CLIMATE CHANGE
10/2023

Urban market approaches under Article 6 of the Paris Agreement – Recommendations for practical implementation

Final report

by:

Erin Danford, Ruth Kassaye and Sonja Butzengeiger
Perspectives Climate Research, Freiburg
Sarah Catto, Tarryn Quayle
ICLEI Africa, Cape Town

publisher:
German Environment Agency

German Environment Agency

Umwelt Bundesamt

CLIMATE CHANGE 10/2023

Project No. (FKZ) 153378
FB000957/ENG

Urban market approaches under Article 6 of the Paris Agreement – Recommendations for practical implementation

Final report

by

Sonja Butzengeiger, Erin Danford and Ruth Kassaye
Perspectives Climate Research, Freiburg

Sarah Catto, Tarryn Quayle

ICLEI Africa, Cape Town

On behalf of the German Environment Agency

Imprint

Publisher
Umweltbundesamt
Wörlitzer Platz 1
06844 Dessau-Roßlau
Tel: +49 340-2103-0
Fax: +49 340-2103-2285
buergerservice@uba.de
Internet: www.umweltbundesamt.de

/umweltbundesamt.de
/umweltbundesamt

Report performed by:
Perspectives Climate Research
Hugstetter Str. 7
79106 Freiburg im Breisgau
Germany

Report completed in:
April 2022

Edited by:
Section V 2.6 Emissions Reductions Projects – CDM (NDA)/JI (DFP)
Kruse, Marcel German Emissions Trading Authority

Publication as pdf:
http://www.umweltbundesamt.de/publikationen

ISSN 1862-4359

Dessau-Roßlau, March 2023

Abstract: Urban market approaches under Article 6 of the Paris Agreement – Recommendations for practical implementation

The main purpose of this report is to develop concrete structures for the use of urban carbon market approaches under Article 6 of the Paris Agreement for Addis Ababa (Ethiopia) and Kampala (Uganda). The report takes into account both ongoing and planned emission reduction measures, so that the results of this report can be used effectively by the two countries. Section 1 presents an analysis of the status quo in Addis Ababa and Kampala, highlighting emissions profiles, existing and planned urban activities and their potential for use under Article 6. Section 2 examines the key national and local stakeholders in both cities, presenting recommendations for cooperation in upcoming case studies related to urban Article 6 activities. Section 3 is comprised of two cases studies each for Addis Ababa and Kampala, providing four potential concepts that could be further developed into Article 6 activities. Emission reduction potential and investment costs have been estimated for each project, along with suspected practical challenges that may arise during the implementation process.

Kurzbeschreibung: Urbane Marktansätze unter Article 6 des Pariser Abkommens – Handlungsempfehlungen für die praktische Umsetzung

Der Hauptzweck dieses Berichts besteht darin, konkrete Strukturen für die Nutzung von städtischen Kohlenstoffmarktansätzen gemäß Artikel 6 des Pariser Abkommens für Addis Abeba (Äthiopien) und Kampala (Uganda) zu entwickeln. Der Bericht berücksichtigt sowohl laufende als auch geplante Emissionsminderungsmaßnahmen, so dass die Ergebnisse dieses Berichts von den beiden Ländern effektiv genutzt werden können. Abschnitt 1 enthält eine Analyse des Status quo in Addis Abeba und Kampala, in der die Emissionsprofile, die bestehenden und geplanten städtischen Aktivitäten und ihr Potenzial für die Anwendung von Artikel 6 hervorgehoben werden. In Abschnitt 2 werden die wichtigsten nationalen und lokalen Akteure in beiden Städten untersucht und Empfehlungen für die Zusammenarbeit bei künftigen Fallstudien im Zusammenhang mit städtischen Artikel-6-Aktivitäten gegeben. Abschnitt 3 umfasst jeweils zwei Fallstudien für Addis Abeba und Kampala, in denen vier potenzielle Konzepte vorgestellt werden, die zu Artikel 6-Aktivitäten weiterentwickelt werden könnten. Für jedes Projekt wurden das Emissionsminderungspotenzial und die Investitionskosten abgeschätzt, ebenso wie die vermuteten praktischen Herausforderungen, die bei der Umsetzung auftreten können.

Table of contents

List of figures

List of tables

List of abbreviations

AACTA	Addis Ababa City Transport Authority
AARTB	Addis Ababa Road and Transport Bureau
AFD	French Development Agency (Agence Française de Développement)
AfDB	African Development Bank
AFOLU	Agriculture, Forestry and Other Land Use
BAU	Business as Usual
BMU	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit)
BOT	Build-Operate-Transfer
BRT	Bus Rapid Transit
CBE	Commercial Bank of Ethiopia
CCD	Climate Change Department
CCT	Controlled Cooking Test
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
Ci-Dev	Carbon Initiative for Development
CME	Coordinating/Management Entity
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
COMPOST NAMA	Creating Opportunities for Municipalities to Produce and Operationalise Solid Waste Transformation Nationally Appropriate Mitigation Action
CPA	Component Project Activity
CRGE	Climate-Resilient Green Economy
CVF	Climate Vulnerable Forum
DBE	Development Bank of Ethiopia
DNA	Designated National Authority
EAA	Eastern Africa Alliance on Carbon Markets and Climate Finance
EAEP	East Africa Energy Program
EEP	Ethiopian Electric Power
EEU	Ethiopian Electric Utility
EFCCC	Environment, Forests and Climate Change Commission
EIB	European Investment Bank
EPA	Environmental Protection Authority
EPC	Electric Pressure Cooker
ERA	Electricity Regulator Authority
ERC	Ethiopian Railway Corporation
EU-ITF	EU-Africa Infrastructure Trust Fund

FSC	Forest Stewardship Council
GDP	Gross Domestic Product
GEF	Global Environment Facility
GGGI	Global Green Growth Institute
GHG	Greenhouse Gas
GIZ	German Agency for International Cooperation (Deutsche Gesellschaft für Internationale Zusammenarbeit)
GKMA	Greater Kampala Metropolitan Area
GoE	Government of Ethiopia
ICS	Improved Cookstoves
ITMO	Internationally Transferred Mitigation Outcome
JCM	Joint Crediting Mechanism
JICA	Japan International Cooperation Agency
KACITA	Kampala City Traders' Association
KCCA	Kampala Capital City Authority
KfW	Credit Institute for Reconstruction (Kreditanstalt für Wiederaufbau)
km	Kilometer
KP1/2	Kyoto Period 1/2
$ktCO_2e$	Kiloton Carbon Dioxide Equivalent
LDC	Least Developed Country
LDV	Light Duty Vehicle
LPG	Liquified Petroleum Gas
LRT	Light Rail Transit
LUCF	Land Use Change and Forestry
MATS	Mobilising Article 6 Trading Structure
MDB	Multilateral Development Bank
MEMD	Ministry of Energy and Mineral Development
MOF	Ministry of Finance
MoFPED	Ministry of Finance, Planning and Economic Development
MoT	Ministry of Transport
MOWIE	Ministry of Water, Irrigation and Energy
MoWT	Ministry of Works and Transport
MRV	Measurement, Reporting and Verification
Mt CO_2e	Million Metric Tonnes of Carbon Dioxide Equivalent
MTIC	Ministry og Trade, Industry an Cooperatives
MW	Megawatt
MWE	Ministry of Water and Environment
NCCP	Uganda National Climate Change Policy
NDC	Nationally Determined Contribution

NEMA	National Environmental Management Authority
NEP	National Electrification Plan
NGO	Non-Governmental Organization
NMT	Non-Motorised Transit
NPA	National Planning Authority
NPV	Net Present Value
NWSC	National Water and Sewerage Corporation
PA	Paris Agreement
PCE	Policy Committee on Environment
PMV	Personal Motor Vehicle
PoA	Programme of Activities
RCC	Regional Collaboration Centre
SB	Standardised Baseline
SCF	Standardised Crediting Framework
SDG	Sustainable Development Goal
SEA	Swedish Energy Agency
SIDA	Swedish International Development Cooperation Agency
SMTE	Sheger Mass Transit Enterprise
SNC	Second National Communication
tCO_2e	Tons of Carbon Dioxide Equivalent
TPMO	Transport Project Management Office
UBA	Federal Environment Agency (Umwelt Bundesamt)
UBD	Uganda Development Bank
UBOS	Uganda National Bureau of Standards
ULGA	Uganda Local Government Association
UNDP	United Nations Development Programme
UNFCCC	United National Framework Convention on Climate Change
UNRA	Uganda National Roads Authority
URA	Uganda Revenue Authority
USD	United States Dollar
UWWM	Urban Wastewater Management
V20	Vulnerable Twenty
VCM	Voluntary Carbon Market
VCS	Voluntary Carbon Standard
VER	Verified Emission Reduction
WHO	World Health Organization
WWMS	Wastewater Management Strategy

Summary

The main purpose of this report is to develop concrete structures for the use of urban carbon market approaches under Article 6 of the Paris Agreement for Addis Ababa (Ethiopia) and Kampala (Uganda). The report takes into account both ongoing and planned emission reduction measures, so that the results of this report can be used effectively by the two countries.

Section 1.1 of the report starts with an overview of each country's greenhouse gas (GHG) emissions profile and their commitments in tackling adverse climate change impacts. In addition, the section presents each city's GHG emissions profile by sector and examines measures taken in reducing GHG emissions. Results show that both Ethiopia and Uganda have been active players in reducing GHG emissions. In its revised NDC, Ethiopia commits to reduce its business as usual (BAU) emissions projection in 2030 (estimated to be around 403.5 million metric tonnes of carbon dioxide equivalents (Mt CO_2e)) by 68.8% in the conditional pathway and by 14% in the unconditional pathway. This corresponds to a reduction of 277.7 Mt CO_2e to an annual emission level of 125.8 Mt CO_2e or to a reduction of 56 Mt CO_2e to 347.3 Mt CO_2e, respectively. The conditional target is contingent upon receiving international support. Similarly, the Ugandan nationally determined contribution (NDC) aims for a 22% reduction in emissions in 2030 compared to BAU, which is estimated to be around 77.3 Mt CO_2e per year in 2030. Uganda's mitigation target is conditional on 70% financing from international sources, with a domestic contribution of 30%. Addis Ababa's GHG emissions analysis show that the transportation sector shares the largest GHG emissions, i.e., around 68%; followed by waste (20%) and building (12%) sectors. In Kampala, results shows that the majority of GHG emissions are a result of the transport and household cooking sectors, due to the high use of charcoal and personal motorised transport.

Section 1.2 focuses on the carbon market and climate financing mechanisms experience of each country. Under the Kyoto Protocol, Ethiopia registered nine clean development mechanism (CDM) activities: two single projects and seven programme of activities (PoAs) with a total of 16 component project activities (CPAs). So far, CER issuance has been archived from four PoAs accounting for a total of over 750,000 CERs. The section also discusses Addis Ababa's carbon market experience. The city hosts four CPAs focusing on dissemination of improved cook stoves to households and one single CDM project in the landfill gas activity type. However, these activities have not issued CERs credits to date. On the other hand, Uganda hosts 24 project activities and 25 PoAs (including multi-country activities). These activities have generated over 13.40 million certified emission reductions (CERs) to date (more than 13 times the amount generated by Ethiopia), with 1.09 million during Kyoto Period one (KP1) and 12.30 million during Kyoto Period two (KP2). Of the 49 projects/PoAs, 10 are related to stoves, seven are reforestation/afforestation projects, seven are run of river projects, and other projects include landfill composting, solar lamps, manure and biodiesel projects. Overall, the largest proportions are related to reforestation and energy efficiency and generation.

