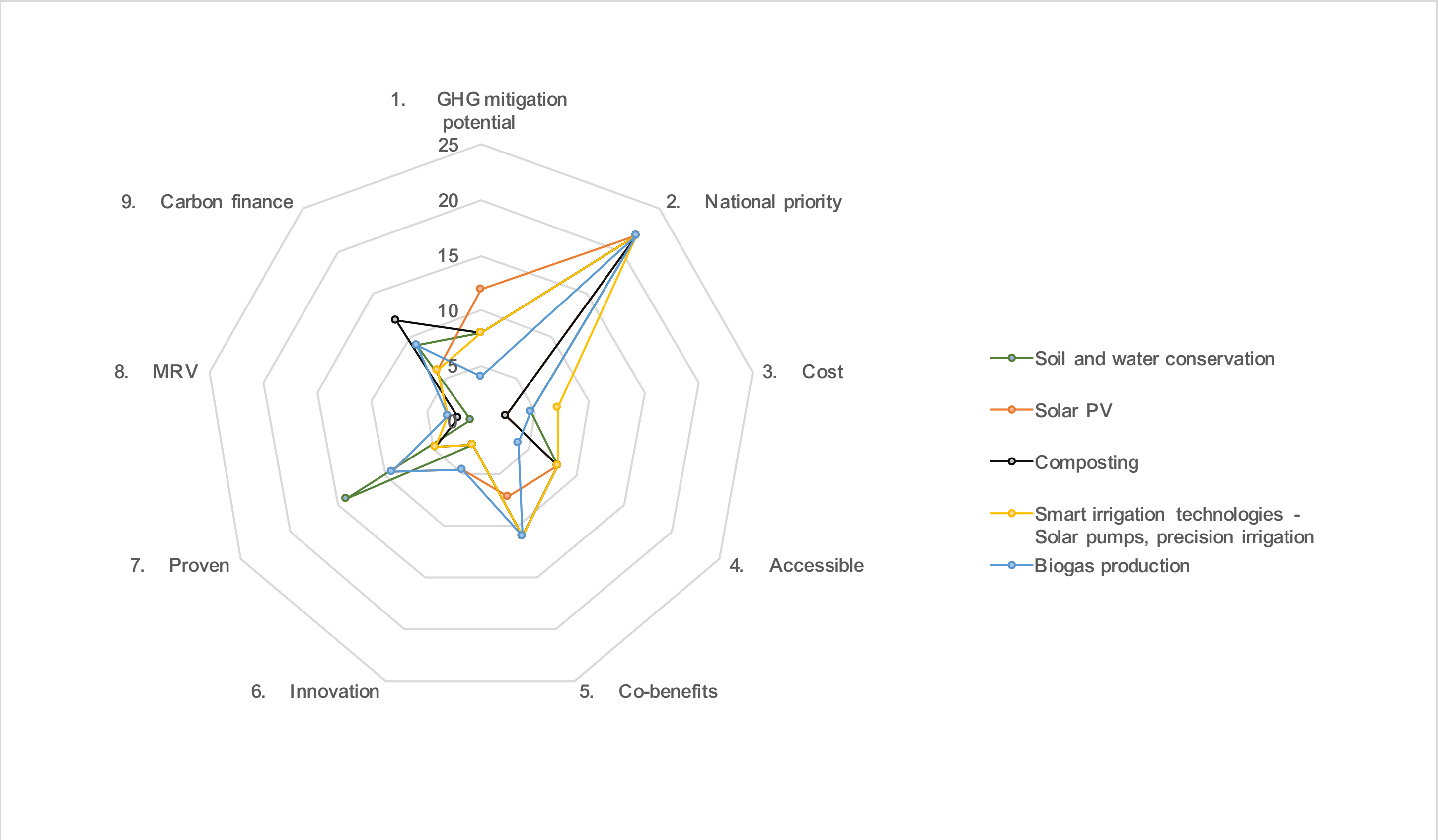

Figure 10: Spider diagram of Sudan's top five-ranking technologies

The following table outlines the outcomes (weighted scores) of all the technologies/activities in the assessment for Sudan. The technologies/activities are presented from highest to lowest weighted scores. Additionally, the table indicates whether each technology is classified as innovative (blue lightbulb icon) or recognised as the best available option (green rosette icon). This comprehensive overview allows for a convenient comparison of the total scores, offering valuable insights into the relative strengths and weaknesses of the technologies related to their current carbon market potential.

Table 15: Overall technologies assessed for Sudan, using multicriteria analysis framework

		Technologies	Weighted scores
1.	(green rosette)	Soil and water conservation	80,00
2.	(green rosette)	Solar PV	74,67
3.	(green rosette)	Composting	72,33
4.	(green rosette)	Smart irrigation technologies - Solar pumps, precision irrigation	72,00
5.	(green rosette)	Biogas production	71,67

6.	Solar home systems	71,33
7.	Compact Fluorescent Lights	70,33
8.	Energy Efficient Boilers	68,33
9.	Substitute clinker in the cement production process	65,67
10.	Improved Cook Stoves	61,33
11.	E-cooking	56,67
12.	Geothermal	54,00
13.	Wind	50,67
14.	E-mobility	47,67
15.	Green Hydrogen	41,00
16.	BECCS	40,67

E-mobility, green hydrogen and BECCS ranked low due to factors such as high costs in implementation as well as MRV, and limited status, performance records, and technical know-how within Sudan. Furthermore, Sudan has limited ability in accessing carbon finance relating to these technologies/activities.

5.6 Tanzania

Eighteen GHG reduction or removal technologies/ activities were considered in Tanzania's multicriteria analysis. The following table outlines the five technologies/ activities that ranked the highest in the multicriteria assessment, with the weighted scores for each criterion.

Table 16: Top five technologies/ activities that contribute to Tanzania's carbon reduction goals

	Tanzania				
	Biofuel	Biomass to energy	Small/micro-hydropower	Sustainable charcoal production	Solar PV
GHG mitigation potential	16	11	11	11	11
National priority	22	22	22	22	22
Cost	3	3	3	3	3
Accessible	6	6	6	6	6
Co-benefits	10	10	10	10	10

Innovation	10	7	3	7	3
Proven	14	14	14	5	9
MRV	-	3	3	2	3
Carbon finance	3	6	6	11	6
Grand Total	**84**	**81**	**78**	**76**	**73**

The assessment for Tanzania ranked technologies/activites based on their potential to contribute to carbon reduction or removal efforts. Biofuel, biomass to energy and small/micro-scale hydropower emerge as the highest-scoring technologies due to their GHG emission reduction potential, technical maturity, proven replicability and their associated co-benefits.

Table 25 in Annexure 2 provides the motivation and scoring breakdown for the top five technologies/ activities for Tanzania. Such table allows for a more extensive understanding to made and provides insight as to why such technologies are perhaps ranked better than others.

The spider graph below visually represents the top five ranking technologies in the multicriteria assessment for Tanzania. The figure graphically illustrates the alignment, or non-alignment, of the five top-ranking technologies in terms of the nine criteria used in the assessment. This tool helps stakeholders and decision-makers quickly understand each technology's essential characteristics, enabling well-informed decisions on their integration into Tanzania's sustainable development trajectory.

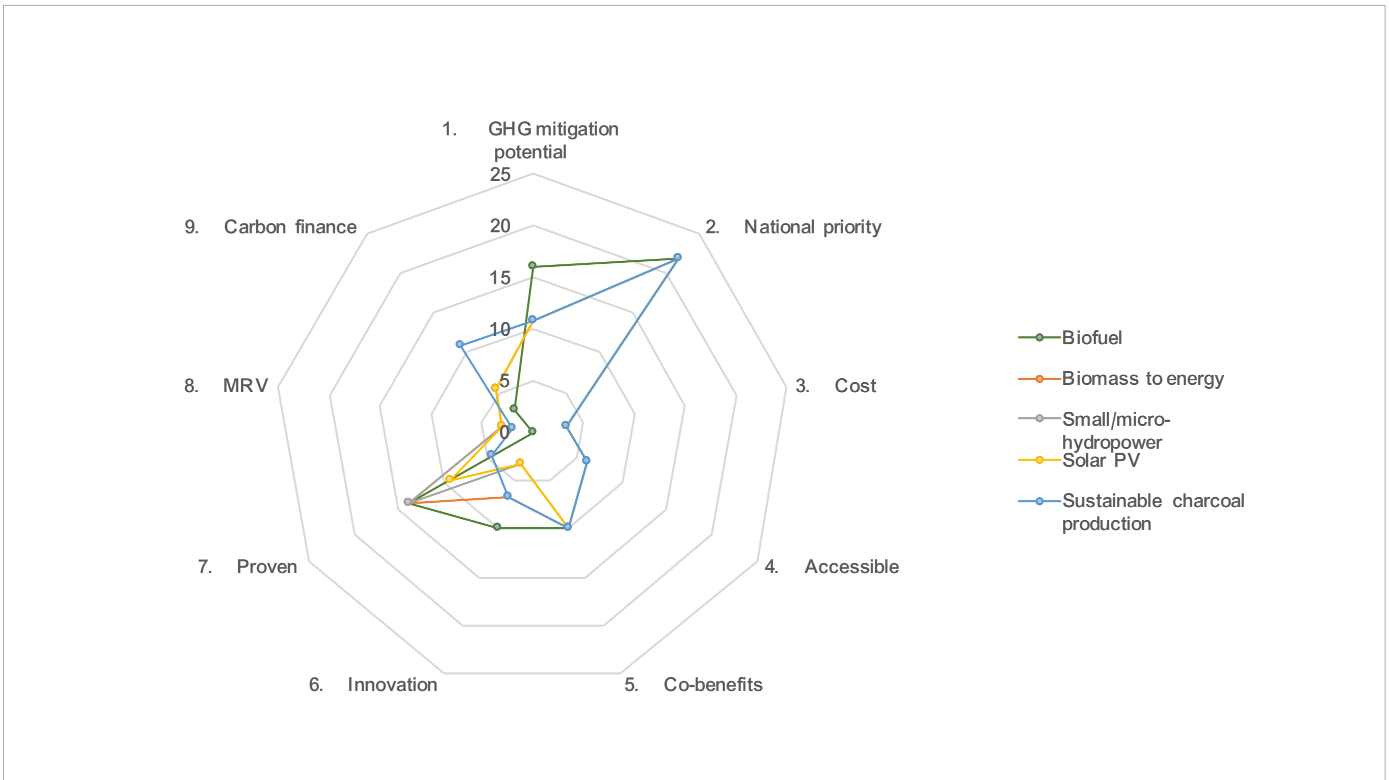

Figure 11: Spider diagram of Tanzania's top five-ranking technologies

Table 17: Overall technologies assessed for Tanzania, using multicriteria analysis framework

	Technologies	Weighted scores
1.	Biofuel	84,1
2.	Biomass to energy	81,2
3.	Small/micro-hydropower	77,8
4.	Sustainable charcoal production	76,3
5.	Solar PV	73,2
6.	Wind	73,2
7.	Landfill gas recovery and use or destruction	72,2
8.	Improved Cook Stoves	70,3
9.	Mangrove ecosystems conservation, Rehabilitation and Restoration	69,9
10.	Geothermal	68,8
11.	Large hydropower	68,2
12.	Sustainable forest management	67,0
13.	Agroforestry	66,6
14.	E-cooking	60,6
15.	Waste re-use / recycling	60,3
16.	E-Mobility	58,9
17.	Green Hydrogen	52,8
18.	BECCS	49,7

The multicriteria analysis framework has organised the technologies best suited for Tanzania in descending order, considering their weighted scores. From this evaluation, E-mobility, green hydrogen, and BECCS have been identified as the three technologies with the least potential to contribute to the country's carbon reduction goals. Despite their innovative nature and the multiple co-benefits they offer, these technologies received lower rankings due to factors such as limited accessibility, high costs, and challenges related to MRV.

5.7 Uganda

Twenty GHG reduction or removal technologies / activities were considered in Uganda's multicriteria analysis. The following table outlines the five technologies/ activities that ranked the highest in the multicriteria assessment, with the weighted scores for each criterion.

Table 18: Top five technologies/ activities that contribute to Uganda's carbon reduction goals

	Uganda				
	Improved livestock management	Biomass to energy	Improved Cook Stoves	Solar PV	Composting
GHG mitigation potential	16	16	11	16	11
National priority	22	22	22	22	22
Cost	3	3	3	3	2
Accessible	6	6	9	6	6
Co-benefits	10	10	10	10	10
Innovation	3	7	3	3	3
Proven	14	9	14	14	14
MRV	2	3	3	3	3
Carbon finance	11	8	8	6	11
Grand Total	**88**	**85**	**84**	**83**	**82**

The assessment for Uganda ranked technologies based/ activites on their potential to contribute to carbon reduction or removal efforts. Improved livestock management, biomass to energy and improved cookstoves emerged as the highest-scoring technologies due to their effectiveness at removing or reducing GHG emissions, provision of co-benefits and likelihood in accessing carbon finances.

Table 26 in Annexure 2 provides the motivation and scoring breakdown for the top five technologies/ activities for Uganda. Such table allows for a more extensive understanding and provides insight as to why such technologies are perhaps ranked better than others.

The spider graph below visually represents the top five ranking technologies in the multicriteria assessment for Uganda. The figure graphically illustrates the alignment, or non-alignment, of the five top-ranking technologies in terms of the nine criteria used in the assessment. This tool helps stakeholders and decision-makers quickly understand each technology's essential characteristics, enabling well-informed decisions on their integration into Uganda's sustainable development trajectory.