Section 1.3 presents an overview of national and urban climate change policies. The section provides key targets of Ethiopia's climate policies, including Ethiopia's Urban Development Policy, Urban Wastewater Management Strategy, the 10-Year Development Plan, 10-Year Development Plan for the transport sector, Ethiopia's Climate-Resilient Transport Sector Strategy and Non-Motorised Transport Strategy. The section further provides an overview of Addis Ababa's resilience strategy and other initiatives and measures contributing to GHG emissions reduction. Likewise, the section discusses Uganda's key climate policies e.g., the National Climate Change Policy, Kampala Climate Change Action Strategy and GHG emissions potential across different sectors.

Chapter 2 focuses on the identification of key players in Article 6 implementation in both cities, highlighted in an informative table. Both the Kampala Capital City Authority and Addis Ababa Environment, Forest and Climate Change Commission will be key stakeholders in any future Article 6 activities.

Chapter 3 focuses of the development of four case studies in key sectors that can be developed into Article 6 pilot activities, including project-specific opportunities and challenges faced by the implementing agencies. Mitigation potentials are determined for every project, and the potential of Article 6 ITMOs to generate enough revenue to sustain the capital and operation costs is evaluated. The social impact generated by mitigation projects are also examined, with policy recommendations to local governments aimed at creating maximum resilience and limiting the negative indirect impacts of the projects.

Section 3.1 approaches the problem of transportation in Addis Ababa, proposing e-mobility activities to electrify the fleet and thus reduce transport sector emissions, which account for about 78% of the city's total emissions. Investment costs are identified as the major hurdle in transport adaptation and ITMOs are identified as the tool to circumvent this barrier, parallel to policy changes such as reduced taxes on e-vehicles, as well as subsidies and loans to catalyse public adoption. High and low capital expenditure scenarios are analysed, and the payback period is calculated, considering the higher initial CAPEX costs and lower maintenance and fuel costs. A public awareness campaign is also emphasised, raising program costs but maintaining a substantial positive NPV after 15 years.

Section 3.2 then focuses on green cooling in Addis Ababa, driven by the unreliability of the mainly hydro-powered energy grid and its consequences on medical facilities of Addis Ababa. Cheap electricity impedes a quick adoption of renewable solar power, and mismanagement has led to an unreliable central grid. The study therefore aims to provide reliable, clean cooling in Addis Ababa health facilities.

Section 3.3 also focuses on transport, introducing a bus rapid transit concept in Kampala. A program covering construction, purchase of vehicles, subsidisation of tickets and a public awareness campaign is developed, leading to high up-front investment costs. Potential emission reductions are calculated, based on estimated ridership and conversion from other forms of transit. The subsidised tickets scenarios are also analysed to get a clear picture of income from system operation. Necessary ITMO prices to fully sustain such a system are then estimated and the socio-environmental benefits duly mentioned, though ITMO prices would need to be extremely high to cover capital expenditure and operational costs of the system. Policy changes are also highlighted to address resistance from taxi and boda boda drivers, who could potentially lose income after implementation of a bus rapid transit system.

Section 4 focuses on the household cooking sector, which also contributes a large share of urban emissions. With a large share of households in Kampala accessing a relatively clean grid, electric cookstoves are promoted as a clean alternative to charcoal. Given the significant emission reduction potential of such a pilot, a comparatively low ITMO price is needed to fund the program.

Overall, this report gives detailed insight into the emissions profiles, climate policies and key players in Addis Ababa and Kampala, developing four case studies for potential development into Article 6 pilot activities. Based on stakeholder consultation and positive cost-benefit analysis, several case studies can be identified that hold significant potential for adoption in Uganda and Ethiopia, with the potential for replication across Africa and similar contexts.

Zusammenfassung

Der Hauptzweck dieses Berichts besteht darin, konkrete Strukturen für die Nutzung von städtischen Kohlenstoffmarktansätzen gemäß Artikel 6 des Pariser Abkommens für Addis Abeba (Äthiopien) und Kampala (Uganda) zu entwickeln. Der Bericht berücksichtigt sowohl laufende als auch geplante Emissionsminderungsmaßnahmen, so dass die Ergebnisse dieses Berichts von den beiden Ländern effektiv genutzt werden können.

Abschnitt 1.1 des Berichts beginnt mit einem Überblick über das Profil der Treibhausgasemissionen (THG) der beiden Länder und deren Verpflichtungen zur Bekämpfung der negativen Auswirkungen des Klimawandels. Darüber hinaus wird das Profil der Treibhausgasemissionen jeder Stadt nach Sektoren dargestellt und es werden die Maßnahmen zur Reduzierung der Treibhausgasemissionen untersucht. Die Ergebnisse zeigen, dass sowohl Äthiopien als auch Uganda aktiv an der Reduzierung der THG-Emissionen beteiligt sind. In seinem überarbeiteten NDC verpflichtet sich Äthiopien, seine für das Jahr 2030 prognostizierten Business-as-usual-Emissionen (schätzungsweise 403,5 Millionen Tonnen Kohlendioxidäquivalente (Mt CO2e)) um 68,8 % im bedingten Pfad und um 14 % im unbedingten Pfad zu reduzieren. Dies entspricht einer Reduzierung um 277,7 Mio. t CO2e auf ein jährliches Emissionsniveau von 125,8 Mio. t CO2e bzw. einer Reduzierung um 56 Mio. t CO2e auf 347,3 Mio. t CO2e. Das bedingte Ziel hängt vom Erhalt internationaler Unterstützung ab. In ähnlicher Weise zielt der ugandische national festgelegte Beitrag (NDC) auf eine 22%ige Verringerung der Emissionen im Jahr 2030 im Vergleich zum BAU ab, was schätzungsweise etwa 77,3 Mt CO2e pro Jahr im Jahr 2030 entspricht. Ugandas Minderungsziel ist an die Bedingung geknüpft, dass 70 % aus internationalen Quellen finanziert werden und der inländische Beitrag 30 % beträgt. Die Analyse der Treibhausgasemissionen in Addis Abeba zeigt, dass der Verkehrssektor mit rund 68 % den größten Anteil an den Treibhausgasemissionen hat, gefolgt von den Sektoren Abfall (20 %) und Gebäude (12 %). In Kampala zeigen die Ergebnisse, dass die meisten THG-Emissionen auf die Sektoren Verkehr und Kochen in den Haushalten zurückzuführen sind, was auf den hohen Einsatz von Holzkohle und den motorisierten Individualverkehr zurückzuführen ist.

Abschnitt 1.2 befasst sich mit den Erfahrungen der einzelnen Länder mit dem Kohlenstoffmarkt und den Klimafinanzierungsmechanismen. Im Rahmen des Kyoto-Protokolls hat Äthiopien neun Aktivitäten im Rahmen des Mechanismus für umweltverträgliche Entwicklung (Clean Development Mechanism - CDM) registriert: zwei Einzelprojekte und sieben Tätigkeitsprogramme (Programme of Activities - PoAs) mit insgesamt 16 Projektkomponenten (Component Project Activities - CPAs). Bisher wurden CERs aus vier PoAs ausgestellt, die insgesamt über 750.000 CERs umfassen. In diesem Abschnitt wird auch auf die Erfahrungen von Addis Abeba mit dem Kohlenstoffmarkt eingegangen. Die Stadt beherbergt vier CPAs, die sich auf die Verbreitung von verbesserten Kochherden an Haushalte konzentrieren, und ein einziges CDM-Projekt im Bereich Deponiegas. Für diese Aktivitäten wurden jedoch bisher keine CER-Gutschriften ausgestellt. In Uganda hingegen gibt es 24 Projekte und 25 PoAs (einschließlich länderübergreifender Aktivitäten). Diese Aktivitäten haben bis heute über 13,40 Millionen zertifizierte Emissionsreduktionen (CERs) generiert (mehr als das 13-fache der von Äthiopien generierten Menge), davon 1,09 Millionen in der ersten Kyoto-Periode (KP1) und 12,30 Millionen in der zweiten Kyoto-Periode (KP2). Von den 49 Projekte/PoAs beziehen sich 10 auf Kocher, sieben auf Aufforstungsprojekte, sieben auf Flusslaufprojekte und weitere auf Deponiekompostierung, Solarlampen, Dünger- und Biodieselprojekte. Insgesamt entfällt der größte Anteil auf die Wiederaufforstung und die Energieeffizienz und -erzeugung.

Abschnitt 1.3 gibt einen Überblick über die nationalen und städtischen Strategien zum Klimawandel. Der Abschnitt enthält die wichtigsten Ziele der äthiopischen Klimapolitik, einschließlich der äthiopischen Stadtentwicklungspolitik, der Strategie für städtisches Abwassermanagement, des 10-Jahres-Entwicklungsplans, des 10-Jahres-Entwicklungsplans für den Verkehrssektor, der äthiopischen Strategie für einen klimaverträglichen Verkehrssektor und der Strategie für den nicht motorisierten Verkehr. Der Abschnitt gibt außerdem einen Überblick über die Resilienzstrategie von Addis Abeba und andere Initiativen und Maßnahmen, die zur Reduzierung der Treibhausgasemissionen beitragen. Ebenso werden in diesem Abschnitt die wichtigsten klimapolitischen Maßnahmen Ugandas erörtert, z. B. die nationale Klimaschutzpolitik, die Kampala Climate Change Action Strategy und das Potenzial für THG-Emissionen in den verschiedenen Sektoren.

Kapitel 2 konzentriert sich auf die Identifizierung der Hauptakteure bei der Umsetzung von Artikel 6 in beiden Städten, die in einer informativen Tabelle hervorgehoben werden. Sowohl die Kampala Capital City Authority als auch die Addis Abeba Environment, Forest and Climate Change Commission werden bei allen zukünftigen Artikel 6-Aktivitäten wichtige Akteure sein.

Kapitel 3 konzentriert sich auf die Entwicklung von vier Fallstudien in Schlüsselsektoren, die zu Artikel 6-Pilotaktivitäten entwickelt werden können, einschließlich der projektspezifischen Möglichkeiten und Herausforderungen für die Durchführungsstellen. Für jedes Projekt wird das Minderungspotenzial ermittelt, und es wird das Potenzial von Artikel-6-ITMOs bewertet, genügend Einnahmen zu erzielen, um die Kapital- und Betriebskosten zu decken. Die sozialen Auswirkungen der Projekte werden ebenfalls untersucht und es werden politische Empfehlungen an die lokalen Regierungen ausgesprochen, die darauf abzielen, eine maximale Widerstandsfähigkeit zu schaffen und die negativen indirekten Auswirkungen der Projekte zu begrenzen.

Abschnitt 3.1 befasst sich mit dem Verkehrsproblem in Addis Abeba und schlägt Maßnahmen zur Elektromobilität vor, um den Fuhrpark zu elektrifizieren und so die Emissionen des Verkehrssektors zu verringern, die etwa 78 % der Gesamtemissionen der Stadt ausmachen. Die Investitionskosten werden als Haupthindernis für die Anpassung des Verkehrswesens identifiziert, und ITMOs werden als Instrument zur Umgehung dieser Hürde angesehen, parallel zu politischen Änderungen wie reduzierten Steuern auf E-Fahrzeuge sowie Subventionen und Darlehen, um die öffentliche Akzeptanz zu fördern. Es werden Szenarien mit hohen und niedrigen Investitionskosten analysiert und die Amortisationszeit wird unter Berücksichtigung der höheren anfänglichen Investitionskosten und der niedrigeren Wartungs- und Kraftstoffkosten berechnet. Außerdem wird eine Kampagne zur Sensibilisierung der Öffentlichkeit hervorgehoben, die zwar die Programmkosten erhöht, aber nach 15 Jahren einen beträchtlichen positiven Kapitalwert aufweist.

Abschnitt 3.2 befasst sich dann mit der umweltfreundlichen Kühlung in Addis Abeba, die durch die Unzuverlässigkeit des hauptsächlich mit Wasserkraft betriebenen Energienetzes und deren Folgen für die medizinischen Einrichtungen in Addis Abeba bedingt ist. Billiger Strom behindert eine schnelle Einführung von erneuerbarer Solarenergie, und Missmanagement hat zu einem unzuverlässigen zentralen Netz geführt. Ziel der Studie ist es daher, eine zuverlässige, saubere Kühlung in den Gesundheitseinrichtungen von Addis Abeba zu gewährleisten.

Abschnitt 3.3 konzentriert sich ebenfalls auf den Verkehr und stellt ein Busschnellverkehrskonzept in Kampala vor. Es wird ein Programm entwickelt, das den Bau, den Kauf von Fahrzeugen, die Subventionierung von Fahrkarten und eine Sensibilisierungskampagne für die Öffentlichkeit umfasst, was zu hohen Anfangsinvestitionskosten führt. Auf der Grundlage der geschätzten Fahrgastzahlen und der

Umstellung auf andere Verkehrsmittel wird die potenzielle Emissionsreduzierung berechnet. Die Szenarien für subventionierte Fahrkarten werden ebenfalls analysiert, um ein klares Bild der Einnahmen aus dem Systembetrieb zu erhalten. Die notwendigen ITMO-Preise, um ein solches System vollständig aufrechtzuerhalten, werden dann geschätzt, und die sozio-ökologischen Vorteile werden gebührend erwähnt, obwohl die ITMO-Preise extrem hoch sein müssten, um die Investitionsausgaben und Betriebskosten des Systems zu decken. Es werden auch politische Änderungen hervorgehoben, um dem Widerstand von Taxi- und Boda-Boda-Fahrern zu begegnen, die nach der Einführung eines Schnellbussystems möglicherweise Einkommensverluste erleiden könnten.

Abschnitt 4 konzentriert sich auf den Kochsektor der Haushalte, der ebenfalls einen großen Anteil an den städtischen Emissionen hat. Da ein großer Teil der Haushalte in Kampala Zugang zu einem relativ sauberen Stromnetz hat, werden elektrische Kochherde als saubere Alternative zu Holzkohle gefördert. Angesichts des erheblichen Emissionsreduktionspotenzials eines solchen Pilotprojekts ist ein vergleichsweise niedriger ITMO-Preis erforderlich, um das Programm zu finanzieren.

Insgesamt gibt dieser Bericht einen detaillierten Einblick in die Emissionsprofile, die Klimapolitik und die Hauptakteure in Addis Abeba und Kampala und entwickelt vier Fallstudien für eine mögliche Weiterentwicklung zu Artikel 6-Pilotaktivitäten. Auf der Grundlage der Konsultation von Interessenvertretern und einer positiven Kosten-Nutzen-Analyse können mehrere Fallstudien identifiziert werden, die ein erhebliches Potenzial für die Übernahme in Uganda und Äthiopien haben und in ganz Afrika und in ähnlichen Kontexten repliziert werden könnten.

1 Introduction

Cities are of great importance in global climate change adaptation and mitigation. Urban areas currently contribute more than 70% of global CO_2 emissions, and it is estimated that more than 60% of the world's population will live in cities by 2050 (Seto et al. 2014). The vast majority of the global increase in emissions (approximately 89%) will come from developing countries (IEA 2016).

At the same time, urban development can offer significant potential for emissions reduction. Measures such as energy efficiency upgrades have been characterised as the heavily sought-after 'low-hanging fruit', offering economic returns and comparatively straightforward implementation. Other measures, such as urban transport systems and improved waste management, can greatly improve the quality of life of urban inhabitants.

The emission reduction potential is highest in fast-growing countries with high urbanisation rates. This includes many cities in Africa – the continent with the highest projected urbanisation rate in the world – which are characterised by weak infrastructure and high vulnerability to the effects of climate change (Wall et al. 2018). At the same time, urban administrations in Africa face major hurdles to meet these challenges.

New approaches to international cooperation, such as the mechanisms defined in Article 6 of the Paris Agreement (PA), can help to overcome these barriers and thus help to realize urban climate protection activities on a large scale. Article 6 of the PA defines possibilities for cooperation between Parties to facilitate the fulfilment of their NDCs and thus enable an increase in ambition in the medium and long term.

Against this background, the Federal Environment Agency (UBA) commissioned a study in 2019, in which a basic concept for an Article 6 approach for small-scale climate protection projects in urban areas was developed (Butzengeiger et al. 2020). In the current study, the framework will be applied and practically developed in two African cities. For this purpose, the capital regions of Addis Ababa (Ethiopia) and Kampala (Uganda) were selected. The aim of the project is to develop concrete structures for the use of urban Article 6 activities in Addis Ababa (Ethiopia) and Kampala (Uganda). This should be done in a practical way, taking into account current and planned emission reduction measures, so that the results of the project can be used effectively by the two countries.

This report focuses on the current status quo of emissions reductions targets and Article 6 activities in Addis Ababa and Kampala. Section 1.1 details the emissions profiles and mitigation targets of the two cities, both nationally and locally. Section 1.2 then focuses on previous Article 6 activities in the areas and interaction with carbon markets. Section 1.3 takes a broader look at existing and planned urban climate protection policies at the national and local level, examining the context in which further Article 6 activities will be developed and highlighting the most promising projects for Article 6 engagement. Section 2.1 briefly describes the different stakeholders engaged in material topics like urban transport, heating/cooling, public infrastructure, electricity and waste in Addis Ababa and Kampala. The stakeholders are further divided by their capacity and influence as local/national authorities, financial sector bodies, international development partners or NGOs. Section 2.2 establishes the potential role played by the stakeholders in context of city specific projects. Section 3 then describes the individual potential mitigation projects in detail. Four case studies are presented to address the transportation, health and household cooking sectors. Emission reduction potential is calculated, as well as potential costs and ITMO

Overall, this report provides a structured overview of the emissions profiles, current and planned mitigation measures in Addis and Kampala and their basic suitability for the use of urban Article 6 activities, preparing a solid basis for further work packages.

1.1 Overview of emissions profile and mitigation targets

1.1.1 Ethiopia

National emissions profiles and mitigation targets overview

Ethiopia is a leading least developed country (LDC) with regards to the ambition and scope of its NDC (African Development Bank, AfDB, 2017a). The country is a member of the Climate Ambition Alliance, which aims to achieve net-zero GHG climate neutrality by 2050. Ethiopia is also a member of Vulnerable Twenty (V20) Group of Ministers of Finance (of the Climate Vulnerable Forum, CVF), which was established in 2015. The Group brings together economies vulnerable to climate change; and calls for, among other things, the removal of fossil fuel subsidies by 2020 and carbon pricing mechanisms by 2025.

Ethiopia submitted its updated NDC in December 2020. The updated NDC directly builds on the first NDC, the Climate-Resilient Green Economy (CRGE) strategy, and the 10-year Development Plan (2020/21-2029/30). The CRGE strategy was developed in 2011, aiming to transform the country into a carbon-neutral middle-income country before 2025 (GoE 2019a). The ten-year development plan lays out a long-term vision of making Ethiopia an "African Beacon of Prosperity" by creating the necessary conditions. The Plan addresses the importance of climate change adaptation and mitigation measures while strengthening the country's economic growth (GoE 2019a).

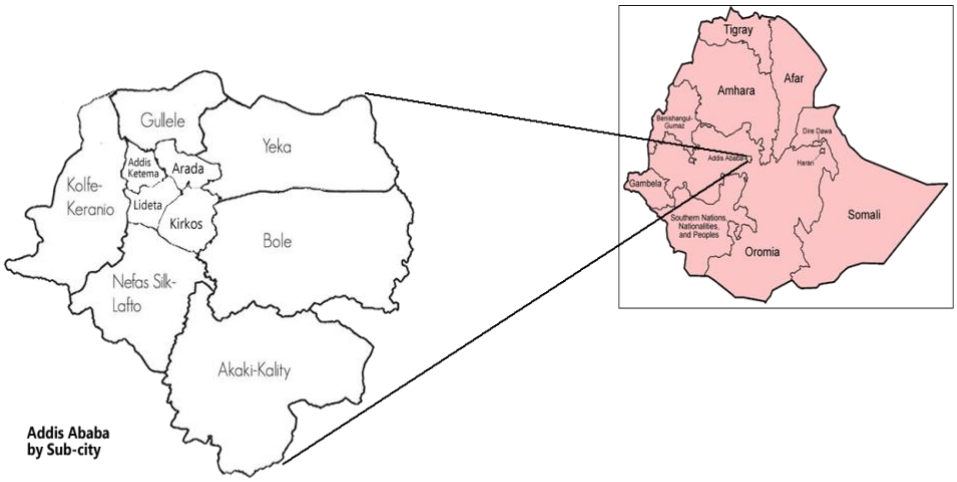
The newly updated NDC aims to reduce BAU GHG emissions (estimated to be around 403.5 Mt CO_2e in 2030) by 277.7 Mt CO_2e in the conditional pathway and by 56 Mt CO_2e in the unconditional pathway. The livestock sector is the main driver of GHG emissions, followed by the land use change and forestry (LUCF) sector. These two sectors are projected to represent more than 89% of total BAU GHG emissions in 2030, followed by the energy sector (10.7%) and waste sector (9.1%). While Ethiopia is committed to reduce around 56 Mt CO_2e using its domestic resources, it requires technical and financial support from the international community to meet the remaining 277.7 Mt CO_2e mitigation target by 2030. An estimated total of USD 316 billion is required to fully implement the revised NDC, of which around USD 275.5 billion will need to be dedicated to activities related to mitigation, and the remaining USD 40.5 billion will need to be allocated to adaptation interventions. Ethiopia is committed to domestically mobilise about USD 63.2 billion to fully implement its NDC target, i.e., 20% of the total budget (GoE 2021b). The remaining 80% is expected to be obtained from international support. Similar to the first NDC, Ethiopia's updated NDC envisages to benefit from Article 6 carbon markets activities. Moreover, Ethiopia is currently considering developing a voluntary domestic carbon market (GoE 2021b).