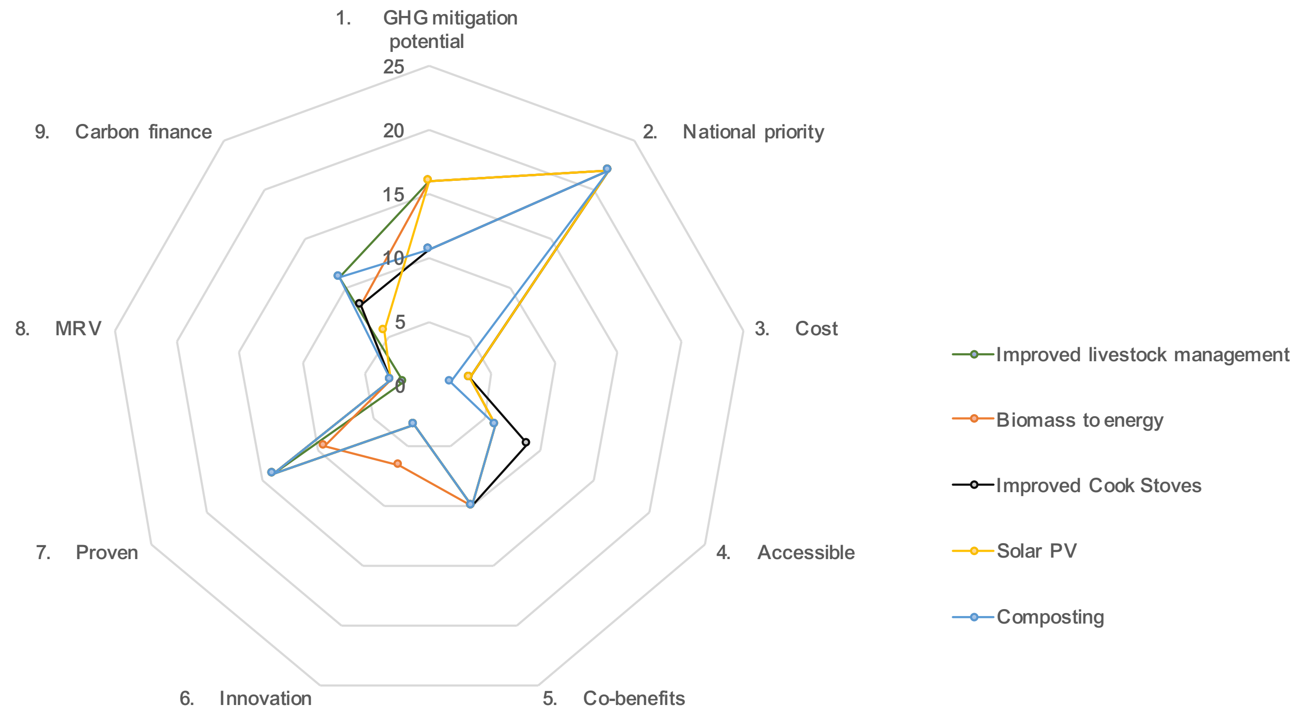

Figure 12: Spider diagram of Uganda's top five-ranking technologies

The following table outlines the outcomes (weighted scores) of all the technologies/ activities in the assessment for Uganda. The technologies/ activities are presented from highest to lowest weighted scores. Additionally, the table indicates whether each technology is classified as innovative (blue lightbulb icon) or recognised as the best available option (green rosette icon). This comprehensive overview allows for a convenient comparison of the total scores, offering valuable insights into the relative strengths and weaknesses of the technologies related to their current carbon market potential.

KEY TAKEAWAY

Improved livestock management, biomass to energy and improved cookstoves emerged as the highest-scoring technologies due to their effectiveness at removing or reducing GHG emissions, provision of co-benefits and likelihood in accessing carbon finances.

Table 19: Outcomes of all technologies assessed for Uganda

	Technologies	Weighted scores
1.	Improved livestock management	87,7
2.	Biomass to energy	84,6
3.	Improved Cook Stoves	83,6
4.	Solar PV	83,2
5.	Composting	81,7
6.	Smart irrigation technologies - Solar pumps, precision irrigation	79,5
7.	Agroforestry	78,6
8.	E-cooking	77,9
9.	Biofuel	77,8
10.	Wetland and Peatland management	76,6
11.	Small/micro-hydropower	76,2
12.	Substitute clinker in the cement production process	69,6
13.	Geothermal	68,5
14.	Refrigerant replacement	67,9
15.	E-mobility	64,5
16.	Wind	58,8
17.	Green Hydrogen	58,2
18.	Bus rapid transport	56,4
19.	Rail Transport	56,4
20.	BECCS	56,0

Although rail transport, bus rapid transport, and BECCS technologies have relatively high GHG mitigation potential and offer multiple co-benefits, they received lower rankings due to factors such as limited accessibility due to infrastructure constraints, high monitoring costs, and challenges related to accessing financing and coverage. Nuclear energy in Uganda has not been assessed in this report due to the fact that such technology is still tentative in the energy sector of Uganda. Whilst in 2023 Uganda has announced plans to start a nuclear power generator, such power generation has not been discussed or disclosed within Uganda's NDC or TNA and there are no defined methodologies within carbon credit standards as of yet.

5.8 Overall Findings

The technologies and activities that feature in the country top-five rankings include:

- Afforestation and reforestation
- Biofuel
- Biogas production
- Biomass to energy
- Composting
- E-cooking
- Improved Cook Stoves
- Improved livestock management
- Industry fuel switches
- Landfill gas recovery and use or destruction
- Small/micro-hydropower
- Smart irrigation technologies
- Soil and water conservation
- Solar dryers
- Solar home systems
- Solar PV
- Sustainable charcoal production
- Sustainable forest management
- Waste to energy
- Wind

Most of the technologies in the top-five rankings may be considered as mature or proven technologies. Notably, solar PV features in four countries' top-five rankings and was considered separately to solar home systems (features in two countries' top-five) and solar dryers (features in Kenya's top-five).

Most of technologies are GHG mitigation technologies, many of which are located in the energy sectors. These technologies include hydropower, wind power, biogas and biomass to energy and waste to energy. This distribution is to be expected, considering the high potential for socio-economic impacts related to the provision of clean, accessible and affordable energy.

There are **four activities in the list above which result directly in carbon sequestration**, namely afforestation and reforestation; improved livestock management (where this relates to improvements to the health of pastures and resulting in better soil carbon sequestration); soil conservation and sustainable forest management. These activities are highlighted in green in the list above.

The only innovative or emerging technology in the top - five rankings is E-cooking, which features in the lists for Ethiopia and Rwanda. The three other innovative or emerging technologies considered in this assessment, namely BECCs, green hydrogen and E-mobility, did not feature in the top-five rankings. This is because they typically scored lower in the assessments relating to the accessibility, proven and cost criteria. As these technologies continue to develop and mature, they are expected to increasingly align with these criteria. Consequently, they are garnering growing attention from the region as well as potential investors who are keen to offer technical support and pioneering financing to facilitate their adoption.


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06

Conclusions and Recommendations

It is hoped that the ranking exercise may assist the seven countries in developing technology "positive lists", which may be used in respective Article 6 Frameworks. Ultimately, the aim is to promote the adoption of sustainable and low-carbon technologies and activities that can mitigate GHG emissions, support the transition to a green economy, and achieve the region's sustainable development objectives.

The main objective of this study is to assist the seven East African countries in considering and prioritising mitigation technologies and project activities. The seven countries within the scope of the study are Burundi, Ethiopia, Kenya, Rwanda, Sudan, Tanzania and Uganda.

The process consisted of the identification and subsequent ranking of technologies and activities for the seven countries. The evaluation and ranking exercise required the use of a multifaceted and robust set of criteria. The nine criteria considered in the assessment were:

- GHG mitigation potential
- National priority
- Cost
- Accessible
- Co-benefits
- Innovation
- Proven
- MRV
- Carbon finance

These criteria were weighted according to different country priorities. The multicriteria analyses provided a decision-making technique to evaluate and compare alternatives based on multiple criteria or objectives. It assisted in developing informed decisions when faced with complex problems that involved multiple conflicting objectives. This approach was necessary because highly-prized climate measures need to provide more than GHG reduction or removal impacts. Increasingly, the underlying technologies and measures can be leveraged to address underlying socio, economic and environmental issues, in addition to mitigating GHG emissions. The nexus of climate and sustainable development measures is accordingly a key area for developing country contexts.

It is hoped that the ranking exercise may assist the seven countries in developing technology "positive lists", which may be used in respective Article 6 Frameworks. Ultimately, the aim is to promote the adoption of sustainable and low-carbon technologies and activities that can mitigate GHG emissions, support the transition to a green economy, and achieve the region's sustainable development objectives.

The following is a summary of the top-five ranking technologies/ activities, per country. The 'green rosette icon' indicates that the technology is considered a best available option and the 'blue lightbulb icon' indicates that the technology is classified as innovative/emerging.

Country	Top-five ranking technologies/ activities
Burundi	Soil and water conservation Composting Small/micro-hydropower Solar PV Biogas production
Ethiopia	Industry fuel switches Solar home systems Landfill gas recovery and use or destruction Sustainable forest management E-cooking
Kenya	Wind Biogas production Solar home systems Solar dryers Afforestation and reforestation
Rwanda	Improved Cook Stoves Small/micro-hydropower Landfill gas recovery and use or destruction E-cooking Waste to energy
Sudan	Soil and water conservation Solar PV Composting Smart irrigation technologies - Solar pumps, precision irrigation Biogas production
Tanzania	Biofuel Biomass to energy Small/micro-hydropower Sustainable charcoal production Solar PV
Uganda	Improved livestock management Biomass to energy Improved cook stoves Solar PV Composting

The outcomes above are the results of the selected assessment methodology and current information at hand. These outcomes are not intended to be definitive measures of appropriate technologies or activities. They are rather intended to be used as guides for further, comprehensive investigations by the respective countries.

Accordingly, the following are recommendations for further work in this regard:

- Explore additional avenues for collaboration and knowledge sharing among the seven East African countries. This could include establishing platforms for exchanging best practices, experiences, and lessons learned in the implementation of sustainable and low-carbon technologies. Such collaboration can facilitate regional cooperation and accelerate the transition to a green economy.

- Continuously monitor and evaluate the progress and impact of adopted and emerging technologies and project activities. Regular MRV of the implemented measures are crucial for assessing their effectiveness, identifying areas for improvement, and ensuring accountability. This will help in refining and updating the prioritised technologies and enhancing the overall impact of mitigation efforts.

- Consider articulating recommended technologies and project activities in the development of Article 6 'positive list' or other national list of priority technologies and project activities.

- Consider proposals for the Supervisory Body of the Article 6.4 Mechanism on simplified approaches for demonstration of additionality (applicable for least developed countries).

- Consider impacts of current or potential tax incentives on technologies or project activities.


07

Annexure 2: Top Five Technologies Per Country

Table 20: Multicriteria assessment of top five technologies/activities for Burundi

Burundi					
	Soil and water conservation	**Composting**	**Small/micro-hydropower**	**Solar PV**	**Biogas production**
GHG mitigation potential	2/3. Effectiveness and scaling up soil and water conservation practices is highly dependent on and requires widespread adoption by farmers and land managers. With appropriate planning, knowledge transfer, and institutional support, soil and water conservation can be implemented at larger scales to achieve long-term GHG mitigation and environmental benefits. Baseline evaluation could however be costly and challenging.	1/3. Composting in Burundi has a relatively low GHG mitigation potential due to the relatively low absolute quantities of waste generated, collected, and available for composting. The scalability of composting for substantial GHG mitigation may be more viable at a localised or community level. Additionally, the baseline emissions will depend on the specific context of each project and therefore alignment with this indicator could not be assessed in this study. Nevertheless, composting can still contribute to waste management, soil health improvement, and nutrient recycling, which are important aspects of sustainable development and environmental conservation in the country.	2/3. Hydro technology is effective at reducing GHG emissions. Burundi has large potential that has not been fully exploited yet, which could assist scalability. However, the relatively low grid emission factor of Burundi (baseline scenario and emissions) limits the volumes of GHG emission reductions	2/3. Solar PV technology offers a highly effective solution for GHG mitigation in Burundi, given the availability of solar resources in the country. Although the distribution and scalability of Solar PV systems is still limited in Burundi, as the first solar PV only became operational in 2021, the absence of emissions during operation make them an important renewable energy technology. The baseline evaluation of Burundi implies that the electricity generated from the grid in Burundi has a relatively low carbon intensity, suggesting the potential GHG reduction impact of solar PV in Burundi may be relatively smaller compared to countries with higher grid emission factors.	1/3. The effectiveness of biogas production in Burundi is dependent on the availability of biomass sources, particularly agricultural wastes which are likely to be available considering that agriculture is one of the primary economic activities. The scalability of the technology depends on factors like biomass volumes, infrastructure development, and policy support, and could not be evaluated in this assessment. Baseline evaluation is crucial to assess the potential GHG mitigation impact of biogas production, considering the existing energy situation and grid emission intensities. Considering that there are different baseline scenarios, alignment with the baseline evaluation indicator could not be determined.