Overview of Addis Ababa's emissions profile

Addis Ababa is home to about 3.7 million inhabitants and is the single largest urban centre in Ethiopia, registering an annual growth rate of 3.8%. While the city represents only 3.6 % of Ethiopia's total population, Addis Ababa plays a pivotal role for Ethiopia's economic development and contributes 30% of the national urban gross domestic product (GDP). The city contributes 68% of total urban jobs in Ethiopia. In addition, the city hosts several international

organizations such as the African Union (AU) and the United Nations Economic Commission for Africa (UNECA) (Addis Ababa City Administration Office et al. 2020).

Figure 1: Addis Ababa by sub-city



Source: Sinshaw et al. 2019

Addis Ababa is working together with more 96 other cities to address the adverse impacts of climate change through the C40 network— a network of the world's cities committed to addressing climate change. The city received a C40 award for being among 11 best cities of 2016 for addressing climate change. The award recognized Addis Ababa's ambition in reducing GHG emissions through the Addis Ababa Light Rail Transit (LRT) Project (C40 2016a). In addition to its C40 membership, in May 2016, the city joined the 100 Resilient Cities network as part of its efforts to protect vulnerable communities from adverse climate change impacts and other physical, social, and economic challenges (Addis Ababa City Resilience Project Office 2018).

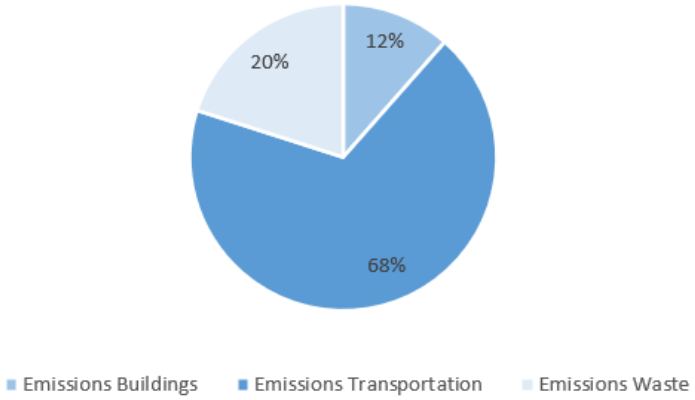
Local mitigation targets by sector

Transportation

Addis Ababa has a high pedestrian rate, accounting for about 54% of trips, followed by public transportation (31%) and personal motor vehicles (15%) (Addis Ababa City Administration Office 2018). While personal motor vehicles are the least common mode of transportation, the number of cars in the city has been rapidly increasing. The city has about 70% of registered cars in Ethiopia. Moreover, Addis Ababa's rapid population and economic growth are expected to have significant effect on the number of vehicles used in the city. The number of vehicles growth rate is estimated to be around 16% per year (C40 2020). Most imported cars in the city are reported to be highly-polluting used vehicles (Addis Ababa City Administration Office 2018; C40 2020) with an average age between 15 to 20 years (C40 2020).

As depicted in Figure 2 below, the transportation sector is reported to be the highest emitter of GHG emissions in Addis Ababa, accounting for about 68%, followed by emissions from the waste (20%) and building (12%) sectors (Global Covenant of Mayors for Climate and Energy 2015; C40 2020). Given that the city has the largest share of registered cars in Ethiopia, interventions in reducing GHG emissions from the transportation sector, for example through leapfrogging to e-mobility, railways and non-motorised transport, will have potential to significantly reduce not only Addis Ababa's total emissions but also Ethiopia's transportation sector emissions in general.

Figure 2: Emissions inventory of Addis Ababa



Source: Global Covenant of Mayors for Climate and Energy 2015

At the national level, the transportation sector emits an insignificant amount of GHG emissions compared to other sectors, such as the livestock sector and land use, land use change and forestry (LULUCF) sector. According to the 10-year Development Plan of the transport sector (2021-2030), GHG emissions reached 5.3 million tons CO_2e in 2016/17. Total GHG emissions are estimated to be around 41 million tCO_2e in 2030 under the BAU scenario (International Energy Agency 2018 as cited in Ministry of Transport 2020). Ethiopia envisages a reduction of around 13.9 million tCO_2e emissions from the sector by 2030 (Ministry of Transport 2020). The CRGE has identified four GHG abatement levers categories including improving the public transport system in Addis Ababa, improving vehicle efficiency, changing the fuel mix, and constructing an electric rail network for efficient freight transport (GoE 2019a).

Currently, Ethiopia has one national PoA, i.e., the Move-Ethiopia Zero-Carbon Mobility Units Program, which is in validation status. The PoA aims to reduce GHG emissions from the transport sector through introducing electric vehicles which are charged by grid electricity and solar power. The PoA has an estimated emission reduction potential of around 428 $ktCO_2e$ by 2020 and 1830 $ktCO_2e$ by 2030 (UNFCCC 2018b). Ethan Bio-Fuels PLC is the Coordinating/Managing Entity (CME) of the PoA.

Waste

The waste sector is the second most GHG emitting sector in Addis Ababa (Global Covenant of Mayors for Climate and Energy 2015). The city generates annually around 338,410 tons of solid waste[1], which is the largest amount compared to other cities in the country. Households share the largest solid waste generation, i.e., 70%; followed by public areas (10%), commercial institutes (9%), industries (6%), hotels (3%), hospitals (1%) and other sources (1%) (Tassie et al., 2019). A study shows that annually about 935,950 tCO_2e were emitted from the waste sector between 2013 and 2017 in the city (Ali & Tarekegn 2019).

Addis Ababa hosts one registered CDM project under the landfill gas activity type. The project aims to reduce methane (CH_4) emissions by collecting and flaring the landfill gas from the Repi/Koshe open dump, the only landfill in Addis. While the project has 96,884 tCO_2e annual average GHG emissions reduction potential, it has not yet issued CERs. Addis Ababa also generates the most wastewater in the country at 24,000 m^3/day (MoWIE 2017).

[1] For comparison, Berlin, which is the largest city in Germany with almost 3.7 million inhabitants, generated 1,350,457 tonnes of municipal solid waste in 2016 (Collectors Project 2020).

At the national level, the waste sector shares 9.14 Mt CO_2e of the total GHG emissions in 2020 (302.9 Mt CO_2e). Under the BAU scenario, GHG emissions in the waste sector are expected to increase from 9.1 Mt CO_2e to 11.5 Mt CO_2e in 2030. Under the conditional pathway (including unconditional mitigation actions), the sector has an abatement potential of 8.6 Mt CO_2e by 2030. From this total amount, Ethiopia is committed to reduce about 2 Mt CO_2e using its domestic resources; the remaining 6.6 Mt CO_2e is expected to be achieved through utilising international resources (GoE 2021b).

Ethiopia is a host country of a regional PoA- *Landfill gas capture, flaring and utilization program in Africa*. However, no CPA has been registered in the country to date.

Energy: Emissions from private off-grid power generation

Almost all households, i.e., 99.9%, in Addis Ababa are connected to the grid (GoE 2019b). Nevertheless, given electricity supply in Ethiopia is greatly insufficient and unreliable, it has become a common trend to see diesel generators widely used, especially by business centres, banks, hotels and public and private institutions. Also, studies show that urban households in Ethiopia rely heavily on traditional biomass. Almost half of urban households in Ethiopia depend on traditional biomass for cooking (Tessama & Davis 2013; World Bank 2014). However, no current data could be found on the amount of GHG emissions associated with private off-grid power generation by cities.

Industry

Addis Ababa's GHG emissions from the industry sector could not be found publicly.

Refrigeration and air conditioning (RAC)

Ethiopia's National Logistics Strategy (2018-2028) envisages enhancing economic growth through attracting private sector investment to avoid delay of imported products at the port, which costs Ethiopia millions of dollars every year. Moreover, the strategy aims at bringing systemic change to logistic challenges in the country (Ministry of Transport 2019). The strategy underlines the importance of cold storage and refrigerated transport for Ethiopia to preserve perishable products such as fruits, dairy and flowers both at logistic hubs as well as at point of production sites. It also states the relevance of setting up green logistics to reduce GHG emissions associated with the logistics sector (Ministry of Transport 2019).

In 2020, Ethiopia transported its first chilled freight across the Modjo-Djibouti corridor (Ethiopian Embassy in London 2020b). CRGE estimates development of refrigerated facilities will cost USD one million per facility for a total of 37 facilities until the year 2030. Sustainable cooling also plays an important role in coordinating COVID-19 responses via disseminating vaccines and other related medical equipment. Ethiopian Airlines has been serving as a logistics hub for disseminating COVID-19 testing kits and personal protective equipment, not only within the African region but even globally, due to Ethiopian Airlines' vast network of flight destinations and a successful reconfiguration from passenger to cargo flights during the pandemic. In December 2020, the airlines reached a deal with Cainiao Network, the logistics arm of China's Alibaba Group, to establish an international cold chain from China for the supply of pharmaceuticals, including vaccines (Reuters 2021).

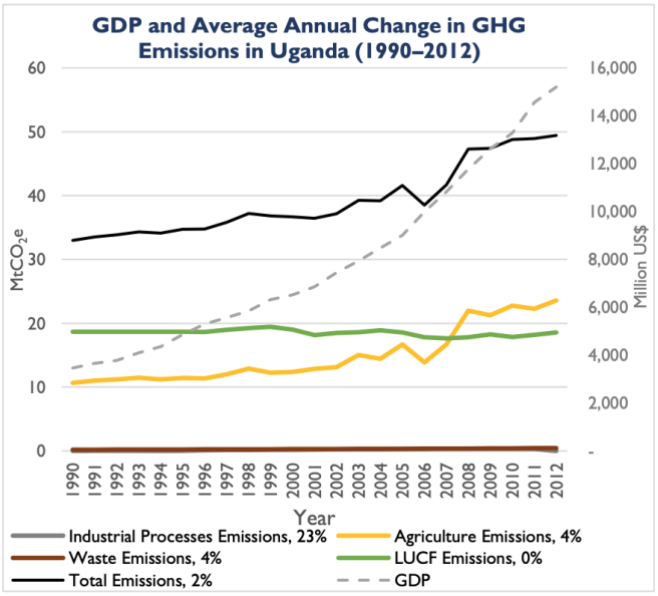
1.1.2 Uganda

Emission sources by sector

National emissions

Greenhouse gas emissions in Uganda reached 49 $MtCO_2e$ in 2012 (USAID 2015). More recent data is limited. Total emissions grew 50% from 1990-2012 and are expected to continue to rise (USAID 2015), particularly within Kampala, the country's capital city and largest urban centre.

Figure 3: GDP and increase in emissions from 1990-2012 in Uganda



Source: USAID 2015

Nationwide, agriculture and the land use change and forestry (LUCF) sectors are the greatest contributors to emissions (as seen in Figure 3), totaling 48% and 38% in 2012 (USAID 2015). According to Uganda's Second National Communication (SNC) to the UNFCCC, activities that drive agriculture sector emissions are livestock production, inefficient animal waste management systems and the cultivation of organic soils (GoE 2015c). Activities that would reduce agriculture emissions include improved intensive livestock management systems, adoption of manure management practices, adoption of minimum tillage practices on cultivated land and increased use of fertilizer accompanied by precision planting techniques to enhance efficiency (USAID 2015).

The LUCF sector is also a major contributor to national GHG emissions, with total forested land decreasing while crop land and bush increases. Forest degradation can largely be attributed to increased crop land, fires and biomass extraction for timber, charcoal, and commercial fuel wood.