Burundi					
	Soil and water conservation	**Composting**	**Small/micro-hydropower**	**Solar PV**	**Biogas production**
National priority	3/3. Well aligned to national priorities. Can improve agricultural productivity and food security. Enhanced soil fertility and water availability contribute to increased crop yields and incomes for farmers. Adoption of sustainable practice protects ecosystems and reduces the vulnerability of rural communities to environmental risks and in turn, fosters sustainable economic growth, creates employment opportunities in the agricultural sector, and enhances the capacity of local communities to manage their natural resources effectively.	3/3. Composting aligns well with the national climate change policies, targets, and strategies of Burundi, including the NDC and TNA. Additionally, it offers potential for economic growth by improving waste management practices and using compost in agriculture. Moreover, composting can contribute to capacity building by developing local knowledge and skills related to waste management and sustainable agriculture.	3/3. Small-scale hydropower is considered a viable and renewable energy source in Burundi, and it aligns with the country's climate change policies and targets. It has the potential to stimulate economic growth and development by creating jobs and attracting investment. Additionally, small-scale hydropower projects can contribute to capacity building efforts, fostering the development of local expertise and knowledge	3/3. Solar PV aligns with the national climate change policies and strategies as outlined in the TNA and NDC. Its implementation not only addresses environmental concerns but also presents economic growth potential through job creation and local value addition. Furthermore, Solar PV technology contributes to capacity building by promoting the development of local skills, knowledge, and capacities in the renewable energy sector. By prioritising Solar PV as a national initiative, Burundi can harness the multiple benefits of this technology while advancing its sustainable development and climate goals.	3/3. Biogas production is considered a national priority in Burundi due to its alignment with the country's climate change policies, targets, and strategies. It offers economic growth potential through job creation and stimulates the development of local industries. Additionally, biogas production contributes to capacity building by promoting the acquisition of new skills and knowledge within communities.

Burundi					
	Soil and water conservation	**Composting**	**Small/micro-hydropower**	**Solar PV**	**Biogas production**
Cost	2/3. Implementation costs of soil and water conservation practices primarily involve materials, labour, and training for farmers or local communities. These costs are generally lower than large-scale infrastructure projects or technology-intensive initiatives. This does however pose a challenge with proving additionality.	1/3. Composting is generally considered a cost-effective waste management strategy, but the GHG mitigation potential through composting in Burundi may be relatively low due to the specific waste generation patterns and quantities. Furthermore, due to the relatively low emission reduction potential, such technology is not seen as very cost-effective. The low costs associated with the measure is a positive indicator for additionality.	2/3. Small-scale hydropower in Burundi requires a significant initial investment and ongoing operational costs. Assessing its cost-effectiveness involves considering the relationship between costs and GHG emissions reductions achieved. Additionally, the higher cost associated with small-scale hydropower is a positive indicator for demonstrating additionality.	2/3. Implementing solar PV in Burundi involves initial high capital costs. However, solar PV is considered cost-effective due to its use of solar energy and its potential to achieve significant GHG emissions reductions. The higher capital costs associated with Solar PV can be viewed as a positive indicator of additionality.	2/3. Biogas production technology entails both capital and operational costs that are relatively high. However, by using waste materials such as bagasse and agricultural waste, biogas production can offer cost-effective solutions for reducing GHG emissions. The higher costs associated with biogas technology also suggest its potential for additionality.
Accessible	2/3. Typically involves simple and locally available techniques, such as contour ploughing, terracing, agroforestry, and water harvesting methods that can be adopted by small-scale farmers and rural communities. Affordability and accessibility are further enhanced as it does not require large-scale investment. The low technology might make demonstration of additionality challenging.	3/3. Composting is an affordable, accessible, and acceptable technology in Burundi. Its cost-effectiveness, minimal infrastructure requirements, and alignment with traditional farming practices make it economically accessible to a wide range of users. Composting technology should be readily available, user-friendly, and compatible with existing waste management systems in order to enhance its accessibility.	2/3. Small-scale hydropower can be accessible due to the presence of multiple river and lake sources, making it easily implementable. However, its affordability and accessibility also depend on factors such as upfront costs, operational expenses, and maintenance requirements. The relative cost of implementation and maintenance may vary depending on the scale and site choice. The low penetration rate of small-scale hydropower indicates the potential for additionality.	2/3. The increasingly affordability of solar power is well recognised. Availability and accessibility consider the ease of access to the technology, its usability, and compatibility with existing systems. Solar PV is largely accepted by communities. The low penetration rate is a positive indicator of additionality.	1/3. Despite the challenges of high capital and operational costs and sustainable firewood biomass supply, the potential use of bagasse and agricultural waste presents an avenue for a more viable and accessible biogas technology in the region. As a result of the low penetration rate and costs of such technology in Burundi, the ability to prove additionality is likely.

Burundi					
	Soil and water conservation	**Composting**	**Small/micro-hydropower**	**Solar PV**	**Biogas production**
Co-benefits	3/3. Enhances soil fertility, water availability, and agricultural productivity which help farmers adapt to climate change impacts such as droughts and floods, ensuring the resilience of agricultural systems. By conserving soil and water resources, local communities can sustainably utilise these resources for irrigation, domestic needs, and other economic activities, adding value to their livelihoods and promoting local economic development.	2/3. Composting offers several co-benefits related to sustainable development. It improves waste management, provides access to valuable nutrients for local farming, and reduces the environmental impacts associated with landfilling and open burning. Additionally, composting presents opportunities for employment, skills development, and local value addition, contributing to economic growth and stimulating local industries. Although composting may not have direct adaptive benefits, it indirectly enhances the resilience and adaptive capacity of communities and ecosystems through improved waste management practices and sustainable agricultural systems.	3/3. This technology offers co-benefits that contribute to sustainable development. These co-benefits include increased access to electricity in rural areas, job creation, and improved energy security. Additionally, the technology enhances the resilience and adaptive capacity of communities and ecosystems to climate change impacts. Furthermore, small-scale hydropower projects have the potential to stimulate local industries, create value chains, and facilitate technology transfer, thus promoting local economic growth and capacity building.	3/3. Solar PV brings about sustainable development by reducing GHG emissions, creating job opportunities, and improving air quality. It enhances adaptation by providing reliable and decentralised energy access, bolstering community resilience to climate change impacts. Furthermore, Solar PV technology stimulates local industries, creates value chains, and facilitates technology transfer, contributing to the growth of a sustainable renewable energy sector in Burundi.	3/3. Biogas production offers multiple co-benefits, including reducing methane emissions, improving waste management practices, contributing to sustainable agriculture, and promoting local economic development and technology transfer. By addressing social, economic, and environmental dimensions of sustainable development, biogas production plays a crucial role in advancing Burundi's sustainability goals and building resilience to climate change.

Burundi					
	Soil and water conservation	**Composting**	**Small/micro-hydropower**	**Solar PV**	**Biogas production**
Innovation	1/3. Soil and water conservation technologies have been greatly explored, are well established and therefore not novel. Due to the low costs associated with such technologies, the ability to prove additionality might be challenging.	2/3. Composting showcases moderate levels of technological advancement but is not novel. The technology is market-ready and can be integrated into existing systems and processes with relative ease. Proving additionality may be facilitated by lack of common practice.	1/3. Small-scale hydropower may not offer significant technological disruption advantages due to its established nature. The market readiness of the technology should be assessed in terms of its ability to be deployed and integrated into existing systems. Additionally, while higher prices and lower penetration rates can be indicators of additionality, the potential for significant additionality may be limited in the context of an already established hydropower sector in Burundi.	2/3. Solar PV is no longer particularly innovative however it is market ready. The technology is mature and reliable. The higher price and lower penetration rate of solar PV in Burundi are positive indicators of additionality.	2/3. While biogas production may not disrupt conventional practices in Burundi, it offers novel features and the potential for transformative changes in GHG emissions reduction. The technology is relatively market-ready and can be integrated into existing systems and processes. The higher cost of implementation and lower penetration rate of biogas technology in Burundi are positive indicators of additionality.
Proven	3/3. Soil and water conservation practices have been used widely for many years all over the world, to various degrees of success.	3/3. Composting has demonstrated technical maturity, with well-established principles and processes. It has a proven track record of successful implementation and operation, showcasing its effectiveness in managing organic waste. Additionally, composting technology exhibits a high level of replicability, allowing for its implementation in various locations within Burundi.	3/3. In Burundi small-scale hydro has proven to be a technically mature technology that has been successfully implemented and operated. Its performance records demonstrate its reliability and effectiveness. Moreover, the technology has a demonstrated replicability, indicating its potential to be scaled up and implemented in different locations within the country or the region.	2/3. While the technical maturity of solar PV technology in Burundi is still evolving, there are performance records that validate its successful implementation and operation in similar contexts. The demonstrated replicability of solar PV technology indicates its potential to be replicated and implemented in different locations within the region. Continued research, development, and knowledge sharing will further contribute to the technical advancement and wider adoption of solar PV technology in Burundi.	3/3. Biogas production from biomass, particularly through methods like anaerobic digestion, is a technically mature technology that has been widely implemented and proven effective in various contexts. Its performance records demonstrate successful operation and use of biogas as a renewable energy source. The technology's replicability and scalability further highlight its potential for implementation in Burundi, providing a sustainable solution for energy generation and waste management.

Burundi					
	Soil and water conservation	**Composting**	**Small/micro-hydropower**	**Solar PV**	**Biogas production**
MRV	1/3. Monitoring of soil and water conservation projects is often complex due to the need for regular inspections and analyses that could vary from soil sampling to remote sensing of vegetation coverage. The cost of monitoring is relatively economical depending on the method/s employed (excluding remote sensing). The evaluation of baseline emissions might be challenging.	1/3. Monitoring of composting is simple assuming the relevant technology, such as weighbridges is available. However, such equipment may be costly. Baseline monitoring could be onerous.	3/3. Monitoring the baseline and project scenarios of small-scale hydropower in Burundi is relatively simple and cost-effective. The technology allows for straightforward data collection, and advancements in digital monitoring further enhance its ease of implementation.	3/3. Solar PV technology in Burundi offers ease of monitoring with relatively low associated costs for both the baseline scenario and the project scenario. These factors make solar PV a favourable option for emissions reductions in Burundi, supporting the country's transition to a sustainable and low-carbon energy system.	2/3. Biogas production technology offers the advantage of ease of monitoring, with relatively simple monitoring requirements due to its mature and well-established nature. This results in lower monitoring costs compared to more complex technologies. However, the baseline monitoring may be complex and therefore alignment with this indicator could not be ascertained.
Carbon finance	3/4. Soil and water conservation activities are likely to access carbon finances due to prevalence of co-benefits. They are prioritised within the NDC and TNA. The activities might be linked to multiple sectors in the NGHGI which may pose difficulties when apportioning emissions reductions. Carbon financing may cover significant proportion of activity costs.	4/4. Composting activities are likely to access carbon finances due to prevalence of co-benefits. Composting has been expressed within the NDC and TNA. Due to the low costs associated with such technology, additional finances may not be required. Such technology can be directly linked to the waste sector and therefore the emission reductions that arise from such technology can be used in the waste sector.	2/4. Well-aligned with the NDC but poses concerns about environmental and social impacts such as the risks of displacement of local communities, alteration of natural river ecosystems, and potential conflicts over water resources. Therefore, access to carbon finance may be challenging. High finance coverage requirements. Would be linked to the energy sector of the NGHGI and emission reductions can be used for this sector.	2/4. Solar PV may be less well-positioned to access carbon finance due to relatively low levels of co-benefits. Solar PV is however articulated in Burundi's NDC goals, furthermore, such technology is directly linked to the energy sector of the NGHGI and therefore the emission reductions can be used for such sector. While smaller projects can rely more on carbon finance for funding, larger capital projects may require additional sources of financing.	3/4. This technology in Burundi has favourable prospects for accessing carbon finance. It aligns with market preferences for projects with co-benefits, demonstrates alignment with the country's NDC targets, and can play a crucial role in the NGHGI. While larger-scale projects may require additional funding sources, carbon finance plays a significant role in supporting smaller-scale biogas initiatives.
Grand Total	80	79	79	77	75

Table 21: Multicriteria assessment of top five technologies/activities for Ethiopia

Ethiopia					
	Industry fuel switches	**Solar home systems**	**Landfill gas recovery and use or destruction**	**Sustainable forest management**	**E-cooking**
GHG mitigation potential	3/3. Industry fuel switches have the potential to effectively reduce GHG emissions in the manufacturing sector of Ethiopia, which is heavily reliant on fossil-fuels. Scalability is achievable with appropriate support and infrastructure. A baseline scenario involving fossil fuels will facilitate GHG reductions. However, the zero-grid emission factor of Ethiopia would not facilitate GHG emission reductions if the baseline scenario is grid electricity.	3/3. While improved solar home systems may not meet the effectiveness indicator individually, their scalability and potential to be implemented on a larger scale can contribute to substantial GHG mitigation. The low electrification rate in Ethiopia (around 45%) implies that these technologies would be applied to rural or off grid communities, where communities use non-renewable biomass or fossil fuels for energy. Such baseline scenario would substantiate emission reductions, whereas a grid electricity baseline would not on account of the very low grid emission factor.	2/3. Landfill gas recovery and use or destruction technologies are effective at reducing GHG emissions. Growth in Ethiopia's large population (118 million) indicates that such measures could be scaled. However, the baseline evaluation may be challenging should there be poor records of data and therefore applicability with the indicator is considered to be low.	2/3. The ability of such measures to remove GHG emission is quite high. Such measures can be implemented on a large scale which will further contribute to GHG emissions. The baseline evaluation will depend on the specific area and hence alignment with this indicator is not currently possible.	2/3. E-cooking scalability is reasonable in Ethiopia, but effectiveness is highly dependent on use and technology adoption rates. The primary current use of cooking is burning of biomass which would facilitate the generation of emission reductions. This will not be possible if the baseline is grid electricity, as Ethiopia's grid emission factor is close to zero.

Ethiopia					
	Industry fuel switches	**Solar home systems**	**Landfill gas recovery and use or destruction**	**Sustainable forest management**	**E-cooking**
National priority	3/3. Aligned to NDC of shifting from fossil-fuels to electricity and/or renewable energy. Industry fuel switches can contribute to economic growth by reducing reliance on expensive fuel imports and improving energy efficiency in the manufacturing sector. Implementing Industry fuel switches requires capacity building efforts to support the adoption of new technologies and practices.	3/3. Despite mention of solar home systems not featuring in Ethiopia's NDC, solar home systems are a national priority in the country, aligning with the national climate change policies, targets, and strategies. They offer substantial economic growth potential, promoting job creation and cost savings while reducing reliance on imported fossil fuels. Additionally, solar home systems contribute to capacity building efforts by fostering the development of local skills and knowledge in the renewable energy sector. As part of the National Electrification Program, the widespread adoption of solar home systems, such as the goal of achieving 35% off-grid energy systems by 2025, demonstrates Ethiopia's commitment to sustainable energy solutions and local development.	3/3. The waste sector is a national priority, although LFG recovery is not explicitly mentioned. Good potential for capacity building and economic growth due to job creation, employment, and skills development.	2/3. Sustainable Forest Management activities have been disclosed within Ethiopia's NDC. By implementing such activities, it will allow for capacity building as it promotes new skills, knowledge, and capacities of Ethiopia's communities. However, such practice does not have significant potential for job creation.	2/3. Aligned with NDC that mentions fuel switch from unsustainable biomass energy demand to electric stoves and renewable biofuels. Additionally, the adoption of e-cooking technologies can contribute to the development of local capacities and skills.

Ethiopia					
	Industry fuel switches	**Solar home systems**	**Landfill gas recovery and use or destruction**	**Sustainable forest management**	**E-cooking**
Cost	2/3. Initial capital outlays may be relatively high. Switching from fossil-fuels such as diesel or similar would however be cost effective in terms of both GHG reduction and potentially operational costs in the long term. High costs could be a positive indicator for additionality.	2/3. The implementation of solar home systems in Ethiopia incurs initial capital costs for homeowners. However, the long-term financial sustainability and cost-effectiveness of the technology make it an attractive choice. The higher capital cost and associated expenses associated with solar home systems can be viewed as positive indicators of additionality.	2/3. Projects are generally considered relatively economical in terms of GHG reduction compared to other technologies. Can potentially generate revenue through the sale of captured gas or generated electricity. Initial capital is high due to installation and operation of gas usage technology (e.g., gas-to-electricity, boilers, etc).	2/3. Sustainable Forest Management in Ethiopia may involve initial high investments and ongoing operational costs but can remove a large amount of GHG emissions and can be seen as quite a cost-effective measures. With the relatively high costs associated with such activity, the ability to prove additionality might be possible.	3/3. E-cooking in Ethiopia has certain cost considerations. While the capital cost and operational costs are relatively low compared to other technologies, they are still high and require an initial investment. However, the cost-effectiveness of e-cooking is evident in terms of its GHG emissions reduction potential. Moreover, the distribution of e-cooking technologies to low-income communities by non-profit organisations is a positive indicator of additionality.
Accessible	2/3. Industrial fuel switches are deemed affordable, considering the financial capacity and the potential cost savings from reduced fuel consumption that industry or manufacturers would achieve. Access to alternative fuel sources and technologies should not be problematic, especially considering Ethiopia's abundance of natural gas reserves, but proposed solutions would need to be acceptable to industries in terms of their performance and compatibility with existing infrastructure. Low current adoption could be positive indicators of additionality.	2/3. Solar home systems are available and accessible in Ethiopia, but there is a high installation costs associated with such technology and therefore, are not seen affordable. Due to the high costs associated with such technology, additionality may be able to be proven.	3/3. The technology is relatively simple, widely available and acceptable.	2/3. Sustainable Forest Management is readily accessible and widely accepted in Ethiopia, but the implementation is perceived as unaffordable due to its high associated costs. Due to the high costs in Ethiopia, the ability to prove additionality is likely.	2/3 In Addis Ababa, the activity’s main market, the electricity connection rate is over 95%. Therefore, it is only feasible and accessible for areas with electricity access. Alternatively, the provision of solar panels in combination with e-cookers would improve accessibility, while also reducing the affordability somewhat.

Ethiopia					
	Industry fuel switches	**Solar home systems**	**Landfill gas recovery and use or destruction**	**Sustainable forest management**	**E-cooking**
Co-benefits	3/3. Industry fuel switching in Ethiopia holds the promise of sustainable development, as it reduces GHG emissions, thereby strengthening resilience to climate change, and fosters local value creation through employment, industry promotion, and technology transfer.	3/3. Solar home systems in Ethiopia offer co-benefits that positively impact sustainable development, adaptation, and local value addition. The technology's ability to provide reliable lighting, improve indoor air quality, create job opportunities, and enhance resilience contributes to a more sustainable and resilient future for communities in Ethiopia.	2/3. No substantial adaptation benefits. Projects can benefit communities and local industries by generating revenue, creating jobs, and promoting environmental protection and responsible waste management, and improving air quality around landfill sites.	3/3. Sustainable Forest Management in Ethiopia contributes to the country's overall sustainable development by preserving vital ecosystems and forests, promoting job creation, and fostering a healthier environment. It safeguards natural resources and enables local communities to adapt to environmental challenges. Sustainable management practices support industries such as timber production, non-timber forest products, and ecotourism, offering employment opportunities and driving economic development. Well-managed forests create a more sustainable and resilient environment for the well-being of local communities	3/3. E-cooking in Ethiopia offers various co-benefits aligned with sustainable development objectives. It reduces GHG emissions, improves air quality, enhances adaptive capacity to climate change, and stimulates local industries and value chains. By promoting the adoption of electric cooking technologies, Ethiopia can achieve positive outcomes in terms of social, economic, and environmental sustainability.

Ethiopia					
	Industry fuel switches	**Solar home systems**	**Landfill gas recovery and use or destruction**	**Sustainable forest management**	**E-cooking**
Innovation	2/3. Industry fuel switches do not offer any technological advancement or disruptive potential. Market readiness would need to be accessed but should prove positive considering benefits offered to industry and/or large manufacturers. Higher implementation costs and low current industry fuel switch adoption rates are positive indicators of additionality.	2/3. Solar home systems in Ethiopia exhibit technological advancement and additionality but are not particularly innovative. The technology is market ready.	1/3. Landfill gas recovery is a well-established technology and does not present technological advancements or disruptive technology potential.	2/3. These measures are demonstrated and not novel. They align with market readiness by meeting the increasing demand for responsibly sourced forest products. The relatively low penetration rate and initial high investments costs are a positive indicator for additionality.	3/3. E-cooking represents a technologically advanced and disruptive solution with significant potential to reduce GHG emissions. The market in Ethiopia is ready for adoption where access to power e-cooking is established or provided. While the initial costs may be higher, the transformative impact of electric cooking justifies its additionality as a valuable approach to combat climate change and promote sustainable cooking practices.
Proven	2/3. Although many fuel alternative technologies and the switch-over to these by large manufacturers (for example cement producers in Europe) are mature and has proven successful in other countries, demonstrated replicability and adoption by Ethiopian industry has not yet been established.	1/3. There is technical maturity of solar home systems in Ethiopia, but the lack of local manufacturing, awareness of operation, frequent system failures, insufficient maintenance expertise, and high maintenance and installation costs are significant challenges affecting the market diffusion and sustainability of solar home systems in Ethiopia.	3/3 Landfill methane capture is a mature technology that has been used widely for many years all over the world, including in Ethiopia.	3/3. These measures have demonstrated technical maturity with proven performance records and replicability in Ethiopia. Sustainable Forest Management practices have been successfully implemented in various forest areas and the replicability of approaches across different locations showcases their adaptability and effectiveness in addressing specific forest ecosystem needs.	2/3. This technology has proven to be effective in similar African contexts, even though it is not yet considered a fully mature technology. The successful implementation and operation of e-cooking demonstrates its potential for reducing GHG emissions and improving cooking practices. Additionally, the technology's replicability and scalability further support its viability and potential for widespread adoption in Ethiopia and other regions.

Ethiopia					
	Industry fuel switches	**Solar home systems**	**Landfill gas recovery and use or destruction**	**Sustainable forest management**	**E-cooking**
MRV	3/3. Monitoring would be fairly easy and therefore cost of monitoring expected to be low.	3/3. Easy to monitor due to their simplicity and compatibility with digital monitoring technologies, indicating that the cost of monitoring should be relatively low. A baseline scenario involving fossil fuels will facilitate GHG reductions. However, the zero-grid emission factor of Ethiopia would not facilitate GHG emission reductions if the baseline scenario is grid electricity, therefore the monitoring of fossil fuel baseline emissions would be required.	2/3. As landfill gas recovery is a proven technology that has been around for many years, the cost of monitoring is low and relatively easy. The baseline evaluation is likely to be challenging due to poor landfill records.	0/3. These measures will have relatively high monitoring costs and will be relatively complex to monitor. The evaluation of the baseline emissions will depend on the project scenario and hence alignment with this indicator could not be ascertained.	2/3. Monitoring the usage and emissions associated with e-cooking devices in Ethiopia can be facilitated by emerging digital monitoring technologies. The cost of monitoring can however be prohibitive.
Carbon finance	2/4. Financial coverage for industrial fuel switches is highly variable and dependent on the scale and specific fuel sources employed. However, carbon finance has been obtained in many CDM projects that entail fuel switching. Industrial fuel switching aligns well with Ethiopia's NDC and should have high degree of visibility in the NGHGI.	4/4. Solar home systems are not explicitly mentioned within Ethiopia's NDC, but aligns with the country's climate change policies, targets, and strategies. The collaboration between the Development Bank of Ethiopia and the World Bank Electricity Network Rehabilitation and Enhancement Project (ENREP) in establishing a financing facility for renewable energy products, including solar home systems, highlights the potential of such financing mechanisms to support the adoption of clean energy technologies in the country. Due to the low costs associated with such technology, additional finances may not be required. Such technology can be linked to the energy sector in the NGHGI which will make it easier when apportioning the emission reductions.	2/4. Landfill gas activities are likely to access carbon finances due to prevalence of co-benefits. Such projects may span across different NGHGI sectors (waste and energy) which could be problematic if the emission reductions are to be used as ITMOs. Waste management is aligned to the Ethiopian NDC. The relatively high costs could not be materially covered by carbon financing.	3/4. In Ethiopia, Sustainable Forest Management practices have the potential to attract carbon finance due to the prevalence of co-benefits associated with these activities. Ethiopia's commitment to the AFOLU sector in the NGHGI makes it well-aligned with global climate goals. The inclusion of Sustainable Forest Management measures is discussed within Ethiopia's NDC. However, it is important to note that implementing such activities may entail higher costs, necessitating the need for additional financial resources.	4/4. Cleaner cooking is aligned with Ethiopia's NDC (although not specifying e-cooking) and the technology can be linked to the energy sector of the NGHGI, therefore the emission reductions can be used for this sector. Although the capital cost is more than improved cookstoves, it is still relatively low in comparison with other technologies and these capital costs could be covered by carbon finance.
Grand Total	**82**	**82**	**79**	**79**	**79**

Table 22: Multicriteria assessment of top five technologies/activities for Kenya

Kenya					
	Biogas production	**Solar home systems**	**Solar dryers**	**Afforestation and reforestation**	**Wind**
GHG mitigation potential	3/3 Biogas technology possesses significant potential for substantial reduction of GHG emissions. Moreover, this technology can be implemented on a large scale in Kenya, thanks to the abundance of agricultural and organic waste resources, resulting in substantial emission reductions. However, the moderate grid emission factor in Kenya limits the extent of GHG emission reductions. This limitation could be addressed by replacing other fossil fuels used in thermal applications.	2/3. Solar home systems in Kenya have the potential to achieve a modest reduction in GHG emissions. However, their implementation on a large scale can contribute significantly to emission reductions. The high electrification rate in Kenya, standing at 75%, indicates that grid electricity will likely serve as the baseline. The moderate grid emission factor in Kenya, both in baseline scenarios and current emissions, slightly limits the volume of GHG emission reductions.	2/3 Solar dryer technology has the potential to significantly reduce a considerable amount of GHG emissions. Moreover, it can be implemented on a large scale in Kenya, given the presence of various manufacturing industries that employ drying processes as part of their production, thus contributing to substantial emission reductions. However, the moderate grid emission factor in Kenya, both in baseline scenarios and current emissions, limits the volume of GHG emission reductions if displacing grid electricity.	2/3 Such measures have the potential to reduce a large amount of GHG emissions. Furthermore, such measures can be implemented on a large scale and therefore can contribute to a substantial emission removals. The baseline scenarios and emissions will depend on the availability of data sets and actual surveys which could be challenging and therefore applicability with the indicator is considered to be low.	2/3 Wind technology has the potential to reduce a large amount of GHG emissions. Furthermore, such technology can be implemented on a large scale and therefore can contribute to substantial emission reductions. The moderate grid emission factor of Kenya (baseline scenario) constrains the volumes of GHG emission reductions.
National priority	3/3. Biogas technology has been extensively discussed and disclosed in Kenya's NDC. Its implementation not only has the potential to create job opportunities and drive economic growth but also promotes capacity building by fostering the acquisition of new skills, knowledge, and capabilities within Kenya's community.	3/3. Solar home systems have been extensively discussed and disclosed in Kenya's NDC. Their implementation not only has the potential to create job opportunities and drive economic growth but also promotes capacity building by fostering the acquisition of new skills, knowledge, and capabilities within Kenya's community.	3/3. Solar dryers have been extensively discussed and disclosed in Kenya's NDC. Their implementation not only holds the potential for job creation and economic growth but also promotes capacity building by fostering the acquisition of new skills, knowledge, and capabilities within Kenya's community.	3/3. Such activity been discussed and disclosed within Kenya's NDC. By implementing such activity, it will potentially allow for job creations to be made and allow for economic growth. Furthermore, such technology allows for capacity building as it promotes new skills, knowledge and capacities of Kenya's community.	3/3. Wind technology have been discussed and disclosed within Kenya's NDC. By implementing such technology, it will potentially allow for job creations to be made and allow for economic growth. Furthermore, such technology allows for capacity building as it promotes new skills, knowledge and capacities of Kenya's community.