Though the agriculture and LUCF sectors are of great importance nationally, they comprise less than 2% of current emissions in Kampala, due to the urban nature of the city (KCCA 2015).

Emissions by sector in Kampala

Figure 4: Map of Kampala and Uganda

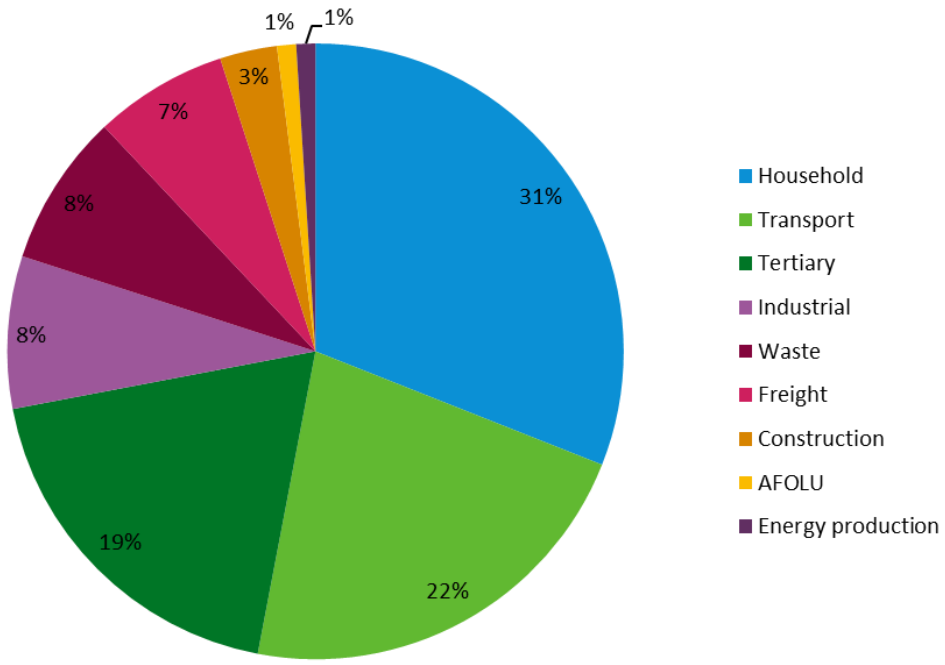
Source: KCCA 2016

Kampala (seen in Figure 4) is the largest city in Uganda and an estimated 65% of national GDP is generated within the city limits, as well as a large proportion of the country's GHG emissions (KCCA 2015). Population growth in Kampala is estimated at 2% per annum, contributing to increasing urban emissions. According to the Climate Change Action Strategy, the Kampala Capital City Authority assesses local GHG emissions on a regular basis. In a BAU scenario, emissions at the greater metropolitan area level are expected to increase from 6.9 million tons in 2014 to 14.6 million in 2030 (KCCA 2016). The GHG emissions per capita reach 2.4 tCO_2e/resident in Kampala and 1.75 tCO_2e/resident at the Greater Kampala level, compared to 1.4 tCO_2e/resident at the national level, highlighting the significant contribution of the urban centre (KCCA 2016). Main contributing sectors include transport, household, freight, waste, tertiary and industrial sectors. This is a major difference as compared to national emissions, where land use change and forestry contribute a majority of emissions.

Emissions in Kampala City

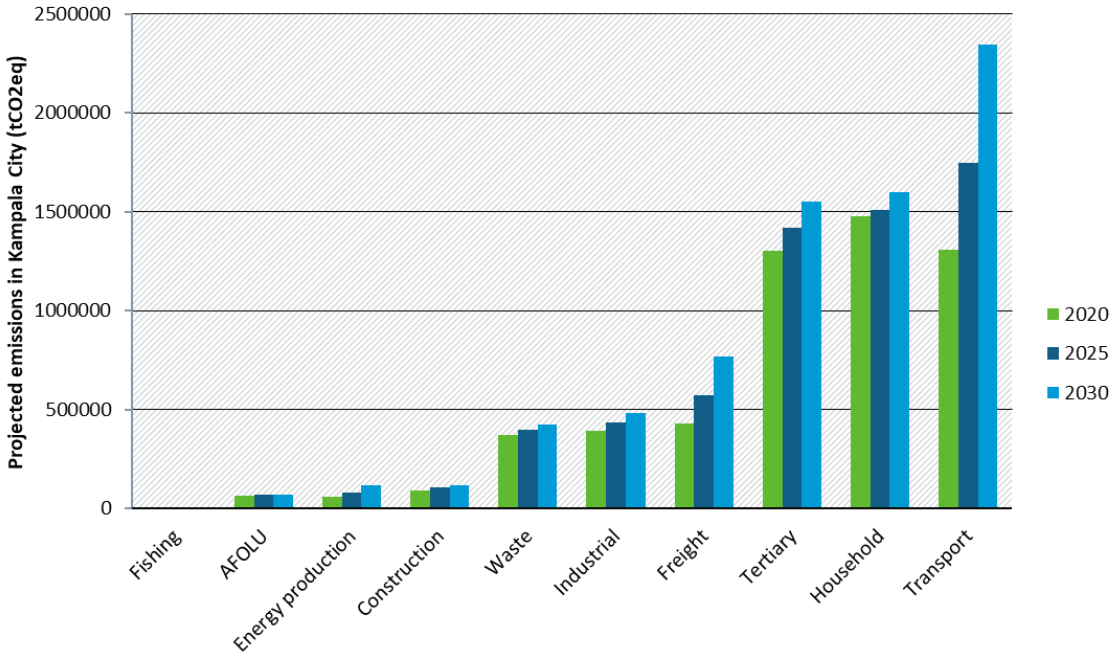
As can be seen in Figure 5, household cooking and transport are the greatest contributors to greenhouse gas emissions in Kampala. Emissions are expected to increase by 2030, particularly in the transport sector, as shown in Figure 6.

Figure 5: Emissions by sector in Kampala, 2014



Source: authors based on KCCA 2015

Figure 6: Projected emissions by sector in Kampala City, 2020-2030



Source: authors based on KCCA 2015

In Kampala City, total emissions are expected to increase from 5.49 million tons CO_2 equivalent in 2020 to 7.48 $MtCO_2e$ in 2030, an increase of approximately 36.2% over ten years. Uncertainty in these figures ranges from +/- 10-25% (KCCA 2015).

Transport

Kampala has a network of approximately 2,100 km of built roads, of which only 500 km are tarmacked (KCCA 2018a). It is estimated that 55% of vehicles in Uganda are in Kampala (KCCA 2015). The city authority predicts that increased income will result in an increase in mobility and greenhouse gas emissions over the next decade (KCCA 2015). In 2030, under a BAU scenario, the transport sector will be the leading source of GHG emissions, contributing 31% of the total emissions (KCCA 2015). Petroleum fuels made up 43% of total energy use across all sectors in Kampala in 2014, significantly more than the proportion nationwide (USAID 2015; KCCA 2015).

Waste

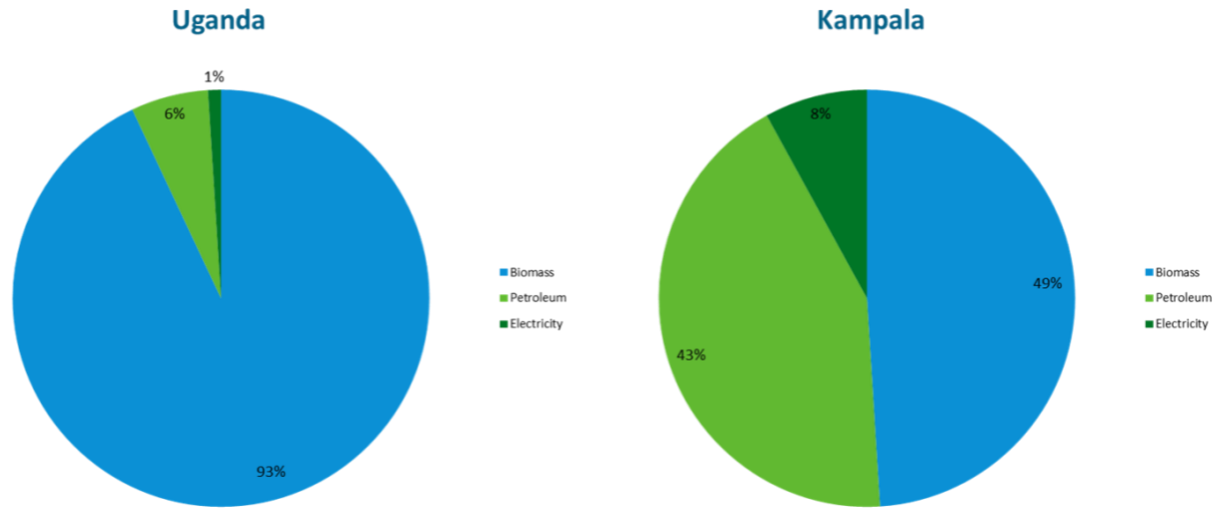
Waste comprises a relatively small proportion of Kampala's annual emissions (currently 8%). Increasing population is expected to result in an increase in waste generation (KCCA 2015). As with many developing countries, most of the waste generated is organic (KCCA 2015).

Energy

In Kampala City, the main forms of energy used are biomass (particularly charcoal and wood fuel), petroleum products and electricity (as seen in Figure 7) (KCCA 2015). The use of all three of these sources has increased in recent years, likely a result of urban population growth (KCCA 2015).

Electricity generation contributes a surprisingly small percentage of overall emissions, mostly due to poor grid connectivity and the fact that a majority of electricity production comes from hydropower. In Kampala City, hydropower constitutes 90.5% of electricity. Nationwide, only 12% of Ugandans are connected to the power grid, and electricity consumption accounts for only 1% of energy use. However, Kampala is better connected, and 78% of households use electricity for lighting (KCCA 2015). The increased use of petroleum in Kampala is due to the increased mobility as compared to the rest of Uganda.

Figure 7: Energy mix in Kampala and nationwide, 2014



Source: authors based on KCCA 2015 and USAID 2015

In terms of emissions from energy, household cooking is a much greater concern. 80% of households in Kampala use charcoal for cooking (KCCA 2015). In 2014, biomass made up 49% of energy use, with petroleum fuels following at 43%. Electricity made up the remaining 8%, mostly used in the industrial sector (KCCA 2015). A BAU scenario assumes a 48% increase in energy demand from 2020 to 2030, with the greatest increases in petroleum and electricity (KCCA 2015).

Kampala Capital City Authority Emissions

The local government represents 1.516 million inhabitants and contributes approximately 0.28% of GHG emissions in Kampala, a comparatively low percentage (KCCA 2016). However, municipal emissions are one of the easiest sources to control and emissions are steadily increasing, rising 9% between 2012 and 2014 (3% per annum). Fuel consumption by the city car fleet represents 92% of total energy consumed by the municipality (with 50% related to waste collection and 24% to road construction activities) (KCCA 2016). Due to energy efficiency measures, restricted use of air conditioning and photovoltaic street lighting, emissions related to building energy consumption are relatively low, resulting in only 8% of KCCA's total emissions (KCCA 2015).