Kenya					
	Biogas production	**Solar home systems**	**Solar dryers**	**Afforestation and reforestation**	**Wind**
Cost	2/3. Biogas technology entails significant capital costs due to its components and implementation. Nonetheless, its ability to reduce GHG emissions is considerable, making it a cost-effective solution. The relatively high costs associated with this technology also provide an opportunity to demonstrate additionality.	1/3. Solar home systems in Kenya entail significant capital costs due to the battery and storage system components. However, such technology is effective at reducing GHG emissions. The relatively low costs associated with these technologies may make it challenging to demonstrate additionality.	1/3. Solar dryers in Kenya entail significant capital costs. Their effectiveness will depend on the implementation and maintenance of the systems. However, the relatively high costs associated with this technology create an opportunity to demonstrate additionality.	2/3. Such measures can have high associated costs. However, the ability to remove GHG emission is relatively high. Therefore, these measures can be seen as cost-effective. With the relatively high costs associated with such measures, the ability to prove additionality might be possible.	2/3. Wind technology in Kenya has relatively low operational costs but fairly high capital costs. Wind is however considered cost effective as the technology can reduce a large amount of GHG emissions. As a result of the high capital costs of such technology, the ability to prove additionality may be possible.
Accessible	2/3. Biogas technology entails significant capital costs due to its components and implementation. Nonetheless, its ability to reduce GHG emissions is considerable, making it a cost-effective solution. The relatively high costs associated with this technology also provide an opportunity to demonstrate additionality.	2/3. Solar home systems are readily available and accessible within Kenyan households and communities. However, the inclusion of storage systems and batteries could make them less affordable. Due to the expensive nature of this technology, proving additionality may be possible.	2/3 Solar dryers are readily available and accessible within Kenyan industry, but their affordability is questionable. Due to the expensive nature of this technology, proving additionality may be possible.	2/3 Such activities are fairly prevalent and acceptable within Kenya. However, due to the high costs associated with such activities, it is seen as unaffordable. Due to the high costs, the ability to prove additionality is likely.	3/3. Such technology is very accessible within Kenya due to excellent wind resources. According to the TNA, wind remains largely under-developed and under-exploited. The affordability of wind power is increasingly on par with other electricity sources and is therefore considered affordable. Currently, the relatively high capital costs and low penetration rate are positive indicators for additionality.

Kenya					
	Biogas production	**Solar home systems**	**Solar dryers**	**Afforestation and reforestation**	**Wind**
Co-benefits	3/3. Such technology contributes to sustainable development by creating a cleaner methane product and creating a cleaner environment and atmosphere for the communities. Furthermore, by implementing such technology it allows for the local community of Kenya to adapt and become less vulnerable. Such technology promotes job creation and create a better, healthier environment for the local community.	3/3. Solar home systems contribute to sustainable development by providing renewable energy to households in Kenya, thereby creating a cleaner environment and atmosphere for communities. Furthermore, their implementation enables the local community to adapt and become less vulnerable. This technology also promotes job creation and fosters a better, healthier environment for the local community.	3/3. Solar dryer technology contributes to sustainable development by providing renewable energy to industries in Kenya, thereby creating a cleaner environment and atmosphere. Furthermore, its implementation enables the local business community to adapt and become less vulnerable. This technology also promotes job creation and fosters a better, healthier environment.	3/3. Such activities contribute to sustainable development by preserving ecosystems and forests within Kenya and creating a more sustainable environment. Furthermore, by implementing such measures it allows for the local community of Kenya to adapt and become less vulnerable.	1/3. Such technology contributes to sustainable development by providing renewable energy to Kenya and creating a cleaner environment and atmosphere. However, wind technologies do not have high levels of adaptation benefits or high potential for long-term employment.
Innovation	3/3. Biogas technology features novel characteristics that distinguish it from other technologies. These systems are market-ready and well-prepared for deployment throughout the country. They come with high costs and therefore have a high potential to effectively fulfil the concept of additionality.	3/3. Solar home systems boast novel features in Kenya that distinguish them from other technologies. Moreover, these systems are well-prepared for the market and ready for deployment nationwide. Although they are relatively easy to assemble, their overall costs are elevated due to expensive components like batteries. Therefore, there is a high probability that this technology can effectively fulfil the concept of additionality.	3/3. Solar dryer technology features novel characteristics that set it apart from other technologies. Moreover, these systems are well-prepared for the market and ready for deployment throughout the country. Although they are relatively easy to assemble, their overall costs are elevated. Therefore, there is a high probability that this technology can effectively fulfil the concept of additionality.	2/3. Such activities are not very new or novel. However, these activities are well-prepared for the market and ready for deployment throughout the country. Such activities are quite complex and have high costs associated with them. Therefore, there is a high probability that these measures can effectively fulfil additionality.	2/3. Such technology has already been widely explored and therefore, does not bring any new, novel features to the renewable technology environment. However, such technology is market ready and is able to be integrated into the numerous regions. Due to the high costs associated with such technology, it might be possible to prove additionality.

Kenya					
	Biogas production	**Solar home systems**	**Solar dryers**	**Afforestation and reforestation**	**Wind**
Proven	2/3. Biogas technology has been successfully implemented in various regions of Kenya and has reached a mature stage. However, fully replicating this technology poses challenges and can be an expensive task, particularly when implementing a biogas plant.	3/3. Solar home systems have been successfully implemented in various regions of Kenya and have reached a mature stage. Thanks to their ease of distribution and use, replication of these systems is easily achievable.	3/3. Solar dryers have been successfully implemented in numerous regions of Kenya and have reached maturity. Thanks to their ease of distribution and use, replication of these systems is easily achievable.	3/3. Such activity has been successfully implemented in numerous regions of Kenya and has reached maturity. Due to natural resources, these measures can be easily replicated.	3/3. Such technology has been successfully implemented within Kenya and has reached its maturity. Furthermore, the technology can be easily replicated.
MRV	3/3. Such technology will have relatively low monitoring costs and will be relatively easy to monitor. However, the evaluation of the baseline emissions (for projects that generate electricity) will be relatively easy as there is a valid standardised baseline currently on the CDM.	2/3. Monitoring these technologies will likely require periodic surveys, which can be complex and costly. However, evaluating the baseline will be straightforward due to the availability of a valid CDM standardized baseline, assuming the baseline is grid electricity.	3/3. Monitoring is likely to fairly simple and therefore cost effective as well. Furthermore, the evaluation of the baseline will be easy as a result of valid CDM standardised baseline.	0/3 Such activity is relatively difficult and expensive to monitor. Furthermore, the evaluation of baseline will be relatively difficult as the baseline values will need to be established through surveys, sampling and or available data sets which could be challenging.	3/3. Such technology will have relatively low monitoring costs and will be relatively easy to monitor. The evaluation of the baseline emissions will be facilitated as a result of a valid standardised baseline currently on the CDM.
Carbon finance	3/4 Biogas technology in Kenya has the potential to attract carbon finance due to the co-benefits it offers. It aligns well with the waste sector in the NGHGI and is acknowledged in Kenya's NDC. However, due to the relatively high capital costs associated with this technology, additional financing may be required.	3/4. Solar home systems in Kenya are likely to access carbon finance due to the prevalence of co-benefits and their extensive discussion within Kenya's NDC. Due to the relatively low costs associated with this technology, additional financing may not be required. Linking such technology to the energy sector in the NGHGI facilitates the allocation of emission reductions.	2/4. Solar dryers may encounter challenges accessing carbon finance due to limited co-benefits. However, they have been extensively discussed in Kenya's NDC. Additional financing may be required due to the high costs associated with this technology. Linking such technology to the energy sector in the NGHGI facilitates the allocation of emission reductions.	3/4 Such activity could feasibly attract carbon finance in Kenya due to prevalence of co-benefits. Furthermore, it is well aligned with the AFOLU sector in the NGHGI. Such technology discussed within Kenya's NDC. However, due to the relatively high costs associated with such activity, additional finances may be required.	3/4 Wind projects in Kenya have received carbon finances in the past, indicating that it is accessible. Wind technologies are however well aligned with the Energy sector in the NGHGI and are prioritised in the country's NDC and TNA. Due to the relatively high capital costs associated with such technology, additional finances may be required.
Grand Total	**88**	**85**	**83**	**81**	**80**

Table 23: Multicriteria assessment of top five technologies/activities for Rwanda

Rwanda					
	Improved Cook Stoves	**Small/micro-hydropower**	**Landfill gas recovery and use or destruction**	**E-cooking**	**Waste to energy**
GHG mitigation potential	3/3. The effectiveness of Improved Cook Stoves (ICS) has been widely recognised and established. The ease of implementing and distributing such technology contributes to its high scalability potential. The baseline emissions, as supported by the expired CDM standardized baseline, have substantiated the development of these projects, and there is a possibility of updating them.	2/3. Hydro technology proves effective in reducing GHG emissions. Rwanda possesses abundant hydro resources, which can contribute to its scalability. However, the relatively low grid emission factor in Rwanda, as observed in the baseline scenario and current emissions, limits the potential volume of GHG emission reductions.	1/3. Landfill gas recovery and use or destruction technologies prove effective in reducing GHG emissions. Rwanda possesses some waste resources; however, the small population size limits scalability. Moreover, the relatively low grid emission factor in Rwanda, as observed in the baseline scenario and current emissions, restricts the potential volume of GHG emission reductions from renewable energy generation.	2/3. E-cooking in Rwanda proves effective in reducing GHG emissions. Moreover, such technology holds the potential for large-scale implementation, thereby contributing significantly to GHG mitigation. However, Rwanda's relatively low grid emission factor may limit the extent of emission reductions achievable through this technology.	1/3. Waste-to-energy technologies prove effective in reducing GHG emissions. Although Rwanda has some waste resources, the limited population size restricts scalability. Additionally, the relatively low grid emission factor in Rwanda places constraints on the potential volumes of GHG emission reductions.
National priority	3/3. Improved cookstoves have been thoroughly discussed and disclosed within Rwanda's TNA and NDC. Implementing this technology holds the potential for job creation and economic growth. Moreover, it promotes capacity building by fostering the acquisition of new skills, knowledge, and capabilities within Rwanda's community.	3/3. Small hydropower has been extensively discussed and disclosed in Rwanda's TNA and NDC, aligning with the country's national climate change policies. Implementing such technology holds the potential for job creation, economic growth, and capacity building by fostering the development of new skills, knowledge, and capabilities within Rwanda's community.	3/3. Landfill gas recovery and use or destruction technologies have been extensively discussed and disclosed in Rwanda's TNA and NDC, aligning with the country's national climate change policies.	2/3. Electric cookers haven't been fully disclosed or discussed within Rwanda's TNA. However, by implementing such technology it will potentially allow for job creations to be made and allow for economic growth. Furthermore, such technology allows for capacity building as it promotes new skills, knowledge and capacities of Rwanda's communities.	3/3. Such technology will have relatively low monitoring costs and will be relatively easy to monitor. The evaluation of the baseline emissions will be facilitated as a result of a valid standardised baseline currently on the CDM.
Cost	2/3. Improved cookstoves have relatively low capital and operational costs while being capable of significantly reducing GHG emissions. This makes them highly cost-effective. However, the low costs associated with this technology pose challenges when attempting to demonstrate additionality.	2/3. Small hydropower projects in Rwanda come with relatively high capital costs while achieving significant GHG emission reductions. The relatively high costs associated with this technology are positive indicators for demonstrating additionality.	2/3. Landfill gas recovery and use or destruction technologies come with relatively high capital costs while achieving significant GHG emission reductions. The relatively high costs associated with this technology are positive indicators for demonstrating additionality	2/3. E-cooking technology in Rwanda has relatively low capital costs but are often considered unaffordable by users. The technology's ability to reduce GHG emissions is relatively high, making it a cost-effective solution. The perceived unaffordability associated with this technology is a positive indicator for demonstrating additionality.	2/3. Waste-to-energy technology in Rwanda comes with relatively high capital and operational costs while effectively reducing a significant amount of GHG emissions. The relatively high costs associated with this technology are positive indicators for demonstrating additionality.

Rwanda					
	Improved Cook Stoves	**Small/micro-hydropower**	**Landfill gas recovery and use or destruction**	**E-cooking**	**Waste to energy**
Accessible	2/3. Such technology is both affordable and acceptable within Rwanda. However, it has not yet reached maturity. Consequently, proving additionality may be facilitated due to the low penetration rate associated with this technology.	2/3. Small hydropower projects in Rwanda are effective at reducing GHG emissions but come with relatively high capital costs. However, the relatively high costs associated with this technology are positive indicators for demonstrating additionality.	3/3. Landfill gas recovery and use or destruction technologies prove effective in reducing GHG emissions. Rwanda possesses some waste resources; however, the small population size limits scalability. Moreover, the relatively low grid emission factor in Rwanda, as observed in the baseline scenario, restricts the potential volume of GHG emission reductions.	2/3. E-cooking has already found implementation in numerous communities and households across Rwanda, making it widely available and acceptable. However, the high costs associated with this technology render it unaffordable for many. The combination of these factors, along with the current penetration rate, is likely to fulfil the criteria for additionality.	3/3. Rwanda's NDC includes considerations and assessments for the implementation of waste-to-energy plants. Furthermore, this technology is affordable due to its low associated costs. Given the current penetration rate, the ability to prove additionality is likely.
Co-benefits	3/3. Improved cookstoves can reduce biomass usage and GHG emissions. Additionally, they create a healthier cooking environment for households and minimise smoke production. This technology enables communities and households to adapt to the impacts of climate change while fostering local value chains and stimulating local industries.	3/3. Small hydropower enables the reduction of GHG emissions while fostering sustainable development. It allows Rwanda to adapt to climate change conditions, providing sustainable electricity to households and communities. Simultaneously, it promotes the creation of local value chains and stimulates local industries.	3/3. Landfill gas extraction and destruction minimise the release of landfill gas (LFG) into the atmosphere, contributing to sustainable development. Additionally, this process enhances community resilience to climate change impacts and fosters the development of local value chains while stimulating local industries.	3/3. Such technology contributes to reducing biomass use and GHG emissions, while simultaneously creating a healthier cooking environment for households and minimising smoke generation. It also enables communities and households to adapt to the impacts of climate change, while fostering the development of local value chains and stimulating local industries.	3/3. Waste-to-energy technology contributes to sustainable development by reducing the amount of waste sent to landfills and creating a cleaner environment. It also provides energy to communities and households, enhancing their resilience to climate change while stimulating local industries.

Rwanda					
	Improved Cook Stoves	**Small/micro-hydropower**	**Landfill gas recovery and use or destruction**	**E-cooking**	**Waste to energy**
Innovation	1/3. Improved cookstoves are not new or novel and have already gained substantial attention and availability. Moreover, they come with relatively low costs, meeting the market readiness criterion.	1/3. Small hydropower is a well-known and established renewable energy technology, lacking new and novel features in the existing environment. Additionally, its prevalence may make it challenging to demonstrate additionality. Market readiness is the only criterion that small hydropower currently meets, as it is ready for deployment in real-world settings.	2/3. Landfill gas extraction and destruction minimise the release of LFG into the atmosphere, contributing to sustainable development. Additionally, this process enhances community resilience to climate change impacts and fosters the development of local value chains while stimulating local industries.	3/3. E-cooking technology is relatively new, featuring innovative aspects. Nevertheless, it is readily available in the market and can be deployed at a large scale within Rwanda's communities and households. The perceived unaffordability associated with this technology is a positive indicator for demonstrating additionality.	1/3. Waste-to-energy technology has been extensively explored and considered, rendering it devoid of novel features. The relatively high costs associated with this technology are positive indicators for demonstrating additionality.
Proven	3/3. Such technology has been proven and demonstrated its performance in Rwanda. There is also evidence and records of its successful implementation within Rwandan communities. The simplicity of its components and design allows for easy replication, resulting in high scalability potential.	3/3. Small hydropower is a well-known and established renewable energy technology. It is scalable due to good hydro resources.	2/3. Landfill gas extraction and destruction minimise the release of LFG into the atmosphere, contributing to sustainable development. Additionally, this process enhances community resilience to climate change impacts and fosters the development of local value chains while stimulating local industries.	2/3. E-cooking technology is relatively new, featuring innovative aspects. Nevertheless, it is readily available in the market and can be deployed at a large scale within Rwanda's communities and households.	2/3. Although waste-to-energy technology has been widely adopted and considered in numerous countries, it is still in its early stages in Rwanda and has not yet reached maturity. Its simplicity and ease of replication make it suitable for deployment across various locations within the region.

Rwanda					
	Improved Cook Stoves	**Small/micro-hydropower**	**Landfill gas recovery and use or destruction**	**E-cooking**	**Waste to energy**
MRV	0/3. Monitoring the baseline and user habits can be complex and costly in Rwanda. Baseline assessments of fNRB are under increasing scrutiny.	3/3. Small hydropower technology is relatively easy to monitor, and the associated monitoring costs are comparatively low. Evaluating the baseline emissions is facilitated by an expired CDM standardized baseline, with the possibility of updating it.	1/3. Monitoring of landfill gas extraction and destruction may be fairly costly and complicated	2/3. E-cooking technology may be relatively easy but costly to monitor. However, the electricity baseline should be fairly easy to establish.	3/3. Monitoring waste-to-energy technology proves relatively straightforward and cost-effective. Furthermore, evaluating baseline emissions can be facilitated by referring to an expired CDM standardized baseline, which could potentially be updated.
Carbon finance	3/4. Improved cookstoves are likely to access carbon finances due to the prevalence of co-benefits and their extensive inclusion in Rwanda's NDC and TNA. Additional financing may not be necessary due to the low costs associated with this technology. However, directly linking this technology to multiple sectors in the NGHGI may present challenges when allocating emission reductions.	3/4. Small hydropower technologies may struggle to access carbon finance due to concerns about environmental and social impacts such as the risks of displacement of local communities, alteration of natural river ecosystems, and potential conflicts over water resources. However, the technology has been expressed in the NDC which is a positive indicator for carbon attracting finance. This technology also aligns with the energy sector of the NGHGI, making it easy to allocate the resulting emission reductions to a single sector.	3/4. Landfill gas destruction technology has been emphasised in Rwanda's NDC and is likely to access carbon finances on account of the prevalence of co-benefits. However, these technologies may fall into both the waste and energy sectors of the NGHGI, making it challenging to allocate the resulting emission reductions to a single sector.	3/4. E-cooking is likely to access carbon finances due to the prevalence of co-benefits. Carbon finances may play a significant role in covering these costs. However, this technology is not fully expressed in Rwanda's NDC and lacks alignment with policy goals. Furthermore, it is directly linked to the energy sector of the NGHGI, allowing emission reductions to be attributed to this sector.	3/4. Waste-to-energy technology finds expression within Rwanda's NDC and is likely to access carbon finances on account of the prevalence of co-benefits. However, this technology straddles both the waste and energy sectors of the NGHGI, posing challenges when apportioning emission reductions arising from this technology.
Grand Total	**83**	**81**	**75**	**74**	**74**

Table 24: Multicriteria assessment of top five technologies/activities for Sudan

Sudan					
	Soil and water conservation	**Solar PV**	**Composting**	**Smart irrigation technologies**	**Biogas production**
GHG mitigation potential	2/3. Water harvesting technologies have proven effective in reducing GHG emissions by preventing water runoff, soil erosion, and soil degradation. These technologies are highly scalable and can be implemented on a large scale, particularly in regions like Sudan, where they can meet water demands year-round and reduce unsustainable groundwater extraction. The impact of water harvesting on GHG emissions depends on the baseline situation and context of each region and hence cannot be assessed	3/3. The effectiveness of solar PV is well established in Sudan because the country has high levels of solar radiation. In addition to the high levels of solar radiation, Sudan has ample space for solar PV which indicates that it could be feasibly scaled up in the country. The electricity baseline in Sudan should favour the development of emission reduction projects, because the common practice for generating electricity is primarily based on thermal power plants, specifically oil-fired and gas-fired plants.	2/3. Such measures could be effective and scalable in Sudan due to the significant agricultural sector. The baseline emissions will depend on the specific project circumstances and therefore alignment with this indicator could not be ascertained.	2/3. Such technology has moderate GHG reduction potential and therefore is not seen to be very effective. However, such technology can be implemented on a large scale and contribute to substantial GHG mitigation. The baseline emissions will depend on the specific project circumstances and therefore alignment with this indicator could not be ascertained.	1/3. Biogas production technologies are effective at reducing GHG emissions but have not been widely implemented or explored extensively in Sudan. The lack of availability of the readymade biogas units is a barrier to scalability. The electricity baseline in Sudan should favour the development of emission reduction projects, because the common practice for generating electricity is primarily based on thermal power plants, specifically oil-fired and gas-fired plants.

Sudan					
	Soil and water conservation	**Solar PV**	**Composting**	**Smart irrigation technologies**	**Biogas production**
National priority	3/3. Soil and water conservation holds great national priority in Sudan due to its alignment with climate change policies, targets, and strategies, including the NDC. The technology not only enhances agricultural productivity and food security but also improves soil fertility and water availability, leading to increased crop yields and incomes for farmers. By promoting the adoption of sustainable practices, water harvesting protects ecosystems, reduces environmental risks, and fosters sustainable economic growth, creating employment opportunities in the agricultural sector. Moreover, it plays a crucial role in capacity building by equipping local communities with new skills and knowledge for effective natural resource management within Sudan.	3/3. Solar PV is reflected as a priority technology in both Sudan's NDA and TNA. In addition, solar PV has economic growth potential because it can generate employment opportunities in the project development, construction, operation, and maintenance stages. Other economic growth opportunities include the export potential of renewable energy, as well as the local provision of energy that is cost effective compared to fossils fuels which are often imported in Sudan. The development of solar PV in Sudan also has the potential to build capacity in the country, through technology transfers.	3/3. Composting of animal dung and forest residue has been discussed and disclosed within Sudan's TNA and composting has been briefly mentioned within the NDC. By implementing such technology, it will potentially allow for job creations to be made and allow for economic growth. Furthermore, such technology allows for capacity building as it promotes new skills, knowledge and capacities of Sudan's community,	3/3. Sudan's NDC recognises the importance of smart irrigation technologies as a national priority, considering their alignment with climate change policies, their potential for economic growth, and the capacity building opportunities they offer. The exemption of customs and fees for solar-powered irrigation equipment, as well as tax and duty exemptions for components of solar pumping systems, demonstrates Sudan's commitment to promoting and facilitating the adoption of these technologies in the country.	3/3. Biogas production has briefly been mentioned in Sudan's NDC and is recognised as the priority technology in the AFOLU sector in the TNA. Implementing this technology will allow for job creation and economic growth. Furthermore, it allows for capacity building as it promotes new skills, knowledge and capacities of Sudan's communities.

Sudan					
	Soil and water conservation	**Solar PV**	**Composting**	**Smart irrigation technologies**	**Biogas production**
Cost	2/3. The cost of implementation is influenced by the movement of earth and stonework, directly impacting expenses and labour intensity. In comparison to large-scale infrastructure projects or technology-intensive initiatives, the costs associated with soil and water conservation practices, including materials, labour, and training, are generally lower. However, this poses a challenge in demonstrating additionality, due to the affordability of these practices.	1/3. Solar can be costly. Typically, high project costs may be positive indicators for demonstrating additionality.	1/3. Composting has low costs associated with it, but the ability to achieve large GHG emission reductions is relatively low unless implemented on a large-scale. Furthermore, due to the low costs associated with such activities, it may be difficult to prove additionality.	3/3. Smart irrigation technologies in Sudan offer advantages in terms of capital and operational costs, cost-effectiveness, and potential additionality. With their relatively low capital costs, these technologies provide sustainable and efficient irrigation options. Furthermore, the exemption of customs and fees for solar-powered irrigation equipment, along with tax and duty exemptions for related components, supports the affordability and uptake of smart irrigation technologies in Sudan.	2/3. Biogas production in Sudan requires a substantial initial investment as a result of the components and implementation of such technology and incurs ongoing operational expenses. However, the ability to reduce GHG emission is relatively high. Therefore, biogas production is seen as quite a cost-effective technology. With the relatively high costs associated with such technology, the ability to prove additionality is possible.
Accessible	2/3. Simple and locally available methods like floodwater harvesting and contour schemes are particularly suitable for small-scale farmers and rural communities in Sudan's semi-arid zones, providing affordable and accessible solutions to water scarcity challenges. Such technology has low costs associated with it and therefore is seen affordable. There is a relatively high penetration rate for such activity at a relatively low cost and the ability to prove additionality might be difficult.	2/3. Solar PV is showing a trend of decreasing capital costs, which is encouraging as it can contribute to more affordable electricity prices. Sudan benefits from high radiation levels, making solar resources readily available. Solar PV is widely accepted by end users due to its renewable and clean nature. This accessibility and acceptability contribute to the potential for wider adoption of solar PV systems in the country. Demonstrating additionality, particularly for large-scale solar PV applications, is becoming increasingly difficult.	2/3. Such technology has low costs associated with it and therefore is seen as affordable. Furthermore, such technology has been successfully implemented in communities and therefore is acceptable and available. Due to the low costs associated with such technology, additionality might be difficult to prove.	2/3. These technologies have been introduced in certain regions of Sudan, particularly in areas with limited access to electricity or unreliable power supply. The exemption of customs and fees for solar-powered irrigation equipment has also contributed to their affordability. While the accessibility of smart irrigation technologies has been improving in Sudan, challenges remain in terms of awareness, financing, and technical support. As a result of the exemption and reasonable costs of this technology, it may be difficult to prove additionality.	1/3. Biogas production technology is currently not very accessible or affordable within Sudan. However, as a result of the low penetration rate and high costs of such technology in Sudan, the ability to prove additionality is likely.