Emissions in the Greater Kampala Metropolitan Area

When analysing emissions, it is important to distinguish between the City of Kampala and the Greater Kampala Metropolitan Area (GKMA). The GKMA is composed of Kampala city, Entebbe municipality, as well as part of the Mukono and Wakiso districts, with an estimated population of 3.23 million in 2014 (KCCA 2016). In this region, emissions are expected to increase significantly as a result of population growth (currently estimated at a staggering 10% per annum, as compared to only 2% within the city limits). Total emissions increased from 6.5 million tons in 2012 to 6.9 million tons in 2014, about 6.4% in two years. Biomass (a high GHG emitter) contributes to 50% of the energy mix, mostly used for household cooking. Petroleum and electricity contribute a subsequent 42% and 8%, respectively (KCCA 2016).

In terms of electricity, more renewable sources are used. Hydropower supplies more than 90% of electricity, with significant investment currently underway in new hydro stations (KCCA 2016).

National and international mitigation targets

In October of 2015, Uganda published its first NDC, designed to limit climate change to 2°C by the end of the century. The NDC highlights that Uganda is classified as a Least Developed Country (LDC) and has contributed to less than 0.099% of global greenhouse gas emissions. Uganda's business-as-usual (BAU) scenario estimates emissions of 77.3 million tons of carbon dioxide equivalent per year in 2030. The NDC aims for a 22% reduction in emissions in 2030 compared to BAU, but is conditional on 70% financing from international sources, with a domestic contribution of 30%.

The most relevant national policy focused on climate change is Uganda's National Climate Change Policy (NCCP), adopted in 2015. According to the document, the goal of the policy is to "ensure a harmonised and coordinated approach towards a climate-resilient and low-carbon development path for sustainable development in Uganda" (Ministry of Water and Environment 2018, p.iii). The NCCP is meant to promote sustainable development and a green economy with an inclusive approach, developed through a comprehensive stakeholder consultation process. Addressing both mitigation and adaptation, the NCCP lays out specific measures for implementation in various sectors, including a focus on topics such as national park

management, wetland degradation and resilient fishing practices. Implementation will be carried out by government agencies, local governments and the private sector, based on various mandates.

An overview of relevant climate agreements and policies from the international to the local level can be seen in Figure 8.

Figure 8: Climate action agreements and policies in Uganda from the national to local level

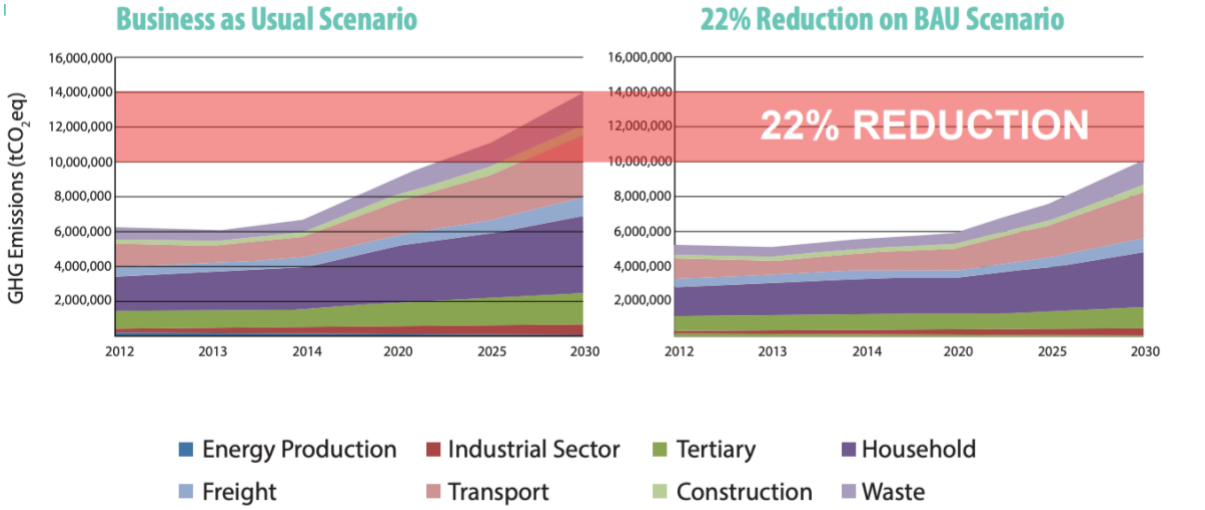
Source: KCCA 2016

Local mitigation targets

The City of Kampala (seen in Figure 4) has also published a Climate Change Action Strategy (2016), in partnership with the World Bank, UNDP and other relevant stakeholders.

The city estimates the cost of adaptation to rise to between USD 33-102 million by 2050, and therefore aims to reduce emissions by 22% as compared to the BAU scenario (in line with Uganda's NDC, seen in Figure 9) (KCCA 2016). By focusing on mitigation and adaptation, the city hopes to minimize negative effects of climate change. Local goals include reducing vulnerability to charcoal, fuel and water supply shocks and reducing emissions from major contributing sectors. Along with the 22% emissions reduction, Kampala also plans to meet 10% of energy demand from local production (within the territory) and generate 20% of cooking energy with renewable alternatives to charcoal (KCCA 2016). Fuel alternatives and energy sources prioritised in the Climate Change Action Strategy include briquettes, biogas, compressed natural gas, biodiesel, solar energy and energy generated from waste.

Figure 9: NDC 22% GHG reduction scenario as compared to business as usual



Source: KCCA 2016

Mitigation goals in Kampala include the following:

- Reduction of (unsustainable charcoal) energy consumption of cook stoves in institutions and households by 20-40%;
- Introduction of alternative cook fuels like briquettes;
- Promoting forestation and afforestation to secure supply of biomass;
- Switching to blended fuel and biodiesel (reducing gasoline consumption 5-10%);
- Improvement in road infrastructure coupled with good driving practices;
- Restrictions on importation and use of (inefficient) second-hand vehicles (estimated to reduce energy consumption by 25-30%);
- Switching households to low carbon fuel alternatives in the long-term;
- Implementing an air quality monitoring system; and
- Improving accessibility, connectivity and transit options in the city (including the use of mass transit systems).

Factors such as increasing traffic and waste volumes are expected to pose challenges as population increases in coming years.

1.2 Previous activities related to Article 6 and carbon markets

1.2.1 Ethiopia

Ethiopia has been participating in several types of international carbon markets including the Kyoto Protocol's CDM, voluntary carbon standards (e.g., Gold Standard, Verra standards), and bilateral cooperation, e.g., under the Joint Crediting Mechanism (JCM) with Japan. Regarding UNFCCC mechanisms, Ethiopia has successfully registered nine CDM activities: two projects (methane avoidance, municipal waste) and seven PoAs (five improved cookstoves, one biomass and one solar program) with a total of 16 CPAs. Four PoAs have successfully issued over 750,000 CERs. Of this total issuance, two improved cookstove PoAs contribute the largest share of issuances, about 78.5.%, followed by a solar lamps PoA (17%) and a biomass gasification PoA (4.5%) (UNEP DTU 2021).

The two registered CDM projects focus on landfill gas flaring and methane collection from wastewater treatment. Both projects have not yet issued certified emission reductions (CERs). The Humbo Ethiopia Assisted Natural Regeneration CDM project has issued over 250,000 CERs. The project was awarded in 2012 for being Africa's first CDM forestry project (World Bank 2012). However, the project was deregistered to operate under Gold Standard due to higher prices for Verified Emission Reduction (VERs) compared to the temporary CERs for forestry CDM projects (UNEP DTU 2021).

Addis Ababa hosts five CDM activities – four CPAs focusing on dissemination of improved cookstoves to households and one single CDM project in the landfill gas activity type. These activities, however, have not yet issued CERs credits. Overall, the CDM activities have an emission reduction potential of around 1,676 $ktCO_2e$ by 2020 and 3,827 $ktCO_2e$ by 2030 (UNEP DTU 2021).

Ethiopia hosts 29 voluntary carbon market (VCM) activities: 27 Gold Standard activities, one VERRA/Voluntary Carbon Standard (VCS) and one Plan Vivo. Around 86% of registered VCM activities are energy efficiency-related activities, followed by agriculture/forestry (7%) and others (7%). 19 Gold Standard activities have issued about 556,017 VERs and the Plan Vivo project has issued 38,600 credits. While Ethiopia has registered one project under the VCM, the project has not yet issued credits (Hoch et al. 2021b). All of the registered VCM activities operate outside Addis Ababa.

Ethiopia's carbon market experience is limited to improved cookstove and off-grid electrification projects and barely covers other key sectors. Many sectors with mitigation potential have not managed to access the CDM nor voluntary carbon standards. For example, the designated national authority (DNA), the Environment, Forests, and Climate Change Commission (EFCCC), has successfully coordinated the development of an approved CDM standardised baseline (SB) for institutional improved cookstoves. While there is a registered CDM PoA that could support this activity type, there is not yet a project supporting the use of this technology. Furthermore, CDM baseline methodologies do not always reflect Ethiopian circumstances and therefore need to be improved under Article 6: grid-connected renewable energy (globally one of the most important CDM project types) has not been able to access the CDM in Ethiopia because the baseline is very low due to Ethiopia's large share of hydropower in the electricity grid. The CDM baseline rules do not reflect the fact that electricity supply in Ethiopia is insufficient and unreliable, leading to high usage of diesel generators, even in urban areas, which is not accounted for.

In order to strengthen its role in the international carbon market, the EFCCC established a Carbon Market Committee in 2019. The Committee comprises five directors from the EFCCC's

Environment Commission Directorate, Resource Mobilization Directorate, Project Monitoring and Evaluation Directorate, Forestry Commission Directorate, Climate Change Commission Directorate, and Policy Law and Standard Directorate (Hoch et al. 2021a). Furthermore, the GoE is currently exploring voluntary domestic carbon market opportunities in the context of a GEF COMPOST NAMA programme. The voluntary domestic carbon market will cover waste and urban afforestation activities with a possibility of adding additional sectors eventually (UNDP 2019). GEF is providing financial support for the implementation of the underlying activities, while UNDP provides technical support. Potential credit buyers would be those who want to promote urban greenery and composting activities in Ethiopia. The Ministry of Urban Development and Housing will co-finance the creation of this voluntary market (AfDB 2017a). The market design was drafted in 2019. Nonetheless, it has not yet been put into practice.

As for Article 6 implementation readiness, Ethiopia should establish required Article 6 infrastructures. For example, Ethiopia doesn't have national legislative or guidance documents that directly address ITMO authorisation and transfer and procedures for Corresponding Adjustments. Considering Ethiopia's limited international carbon market experience under the Kyoto Protocol, the DNA, as well as the Carbon Market Committee, require strong institutional capacity support. It is expected that the current DNA, i.e., EFCCC, will have extended roles and responsibilities in coordinating and managing Article 6 related activities (Hoch et al. 2021a).

Ongoing Article 6 related initiatives

Joint Crediting Mechanism (JCM): Ethiopia has established some initial experience in bilateral agreements with Japan for the JCM and other potential buyer countries. Three methodologies have been approved so far under the JCM, targeting power generation, i.e., biomass combined heat and power, solar photovoltaic and electrification of rural communities with micro hydropower generation (JCM Ethiopia-Japan, n.d.). However, no project has been registered to date.