Sudan					
	Soil and water conservation	**Solar PV**	**Composting**	**Smart irrigation technologies**	**Biogas production**
Co-benefits	3/3. Soil and water conservation practices and technologies in Sudan offer several co-benefits related to sustainable development, adaptation, and local value addition. These practices enhance soil fertility and structure, leading to increased agricultural productivity, ensuring food security, and contributing to sustainable development. Additionally, they help Sudan adapt to climate change conditions by conserving soil and water resources that are susceptible to climate impacts. Moreover, the implementation of these technologies supports local value chains, stimulates local industries, and promotes economic development in the region.	2/3. Solar PV has various sustainable development impacts related to socio-economic development, related to the provision of clean and affordable electricity. In addition, solar PV has local value addition potential, due to its potential to attract foreign investment and foster trade opportunities. The country's abundant solar resources make it an attractive destination for international solar companies and investors. Foreign direct investment can contribute to the development of solar PV infrastructure, technology transfer, and local manufacturing, stimulating economic growth.	3/3. Composting has the potential to improve air quality, health and environmental emissions. Furthermore, by implementing composting of animal dung and forest residue, it allows for the local communities of Sudan to adapt and become less vulnerable. Also, composting promotes job creation and creates a better, healthier environment for the local communities.	3/3. Smart irrigation technologies offer multiple co-benefits, including water conservation, energy efficiency, increased crop yield and quality, soil health improvement, and reduced labour and operational costs. By implementing such technology, it allows for the local communities of Sudan to adapt and become less vulnerable. This technology promotes job creation and creates a better, healthier environment for the local communities.	3/3. Biogas production technology in Sudan offers significant co-benefits for sustainable development, adaptation, and local value addition. It promotes local employment, provides reliable energy for household needs, reduces reliance on traditional fuels, and decreases deforestation. Proper dung management through biogas technology also addresses environmental concerns, reducing pollution and health hazards.

Sudan					
	Soil and water conservation	**Solar PV**	**Composting**	**Smart irrigation technologies**	**Biogas production**
Innovation	1/3 Soil and water conservation technologies have been greatly explored and is well established in Sudan and therefore is not novel., but market ready. Due to the low costs associated with such technologies, the ability to prove additionality might be challenging.	2/3. The market readiness for solar PV in Sudan is evident. However, solar PV is increasingly maturing in technology and is no longer a particularly disruptive technology. Furthermore, the additionality of solar PV, especially large-scale applications, is increasingly difficult to demonstrate.	1/3. Composting only meets the market readiness criterion. Furthermore, the low costs associated with composting limits the ability to prove additionality. Composting has been greatly researched and implemented and is therefore not very novel.	1/3. Solar irrigation initiatives in Sudan represent an innovative and potentially disruptive solution that can address the challenges faced in the agricultural sector. While smart irrigation technologies show promise and have been implemented in some regions of Sudan, their overall technical maturity across the country is still developing and is therefore not market ready. Furthermore, due to the relatively low costs associated with such technology, the additionality criterion may not be met.	2/3. Biogas production technology is quite novel in its features and sets them apart from other technologies in Sudan. However, these systems are not yet market ready or ready for deployment throughout the country due to accessibility constraints. These technologies are quite complex and have high costs associated with it. Therefore, it is probable that this technology will effectively prove additionality.
Proven	3/3. The technical maturity of soil and water conservation technologies in Sudan is well-established, reflecting their advanced stage of development and commercialisation, as well as their demonstrated performance and reliability. Replicability and scalability are crucial factors, with four types of water and soil conservation technologies demonstrating their ability to be implemented in different locations within Sudan. Water harvesting is significant as it is ranked as the fifth priority in Sudan's TNA for addressing soil and water conservation.	2/3. The technical maturity, performance records and replicability of solar PV are well established. Given the rate of sunshine in Sudan, the exploitation is not optimum, and the performance of existing plants is disappointing.	1/3. Specific information about the extent of composting practices and their maturity in Sudan is limited, but there are plans to implement composting more within Sudanese communities. Such technology has the ability to be easily replicated and can be distributed to different locations within the region.	1/3. The implementation of smart irrigation technologies in Sudan has shown promise and yielded positive results in specific regions, but their overall technical maturity across the entire country is still evolving. Efforts to raise awareness, build trust among stakeholders, and ensure easy access to financing and technical support are vital to further advance the technical maturity and wider adoption of these technologies throughout Sudan's agricultural landscape. Such technology can be easily replicated as it can be distributed at a large scale.	2/3. Biogas production technology in Sudan has demonstrated a certain level of technical maturity and performance records. Various organisations and institutions have successfully built and operated biogas units in the country. However, the full replicability of this technology remains challenging and expensive due to the complex implementation process, particularly the crucial requirement of water availability. Despite these challenges, the existence of operational biogas plants in Sudan showcases the reliability of the technology and its potential for further development and replication in suitable contexts.

Sudan					
	Soil and water conservation	**Solar PV**	**Composting**	**Smart irrigation technologies**	**Biogas production**
MRV	1/3. Water and soil conservation technologies in Sudan, including water harvesting, may require more complex monitoring due to specific project requirements. While monitoring costs can vary, they are generally considered economical, except when involving remote sensing. Evaluating the baseline and any project emissions will depend on the specific project context and therefore alignment with this indicator could not be ascertained.	3/3. The ease of baseline and project monitoring solar PV is well established, which lends to low costs of monitoring.	2/3. Monitoring of composting is simple assuming the relevant technology, such as weighbridges is available. However, such equipment may be costly.	3/3. Such technology will have relatively low monitoring costs and will be relatively easy to monitor.	3/3. Such technology will have relatively low monitoring costs and will be relatively easy to monitor.
Carbon finance	3/4 Soil and water conservation activities are likely to access carbon finances due to prevalence of co-benefits. They are prioritised within the NDC and TNA. The activities might be linked to multiple sectors in the NGHGI which may pose difficulties when apportioning emissions reductions. Carbon financing may cover significant proportion of activity costs.	2/4. Sudan prioritises solar PV in its NDC, and such applications are easily aligned with the energy sector in NGHGIs. However, solar PV projects may face challenges in accessing carbon finance due to concerns about the additionality of such technologies, as well as the limited number of co-benefits, compared to other project activities. In addition, carbon finances are unlikely to cover a material portion of large-scale solar PV costs	4/4 Waste composting could feasibly attract carbon finance in Sudan due to prevalence of co-benefits. It is also well aligned with the waste sector in the NGHGI. Waste composting is also discussed within Sudan's NDC. Due to the relatively low costs associated with such technology, additional finances may not be required.	2/4 Such technology is likely access carbon finance due to prevalence of co-benefits. It has also been greatly expressed within their NDC and TNA. Due to the low costs associated with such technology, additional finances may not be required. However, such technology could be apported to the energy or the AFOLU sectors of the NGHGI, which may be a challenge if used as ITMOs.	3/4 Such technology could feasibly attract carbon finance due to prevalence of co-benefits. It is well aligned with the waste sector in the NGHGI. Such technology is discussed within Sudan's NDC. However, due to the relatively high capital costs associated with such technology, additional finances may be required.
Grand Total	80	75	72	72	72

Table 25: Multicriteria assessment of top five technologies/activities for Tanzania

Tanzania					
	Biofuel	**Biomass to energy**	**Small/micro-hydropower**	**Sustainable charcoal production**	**Solar PV**
GHG mitigation potential	3/3. Biofuel technology proves effective in significantly reducing GHG emissions. Moreover, Tanzania's abundant biomass and agricultural resources allow for large-scale implementation, resulting in substantial GHG emission reductions. The baseline scenario, which involves the use of fossil fuel vehicles and equipment, should provide the necessary substantiation for emission reductions.	2/3. Biomass to energy technology proves highly effective in reducing a significant amount of GHG emissions. Tanzania's abundant biomass resources make it suitable for large-scale implementation, resulting in substantial GHG emission reductions. However, the moderate grid emission factor is likely to limit the magnitude of emission reductions achievable through this technology.	2/3. Small hydro technology has the potential to significantly reduce GHG emissions. Tanzania's abundant hydro resources enable the large-scale implementation of such technology, leading to substantial emission reductions. However, the moderate grid emission factor may constrain the extent of emission reductions achievable through this technology.	2/3. For sustainable charcoal production in Tanzania to significantly reduce GHG emissions it needs to be scaled up, which could lead to substantial GHG emission reductions. The typically high emissions intensities associated with charcoal use in the baseline scenario may contribute to achieving emission reductions through the production of improved charcoal.	2/3. Solar photovoltaic (PV) technology has the potential to significantly reduce GHG emissions. Moreover, due to the abundance of solar resources in Tanzania, this technology can be implemented on a large scale, leading to substantial emission reductions. However, the moderate grid emission factor may limit the extent of emission reductions achievable with this technology.
National priority	3/3. Biofuel technology has been extensively discussed and disclosed within Tanzania's NDC. Implementing this technology holds the potential for job creation, economic growth, and capacity building, fostering new skills, knowledge, and capabilities within Tanzania's community.	3/3. Biomass to energy technology has been thoroughly discussed and disclosed within Tanzania's NDC. Implementing this technology holds the potential for job creation, economic growth, and capacity building, promoting new skills, knowledge, and capabilities within Tanzania's community.	3/3. Small hydro technology has been extensively discussed and disclosed within Tanzania's NDC. Implementing this technology holds the potential for job creation, economic growth, and capacity building, fostering new skills, knowledge, and capabilities within Tanzania's community.	3/3. Sustainable charcoal production has been extensively discussed and disclosed within Tanzania's NDC and aligns with their climate change policies. Implementing this technology holds the potential for job creation, economic growth, and capacity building, promoting new skills, knowledge, and capabilities within Tanzania's community.	3/3. Solar PV technology has been extensively discussed and disclosed within Tanzania's NDC. Its implementation has the potential to create job opportunities, foster economic growth, and facilitate capacity building by promoting new skills, knowledge, and capabilities within Tanzania's community.

Tanzania					
	Biofuel	**Biomass to energy**	**Small/micro-hydropower**	**Sustainable charcoal production**	**Solar PV**
Cost	2/3. Biofuel technologies are proven to be cost-effective at reducing GHGs. However, biofuel technologies and applications can be costly. Typically, high project costs may be positive indicators for demonstrating additionality.	2/3. Biomass to energy technology in Tanzania comes with relatively high capital and operational costs while effectively reducing a significant amount of GHG emissions. Typically, high project costs may be positive indicators for demonstrating additionality.	2/3. While effective at reducing GHG emissions, small hydro technology in Tanzania comes with relatively high capital costs. Typically, high project costs may be positive indicators for demonstrating additionality.	2/3. Sustainable charcoal production in Tanzania comes with relatively low capital and operational costs while effectively reducing a significant amount of GHG emissions. This makes it highly cost-effective. However, the low costs associated with this technology may pose challenges in proving additionality.	2/3. In Tanzania, solar PV technology comes with relatively high capital costs while effectively reducing a significant amount of GHG emissions. This makes it highly cost-effective. Typically, high project costs may be positive indicators for demonstrating additionality.
Accessible	2/3. The costs of energy from biofuel technologies can be relatively high due to the relatively high capital and operating costs. While the technology could be accessible due to the good potential to develop feedstocks, it may not be acceptable due to food security concerns. However, the fairly high costs of the technology and fairly low penetration rate are positive indicators for additionality.	2/3. According to Tanzania's TNA, biomass to energy technology is not easily accessible. The fairly high costs of the technology and fairly low penetration rate are positive indicators for additionality.	2/3. Such technology is readily accessible within Tanzania due to good hydro resources. Moreover, affordability of hydro power increases its accessibility. However, its widespread use may make proving additionality more difficult.	2/3 Sustainable charcoal is still a relatively new concept in Tanzania and therefore may not be widely accessible or accepted. However, due to its affordability resulting from low costs, it is seen as a very affordable activity. The low penetration rate may facilitate proving additionality.	2/3. Solar PV technology is highly accessible within Tanzania, and its affordability further enhances its appeal. However, due to its widespread use and reducing technology costs, demonstrating additionality may be more challenging.
Co-benefits	3/3. Biofuel technology contributes to sustainable development by reducing biomass consumption and creating a cleaner environment and atmosphere for communities. Moreover, implementing this technology allows Tanzania's local community to adapt and become less vulnerable, while promoting job creation and fostering a healthier environment.	3/3. Biomass to energy technology contributes to sustainable development by reducing biomass consumption, creating a cleaner environment and atmosphere for communities. Furthermore, its implementation enables Tanzania's local community to adapt and become less vulnerable while fostering job creation and a healthier environment.	3/3. Small hydro technology allows for the reduction of GHG emissions and contributes to sustainable development by providing accessible and clean energy. Additionally, it enables Tanzania to adapt to climate change conditions through diversified energy sources. This technology is also expected to create local value addition by stimulating industries that rely on consistent power supplies.	3/3. Implementing sustainable charcoal production contributes to sustainable development by producing a more sustainable and eco-friendly charcoal product. This product helps create a cleaner environment and atmosphere for communities. Furthermore, it enables Tanzania's local community to adapt and become less vulnerable while promoting job creation and fostering a better, healthier environment.	3/3. Implementing solar PV technology contributes to sustainable development by providing renewable energy to Tanzania and creating a cleaner environment and atmosphere for communities. Furthermore, it enables Tanzania's local community to adapt, become less vulnerable to climate change impacts, and promotes job creation, fostering a better, healthier environment.

Tanzania					
	Biofuel	**Biomass to energy**	**Small/micro-hydropower**	**Sustainable charcoal production**	**Solar PV**
Innovation	3/3. Biofuel technology is still a new concept within Tanzania, making it novel in its features. However, it is market-ready and deployable in real-life settings. Given the low penetration rate of this technology in Tanzania, proving additionality is likely.	2/3. Biomass to energy technology has been available for some time and does not introduce novel features. However, it is market-ready and can be deployed in real-life settings. Given the low penetration rate of this technology in Tanzania, proving additionality is likely.	1/3. Small hydro technology has been in existence for a considerable time and does not introduce any new or novel features. However, it is market-ready and can be deployed in real-life settings. The high penetration rate and low costs associated with this technology in Tanzania may present challenges in proving additionality.	2/3. Sustainable charcoal production has not been implemented extensively within Tanzanian communities and is still in its early stages, yet it can be easily replicated on a large scale and distributed to communities and households. Given the low penetration rate of this technology in Tanzania, proving additionality is likely.	1/3. Solar PV technology has been in use for some time and does not introduce any new or novel features. However, it is market-ready and can be effectively deployed in real-life settings. The high penetration rate and low costs of this technology in Tanzania may present challenges in proving additionality.
Proven	3/3. Biofuel technology has been successfully implemented in numerous communities and households across Tanzania and has reached maturity. Adequate feedstocks could facilitate replication.	3/3. Biomass to energy is a mature technology. It may be replicated fairly easily assuming that the feedstocks are readily available.	3/3. Small/micro hydro power is a proven technology. Excellent hydro resources facilitate replication.	1/3. Sustainable charcoal production is proven however it has not been widely utilised or replicated in Tanzania.	2/3. PV technology is relatively easy to monitor, and the associated monitoring costs are relatively low. The baseline emissions from the electricity sector, primarily driven by fossil fuel sources, should facilitate the generation of emission reductions.
MRV	0/3. Such technology will have relatively high monitoring costs however and relatively difficult to monitor. The evaluation of the baseline emissions might be difficult if there are inadequate records or information.	3/3. Biomass to energy technology is relatively easy to monitor with relatively low monitoring costs. The baseline emissions from the electricity sector, mainly from fossil fuel sources, should be quantifiable.	3/3. Hydro technology is relatively easy to monitor, and the associated monitoring costs are relatively low. The baseline emissions from the electricity sector, mainly derived from fossil fuel sources, should be quantifiable.	2/3. Such technology will have relatively low monitoring costs and will be relatively easy to monitor. The evaluation of the baseline emissions will depend on the project scenario and hence alignment with this indicator could not be ascertained.	3/3. PV technology is relatively easy to monitor, and the associated monitoring costs are relatively low. The baseline emissions from the electricity sector, primarily driven by fossil fuel sources, should be quantifiable.

Tanzania					
	Biofuel	**Biomass to energy**	**Small/micro-hydropower**	**Sustainable charcoal production**	**Solar PV**
Carbon finance	1/4. Biofuels may encounter challenges accessing carbon finances due to concerns regarding food security. However, biofuel aligns with Tanzania's NDC. Additional financing may be required due to the high costs associated with implementing this technology. It is worth noting that biofuel technology can be linked to multiple sectors within the NGHGI, posing difficulties when apportioning emission reductions.	4/4. Biomass to energy technology may have access to carbon finances due to the prevalence of co-benefits. It has been strongly emphasised in Tanzania's NDC and TNA. Additional financing may be required due to the relatively high costs associated with implementing this technology. Moreover, this technology is linked to the energy sector of the NGHGI, allowing for the use of emission reductions within the energy sector.	2/4 Hydro technology may encounter challenges in accessing carbon finances due to socio and environmental concerns. However, it has received significant emphasis within Tanzania's NDC and TNA. Additional financing may be required due to the relatively high costs associated with this technology. Furthermore, hydro technology is directly linked to the energy sector of the NGHGI, allowing the use of emission reductions within that sector.	4/4. Such technologies are likely to access carbon finances due to the prevalence of co-benefits. They align with Tanzania's NDC and TNA. Due to the relatively low costs associated with these measures, additional financing may not be required. Furthermore, they can be linked to the AFOLU sector in the NGHGI, facilitating the apportionment of emission reductions.	2/4. Solar PV technology may encounter challenges in accessing carbon finances due to concerns related to additionality and the limited prevalence of co-benefits. Despite being prominently expressed in Tanzania's NDC and TNA, additional financing may be necessary due to the relatively high costs associated with this technology. Solar PV is closely linked to the energy sector of the NGHGI, making the allocation of emission reductions for this sector more relevant.
Grand Total	84	81	78	76	73

Table 26: Multicriteria assessment of top five technologies/activities for Uganda

Uganda					
	Improved livestock management	**Biomass to energy**	**Improved Cook Stoves**	**Solar PV**	**Composting**
GHG mitigation potential	3/3. This activity exhibits a significant potential for reducing GHG emissions. Moreover, its ability to be widely distributed enables substantial GHG mitigation. The baseline for improved livestock management will be current practices which have GHG impacts, which should therefore substantiate emission reductions or removals from such activities.	3/3. This activity exhibits significant potential for reducing GHG emissions. Furthermore, its scalability allows for substantial GHG mitigation. The standardized grid emission factor for Uganda facilitates the generation of emission reductions.	2/3. The effectiveness in reducing GHGs and the scalability of improved cookstoves are well recognised. However, determination of the baseline values, especially the fNRB values, will depend on each project area and could not be assessed in this study.	3/3. Due to its high emission reduction potential and cost-effectiveness, Solar PV technology is widely regarded as an effective renewable energy solution. It is easily scaled in Uganda due to excellent solar resources. The standardized grid emission factor for Uganda facilitates the generation of emission reductions.	2/3. While the ability of this technology to reduce GHG emissions is not substantial, its potential for large-scale implementation contributes to significant emission reductions. The baseline emissions will depend on the specific context of each project and could therefore not be assessed in this study.
National priority	3/3. Livestock management has been extensively discussed and disclosed within Uganda's NDC. Its implementation has the potential to create job opportunities, foster economic growth, and facilitate capacity building by promoting new skills, knowledge, and capabilities within Uganda's community.	3/3. Biomass to energy activities, specifically sustainable charcoal production, has been extensively discussed and disclosed within Uganda's NDC. Its implementation has the potential to create job opportunities, drive economic growth, and facilitate capacity building by promoting new skills, knowledge, and capabilities within Uganda's community.	3/3. Improved cookstoves have been extensively discussed and disclosed within Uganda's TNA and NDC. Implementing this technology has the potential to generate job opportunities, stimulate economic growth, and facilitate capacity building by promoting new skills, knowledge, and capabilities within Uganda's community.	3/3. Solar PV systems have been extensively discussed and disclosed within Uganda's TNA and NDC. Implementing this technology has the potential to generate job opportunities, stimulate economic growth, and facilitate capacity building by promoting new skills, knowledge, and capabilities within Uganda's community.	3/3. Composting methods, such as bio latrines, have been extensively discussed and disclosed within Uganda's TNA and NDC. Implementing this technology has the potential to generate job opportunities, stimulate economic growth, and facilitate capacity building by promoting new skills, knowledge, and capabilities within Uganda's community.

Uganda					
	Improved livestock management	**Biomass to energy**	**Improved Cook Stoves**	**Solar PV**	**Composting**
Cost	2/3. Livestock management demonstrates the capacity to effectively reduce a significant amount of GHG emissions at relatively low costs. Consequently, the low costs associated with this technology may make it challenging to prove additionality.	2/3. Biomass to energy technology, such as improved charcoal kilns, has the ability to significantly reduce GHG emissions at relatively low costs. Consequently, the low costs associated with this technology may make it challenging to prove additionality.	2/3. This technology offers cost-effective solutions, with low capital and operating costs. Moreover, in relation to its cost, it effectively reduces GHG emissions. However, the low costs associated with this technology may pose challenges in proving additionality.	2/3. This technology offers affordable prices in relation to its capital and operating costs. Additionally, it effectively reduces emissions in relation to its cost. However, the low costs associated with this technology may pose challenges in proving additionality.	1/3. Composting is a cost-effective solution; however, its ability to achieve significant GHG emission reductions is relatively low. The low cost associated with this technology may present challenges in proving additionality.
Accessible	2/3. This technology is easily accessible in Uganda, and its affordability further enhances its feasibility. However, due to its low costs and high accessibility, demonstrating additionality may present difficulties.	2/3. This technology is easily accessible in Uganda, and its affordability enhances its feasibility. However, due to its low costs and high accessibility, meeting the additionality requirement may prove difficult.	3/3. Due to its affordability and accessibility, this technology can be readily adopted within Ugandan communities. Furthermore, given its low penetration rate, demonstrating additionality is likely.	2/3. This technology offers affordable prices in relation to its capital and operating costs. Additionally, it effectively reduces emissions in relation to its cost. However, the low costs associated with this technology may pose challenges in proving additionality.	2/3. This technology is affordable and accessible in Uganda, with successful implementations in communities and schools. Its acceptance and availability are widespread. Due to the low costs associated with this technology, proving additionality may be challenging.
Co-benefits	3/3. Implementing livestock management contributes to sustainable development by reducing livestock emissions and enabling Uganda's local community to adapt and become less vulnerable to environmental challenges. Furthermore, it promotes job creation and fosters a better, healthier environment for the local community.	3/3. Implementing biomass to energy technology contributes to sustainable development by reducing biomass consumption, creating a cleaner environment and atmosphere for communities. Furthermore, it enables Uganda's local community to adapt and become less vulnerable to environmental challenges. This technology also promotes job creation and fosters a better, healthier environment for the local community.	3/3. Implementing this technology effectively reduces biomass usage and GHG emissions while creating a healthier cooking environment for households and minimising smoke generation. It also enables communities and households to adapt to climate change impacts, fostering local value chains and stimulating local industries.	3/3. Solar PV technology enables the reduction of GHG emissions and fosters sustainable development. It facilitates Uganda's adaptation to climate change conditions, provides sustainable electricity to households and communities, and promotes the creation of local value chains and stimulation of local industries.	3/3. Composting has the potential to improve air quality, health, and environmental emissions. Implementing this technology enables Uganda's local community to adapt, become less vulnerable, and promotes job creation, leading to a better and healthier environment.

Uganda					
	Improved livestock management	**Biomass to energy**	**Improved Cook Stoves**	**Solar PV**	**Composting**
Innovation	1/3. Livestock management has been in practice for a considerable period, making it a well-established technology. However, the low costs associated with this activity may pose challenges in proving additionality, thereby meeting only the market readiness criterion.	2/3. Biomass to energy technology, specifically sustainable charcoal production, offers a more novel approach to kilns and cooking. Although still in its early stages of implementation, it is market ready. However, proving additionality may be challenging due to the low costs associated with some of these technologies.	1/3. Although well-known, this technology does not introduce novel features but is market-ready for deployment in real-world settings. Furthermore, the low costs associated with this technology may pose challenges in proving additionality.	1/3. Although well-known in the renewable energy sector, Solar PV technology does not introduce novel features to the existing environment. Nevertheless, it is market-ready and deployable in real-world settings. However, its steadily reducing capital costs may present difficulties in proving additionality.	1/3. Composting is a proven activity and is therefore not particularly innovative. These activities do meet the market readiness criterion but may face challenges in proving additionality due to its low costs. Additionality would need to be demonstrated using a different approach, for example low application rates in the project area or lack of formal collection of such waste.
Proven	3/3. Livestock management has been successfully implemented and widely adopted within Ugandan communities, indicating its maturity as an activity. Its ease of replication lies in its ability to be easily distributed to numerous communities and households.	2/3. This technology has been successfully implemented in numerous communities and households across Uganda. Although it is still in the process of reaching maturity, its ease of distribution and use allows for easy replication.	3/3. This technology has been successfully implemented and proven in Ugandan communities, with documented evidence of its performance. Its simple components and design facilitate easy replication.	3/3. Solar PV technology has been proven to perform effectively in Uganda, with evidence and records of successful implementations. Its scalability due to good solar resources allows for easy replication in various regions and areas.	3/3. Composting has already been successfully implemented in Uganda, and there are plans to expand its distribution further within Ugandan communities. Its replication and distribution to different regions of Uganda are easily achievable.
MRV	2/3. Monitoring livestock management activities may incur high fees, notably due to complexities associated with the baseline and project monitoring.	3/3. Monitoring biomass to energy technology will incur relatively low costs and pose minimal difficulties. The valid CDM standardized baseline for the grid emission factor significantly reduced monitoring costs and complexity.	3/3. The expired CDM standardized baseline could feasibly be updated, which could significantly reduce monitoring costs and complexity.	3/3. Monitoring Solar PV technology incurs relatively low costs and presents minimal challenges. The valid CDM standardized baseline for the grid emission factor significantly reduced monitoring costs and complexity.	3/3. Monitoring composting activities is straightforward, assuming the availability of relevant technologies such as weighbridges.

Uganda					
	Improved livestock management	**Biomass to energy**	**Improved Cook Stoves**	**Solar PV**	**Composting**
Carbon finance	4/4. Carbon finances are expected to be accessible due to the prevalence of co-benefits. Livestock management has been prominently expressed in their NDC and TNA. Due to the low costs associated with this technology, additional financial support may not be necessary. Furthermore, as it is directly linked to the AFOLU sector of the NGHGI, its emission reductions can be attributed to this sector.	3/4. Carbon finances are expected to be accessible due to the prevalence of co-benefits. In particular, sustainable charcoal production has been strongly emphasised in the NDC and TNA. Due to the low costs associated with this technology, additional financial support may not be required. However, as biomass to energy can be directly linked to multiple sectors in the NGHGI, apportioning the emission reductions may pose challenges.	3/4. Carbon finances are expected to be accessible due to the prevalence of co-benefits. The technology has received significant emphasis within the NDC and TNA. Due to their cost-effectiveness, additional financial support may not be required. However, as cookstoves can be directly linked to multiple sectors in the NGHGI, apportioning the emission reductions may present challenges.	2/4. Solar PV may encounter challenges in accessing carbon finance due to concerns regarding additionality and the limited prevalence of co-benefits. It has been emphasised within Uganda's NDC. Additional financial support may be required due to the relatively high costs associated with this technology. Solar PV aligns with the energy sector of the NGHGI, allowing its emission reductions to contribute to that sector.	4/4. Carbon finances are expected to be accessible due to the prevalence of co-benefits. Composting activities have been prominently emphasised within the NDC and TNA. Due to the low costs associated with this technology, additional financial support may not be required. The emission reductions arising from this technology can be directly linked to the waste sector, allowing its emission reductions to contribute to that sector.
Grand Total	88	85	84	83	82

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