The Mobilising Article 6 Trading Structure (MATS) Program: Supported by Swedish Energy Agency (SEA) and the Global Green Growth Institute (GGGI), MATS supports Ethiopia in refining and developing relevant Article 6 institutional frameworks through practical authorisation of ITMO transactions under Mitigation Outcome Purchase Agreements (MOPAs). Ethiopia has two MATS Article 6 pilot activities in the energy sector (GGGI 2020).

Carbon Initiative for Development (Ci-Dev) program: The World Bank through the Ci-Dev program is supporting two PoAs, focusing on solar and cookstove activity types. The Development Bank of Ethiopia (DBE) is the coordinating/managing entity of both PoAs. While these PoAs do not yet participate in the World Bank's standardised crediting framework (SCF), they are being supported by Ci-Dev. This may offer Ethiopia an additional entry point to exchange experiences on Article 6 piloting with regional peers, in particular Rwanda, which is already piloting the SCF.

Table 1 below presents an overview of current potential Article 6 activities (candidates) in Addis Ababa.

Table 1: Overview of all potential Article 6 activities in Addis Ababa

Sector	Activities	Status	Implementing actor	Budget	Funding source
Urban transport	Urban light rail	Ongoing	Ethiopian Railway Corporation	USD 475m	85% loan from China, 15% GoE

Sector	Activities	Status	Implementing actor	Budget	Funding source
	Electric 2&3 wheelers	Planned	Road Transport Authority	n.a.	UNEP, IKI
	Cycle paths	Ongoing	Addis Ababa City Administration	n.a.	Domestic and international
Planting trees	Green Legacy Campaign	Ongoing	Regions and cities	n.a.	GoE
Private buildings	Energy efficient buildings	Planned	Ethiopian Energy Authority	n.a.	Domestic and international
	A/C residential	n.a.	Ethiopian Energy Authority	n.a.	Domestic and international
Public infrastructure (buildings and street lighting)	Market halls (cooling)	n.a.	n.a.	n.a.	n.a.
	Street lighting	n.a.	n.a.	n.a.	n.a.
	Hospitals and health wards (energy supply, cooling - also related to Covid)	n.a.	n.a.	n.a.	n.a.
Local energy production	Households improved cookstoves- 4 CPAs	Registered /ongoing	CME- Project Gaia Inc. (2 CPAs) CME- Green Development AS (2 CPA)	n.a.	Carbon credit
	Ethanol mixing with gasoline (E5)	Ongoing	Companies	n.a.	n.a.
Industry	Cement production	n.a.	n.a.	n.a.	n.a.
Waste sector	PETCO Ethiopia recycling community organization (Plastic)	Ongoing	PETCO	n.a.	n.a.
	Methane Capture and Flaring from Addis Ababa Repi open dump fill (CDM project)	Registered /ongoing	Addis Ababa City Administration	n.a	Carbon credit

1.2.2 Uganda

Uganda is a signatory and party to multiple international agreements, including the UNFCCC, Kyoto Protocol and the Paris Agreement. Under the Kyoto Protocol, Uganda registered 24 projects and 25 Programmes of Activities (PoAs)[2], mostly related to reforestation and energy (UNFCCC n.d. b,c). Uganda is considered by many NGOs and MDBs to be an African leader in the use of carbon finance markets. In fact, the BMU explains, "To date, Africa and especially Africa's least developed countries (LDCs) have seen only marginal representation in the global carbon market. Uganda is a notable exception – with over 25 programmes and project activities conducted under the Clean Development Mechanism (CDM), it is one of the most successful CDM host countries in East Africa" (n.d.).

Although Uganda is considered a forerunner in African carbon markets, the sector is not without controversy. In 2009, a voluntary carbon offset project by the Uganda Wildlife Authority and FACE Foundation in Mount Elgon National Park received negative media attention for displacing indigenous peoples in the name of reforestation. GreenSeat, the potential buyer, pulled out of the project as a result of the controversy and the FSC was criticised for certifying the project (Michael 2009).

Similar concerns ended a Swedish Energy Agency-Green Resources project in Uganda. The SEA cancelled its contract to purchase carbon credits from the Norwegian firm after realizing the harm caused to local communities by tree plantations. Unresolved questions of land ownership and ongoing legal battles ended the relationship, an issue seen throughout East Africa (Lang 2020).

CDM Projects

Uganda's 49 projects/PoAs have generated over 13.40 million CERs to date (more than 13 times the amount generated by Ethiopia), with 1.09 million during KP1 and 12.30 million during KP2. Total capital investment is listed as USD 979 million. Of the 49 projects/PoAs, 10 are related to stoves, seven are reforestation/afforestation projects, seven are run of river projects, and other projects include landfill composting, solar lamps, manure and biodiesel projects. Overall, the largest proportions are related to reforestation and energy efficiency and generation.

Cooperative initiatives

The GIZ Global Carbon Markets Programme is currently based in Uganda and is working to support the development of economic and carbon pricing instruments that would facilitate NDC implementation among East African countries (Promethium Carbon 2019). From 2014-2017, the Uganda Investment Authority also worked with GIZ on the Clean Development Mechanism Project, which sought to "identify, appraise and provide in-process support for potential climate finance (especially CDM) projects and programmes" (UIA n.d.). Uganda has also registered multiple projects with Gold Standard and Verra Verified Carbon Standard (Gold Standard n.d.; Verra n.d.). However, unlike Ethiopia, Uganda is not a partner country to Japan's Joint Crediting Mechanism (JCM n.d.).

Uganda is also host to a World Bank Ci-Dev (Carbon Initiative for Development) programme focused on rural electrification. Emission reductions resulting from 470,000 on-grid connections implemented under Uganda's Rural Electrification Strategy generate carbon credits that Ci-Dev purchases, creating the funding for an electrification subsidy program for 82,250 low-income households (Ci-DEV n.d. b).

[2] Source: https://cdm.unfccc.int/Statistics/Public/files/Database%20for%20PAs%20and%20PoAs.xlsx

Other initiatives, such as GGGI and Carbon Market Foundation are also cooperating with Uganda, based on the country's Green Growth Development Strategy (KfW n.d.; GGGI n.d.). These projects apply a market-based carbon finance approach, utilising emission reductions credits to generate revenue.

The UNFCCC Regional Collaboration Centre for Eastern and Southern Africa is in Kampala, perhaps reflective of Uganda's status as an African forerunner in carbon markets (UNFCCC n.d. d). Uganda is also involved in the East African Alliance on Carbon Markets and Climate Finance, launched in 2019 by the RCC Kampala and the GIZ Carbon Markets Programme. The purpose of the alliance is to "enhance the long-term vision of Eastern African countries on carbon markets and climate finance and… support the readiness of the countries to implement Article 6 of the Paris Agreement" (UNFCCC RCC Kampala 2019).

Along with Ethiopia, Uganda was also involved in Perspectives Climate Group's Linking Market Mechanisms and Climate Finance in Africa project, implementing climate financing models to meet NDC goals (IKI 2021b).

Relevant activities

A (non-exhaustive) overview of current and past Article 6 activities in Kampala can be seen in Table 2.

Table 2: Overview of all currently ongoing or planned Article 6 activities in Kampala

Sector	Activities	Status	Implementing actor	Budget	Funding source
Urban transport	Bus rapid transit (BRT) system	Proposed	Ministry of Works and Transport, KCCA, Uganda National Roads Authority	USD 5m	World Bank, UNRA
	Light rail transit (LRT)	Planned	Ministry of Works, China Civil Engineering Construction Corporation	USD 700m	n.a.
	Electromobility (Boda-Bodas)	Planned	UNEP, IEA, Ministry of Energy and Mineral Development	n.a.	GEF
	Standard Gauge Railway	Planned	n.a.	n.a.	China
	Non-motorised transport strategy	Planned	KCCA	n.a.	n.a.
	Cable cabin project	Planned	KCCA	n.a.	n.a.
	Solar energy car sharing stations pilot	Planned	KCCA	n.a.	n.a.
Private buildings	GKMA High density affordable housing pilot	Proposed	National Planning Authority, Ministry of Lands, Housing and Urban Development	n.a.	n.a.

Sector	Activities	Status	Implementing actor	Budget	Funding source
Public infrastructure	Solar street lighting	Ongoing	KCCA	EUR 77bn	AFD (with USD 3m from KCCA city budget)
	Planting 500,000 trees	Planned	KCCA, Uganda National Roads Authority	n.a.	n.a.
Local energy production	Ayago hydropower plant	Planned	Ministry of Energy and Mineral Development	USD 1.4bn	JICA
	Cook stoves	Complete	UNDP	EUR 248,000	BMU
	Kampala metropolitan transmission system improvement project	Ongoing	Uganda Electricity Transmission Company Ltd	JPY 13.66bn	JICA
	Eco-stoves in the Wandegeya Market Kitchen	Complete	KCCA	n.a.	n.a.
Waste	EcoSan (ecological sanitation)	Complete	Kampala City Council	USD 1.1m	SIDA
	Plastic recycling	Complete	KCCA	USD 1m	World Bank
	Biogas recovery from landfills	Planned	KCCA	n.a.	n.a.
	Waste to biogas on farms pilot project	Planned	KCCA, Ministry of Energy	n.a.	n.a.
Wastewater treatment	Bugolobi-Nakivubo wastewater treatment plant	Complete	National Water and Sewerage Corporation	n.a.	Ugandan government, AfDB, KFW, AFD
	Kampala Water-Lake Victoria Water and Sanitation Project	n.a.	National Water and Sewerage Corporation	n.a.	GoU, KfW, AFD, EU-ITF, EIB

Note: N.a. indicates information not available.

Sources: Biryabarema 2020; European Commission n.d.; IKI 2021c; JICA n.d.; JICA 2018; KCCA 2015; KCCA 2018b; Ministry of Health 2020; NPA 2018; SGR n.d.; Takouleu 2021; Uganda Business News 2017; UNEP n.d.; UNFCCC n.d. a

1.3 Existing and planned urban climate protection policies

1.3.1 Ethiopia

National strategies

Ethiopia's Urban Development Policy emphasises that urban administrations, government and people should give proper attention to environmental protection to avoid continuous suffocation and pollution that follows the expansion of cities (cited in MOWIE 2017).

In 2017, Ethiopia developed an **Urban Wastewater Management Strategy** (WWMS). The strategy was initiated by MOWIE to enable cities and towns to ensure a sustainable, resilient, safe and healthy urban environment through an improved wastewater management chain devoid of human contact by 2026. Below is detailed list of the strategy goals:

Develop strong wastewater management institutions in major towns and cities;

Prepare a national WWMS plan and management structure aligned with sustainable development growth (SDG 2016 -2030) for provision of appropriate wastewater services;

Protect the public from the potential harmful effects of wastewater through provision of a centralised, decentralised and on-site UWWM system based on the population category of cities and towns;

Protect and maintain a safer environment by minimising adverse environmental effects from wastewater discharge to natural resources;

Support city and town utilities in working with the respected communities to provide for social and cultural sustainability; and

Develop sustainable management structure for wastewater collection, transportation and treatment actions (MOWIE 2017).

Similarly, **the 10-Year Development Plan** (2021-2030) aims to improve greening and sanitation services so that cities/towns are liveable and resilient to economic, social, environmental and ecological shocks. The plan envisages: 1) raising the coverage of **liquid waste removal**[3] from 1% to 50% and **dry waste removal** from 30% to 80% in towns with a population of over 20,000; and 2) raising the coverage of **green infrastructural development** that is accessible and up to standard in all urban areas to 30%, thereby raising the number of cities/towns that meet the standard from 6 to 200 (GoE 2021a). The **10-Year Development Plan of the transport sector** also promotes green development activities. The Plan indicates that around 2.1 million seedlings have been planted in 2017-2018 (Ministry of Transport 2020a). Related, in 2019, Ethiopia launched a national Green Legacy Initiative aiming to plant 20 billion seedlings by 2024. Ethiopia has so far planted more than 4.1 billion trees out of the intended 5 billion (Ethiopian Embassy in London 2020a).

Ethiopia's Climate Resilient Transport Sector Strategy envisages to increase the non-motorised transport mode share to 35% by 2030 in urban areas, measured in terms of trip legs. In order to reduce the sector's GHG emissions, the following key interventions are envisioned:

- Introducing stricter fuel efficiency standards for passenger and cargo transportation;

[3] Though the 10-Year Development Plan does not specify what sources are covered under this definition, in the Urban Wastewater Management Strategy, liquid waste is taken to mean effluents of industries, fertilizer and pesticide solutions from agricultural fields, leachate from landfills, urban runoff of untreated wastewater and garbage, mining wastes, etc.

- Imposing age limits for the importation of used vehicles;
- Promoting hybrid and electric vehicles to counter the low efficiency of the existing vehicle fleet;
- Constructing an electric rail network – powered by renewable energy – to substitute road freight transport;
- Improving urban transport in all urban centres of the country by introducing urban electric rail, light rail transit;
- Introduce bus rapid transit, and improve bus operation system.
- Substituting imported fossil fuels with domestically produced biodiesel and bio-ethanol; and
- Promote walking and cycling in all urban centers (GoE n.d.).

In 2020, Ethiopia developed a **non-motorised transport strategy** (2020-2029). The strategy aims to develop safe, efficient, and accessible walking and cycling networks in major cities and rural centres. The following table shows the strategy's goals, along with proposed actions.

Table 3: Overview of Ethiopia's non-motorised transport strategy

Goal	Contributing actions	10-year targets
Increased share of walking, cycling, and public transport	Investments in high quality walking and cycling facilities Improved last-mile connectivity to public transport	Public transport and paratransit constitute 80% of all motorised trips Modal share of NMT remains at or above 60% of trips Women constitute 50% of cyclists
Reduction in the use of personal motor vehicles (PMV)	Measures to manage/control private vehicle use Improved attractiveness of sustainable modes	Vehicle kilometres travelled (VKT) by PMVs are no more than 2020 levels
Improved road safety	Safe crossings, improved intersections, and dedicated facilities for NMT	Fatalities of pedestrians and cyclists are reduced by 80 percent below 2019 levels
Improved air quality	Increased investments in high quality walking and cycling facilities Measures to control private vehicle use in place	WHO ambient air quality norms are met 350 days a year Greenhouse gas emissions follow the overall targets set in Ethiopia's Nationally Determined Contribution

Source: Ministry of Transport 2020b

Addis Ababa's climate policies and strategies

Addis Ababa Resilience Strategy: the overall vision of the strategy is to transform Addis Ababa into a safe, liveable, and prosperous city by 2030. While the strategy has 3 main pillars, the last

pillars, i.e., 'healthy and liveable places' emphasises natural resources protection-related actions. The pillar aims at strengthening the city's ability to effectively protect its natural resources and ecosystems, and thereby secure a more sustainable future. The following table presents targeted activities under this pilar.

Table 4: Overview of Addis Ababa Resilience Strategy

Goal	Contributing Actions	10-Year targets
Provide adequate, safe and reliable water and sanitation services for all	Build a water-resilient city	New
	Establish a water fund	New
	Enhance water security through improved groundwater abstraction monitoring and regulation	New
	Promote decentralised waste treatment and water-sensitive design	New
	Improve sanitation service provision	New
Manage our resources sustainably	Develop a sustainable public procurement policy	New
	Scale up adoption of clean cookstoves and fuels	Scale up
	Design and implement energy-saving measures	Ongoing
	Establish a recycling park	New
	Develop a participatory mountain range rehabilitation program	Scale up
Improve the quality of our environment	Modernise solid waste management	New
	Build institutional capacity and partnerships to reduce air pollution	Ongoing
	Establish an accredited environmental pollution monitoring laboratory and data management system	New
Embrace risk-aware and participatory urban design practices	Design and build green and multifunctional streets	New
	Improve participatory design in resilient public spaces	Ongoing
	Launch a tactical urbanism program	Scale up
Ensure the provision of healthy, affordable, and reliable food for all	Build a sustainable and resilient city-region food system	New

Source: Addis Ababa City Administration Office et al. 2020

Addis Ababa Non-Motorised Transport Strategy: Similar to the national non-motorised transport strategy, Addis Ababa Road and Transport Bureau has developed a **non-motorised transport** strategy in 2018 for the period between 2019-2028. The strategy aims to "*provide safe, efficient, and accessible pedestrian and cycling networks to improve access to opportunities and mobility for all residents, foster equitable allocation of street space, and create a dignified walking*

and cycling environment" (Addis Ababa City Administration 2018). The following table summarises the key goals of the strategy aims to achieve by 2028.

Table 5: Overview of Addis Ababa Non-Motorised Transport Strategy

Goal	Contributing actions	Targets for 2028
Improved road safety	• Safe crossings, redesigned intersections, and dedicated facilities for NMT	• Fatalities of pedestrians and cyclists are reduced 80 percent below 2018 levels
Increased mode share of walking, cycling, and public transport	• Investments in high-quality walking and cycling facilities • Improved last-mile connectivity to public transport	• Mode share of NMT remains at or above 60% of trips • Public transport constitutes 80% of motorised trips • Women constitute 50% of cyclists
Reduction in the use of personal motor vehicles (PMV)	• Measures to manage vehicle use • Improved attractiveness of sustainable modes	• Vehicle kilometres travelled (VKT) by PMVs are no more than 2018 levels
Improved air quality	• Investments in high-quality walking and cycling facilities • Measures to manage vehicle use	• WHO ambient air quality norms are met 350 days a year • Greenhouse gas emissions follow the targets set in Ethiopia's NDC

Source: Addis Ababa City Administration 2018

In supporting the aforementioned strategies, Addis Ababa is implementing different measures. In the transportation sector, for example, the city is undertaking **emission testing** to understand the current state of the fleet with the support of C40's Empowering Cities with Data Programme. The programme aims to draft **emissions standards** which will progressively ban the oldest and most polluting vehicles from the city, with additional incentives for adopting recent models (C40 2020). Almost 85% of cars in Ethiopia are used cars and the country has no restriction on the age of imported vehicles (UNECA 2020).

In order to promote non-motorised mobility, the Addis Ababa administration has planned to construct **200 kilometres of cycle tracks by 2028**; furthermore, to improve the city's cycling infrastructure, the administration office has planned to build **bicycle parking** at BRT and LRT stations. Also, the city administration has set a plan to develop 600 kilometres **of pedestrian networks** of new and existing streets (Addis Ababa City Administration office 2018). More recently, on June 13, 2021, Addis Ababa inaugurated the grand Meskel Square-Addis Ababa City Hall project, built at a cost of around 50 million EUR as part of the Beautifying Sheger initiative. The project has developed Addis Ababa's roadside greenery works and sidewalks (Embassy of Ethiopia 2021).

In a similar effort, Addis Ababa has joined other African cities in the **Car-Free Days initiative** in 2018. The initiative was renamed in Amharic language *Menged Le Sewe* – meaning 'Streets for People'. The Ministry of Transport and regional governments, with support from partners including the United Nations Human Settlements Programme, are leading the initiative. The initiative has planned to further **scale-up the initiative to other cities** such as Dire Dawa, Bahir Dar, Hawassa, Adama, Jimma, and Jigiga (Institute for Transportation and Development Policy, ITDP, 2019; Abubaker 2019).

Addis Ababa also launched the **Light Rail Transit Project** (LRT) in 2015. The cumulative **emission reduction potential** is forecasted at **1.8 million tCO_2e by 2030**. The city is working together with other cities to expand the project's wider impacts beyond Addis's border (C40 2016b). While Addis Ababa's LRT project plans to provide transport services to 300,000 people on average daily, it has however achieved 36% of this target. A number of challenges were reported, including planned construction of additional railway infrastructure not completed, scarcity of spare parts, lack of train maintenance workshops and repeated electric power supply cuts (Addis Ababa City Administration Office 2018). Furthermore, recent reports show that the **LRT has incurred a loss of around 89 million EUR** during its first four years of operation, which led the project to borrow money from the state-owned Commercial Bank of Ethiopia (CBE). A number of factors were raised for the financial loss, including shortage of foreign currency, difficulty of getting returns on public projects and an inadequate feasibility study (The Reporter 2021).

In addition to the LRT project, Addis Ababa has launched Ethiopia's first **electric car,** which is fully assembled locally by Marathon Motor Engineering, a joint venture between Korean auto giant Hyundai and the Ethiopian Olympic champion Haile Gebrselassie. The Marathon Motor Engineering company reported to have a capacity to produce 10,000 cars per year (Tekle 2020). According to Ethiopia's 10-Year Transport Sector Perspective Plan, GoE hopes to expand electric cars and sets a target to introduce 4,850 **electric buses** and 148,000 **small electric vehicles** by 2030 (Ministry of Transport 2020, p 63).

Addis Ababa has also launched the construction of a **Bus Rapid Transit** project. A total of 15 lines are proposed. A French contractor is tasked to carry out the construction project, which will cost the government a total of ca. 114 million EUR (Ethiopian Monitor 2020).

In the **waste sector**, Addis was reported of becoming a regional leader in solid waste management in 2019. The recognition was given considering the city's effort in transforming the Koshe landfill site, which served the city for half a century as an unprotected and unregulated open dump site, into a new waste-to-energy plant. The plant incinerates up to 1,400 tons of waste every day, roughly 80% of the city's rubbish, supplying Addis with 25% of its household electricity needs. The Koshe landfill project is managed by UN-Habitat with the support of the Government of Japan (Abebe 2018; UNEP 2019; Addis Ababa City Administration Office et al. 2020). Furthermore, the Koshe landfill is expected to generate 50 MW of clean energy annually (GoE 2015b).

Examination of current and planned measures and policies that are suitable for urban Article 6 activities

Table 6: Criteria for urban Article 6 activities

Measure	Role within NDC (conditional, unconditional, inside, outside)	Quantifiability of the effects	Emissions reduction target	Timeline	Key institutions relevant for Article 6 implementation	Additionality	Contribution to SDGs	Cost efficiency and Article 6 market demand	Replicability or transferability to other cities	Potential conflicts between involved institutions
Addis Ababa light rail (LRT)	Inside	High (existing MRV of rail journeys/ticket sales)	1.8 million tCO_2e by 2030	Ongoing, no timeline	Ethiopia Railways Corporation	High additionality (LRT currently makes a big loss)	SDGs 8, 9, 11 and 13	High costs, demand unclear	Limited (at city level), but large expansion of national railway network	Excessive debt - China- CBE
Bus Rapid Transit (BRT)	Inside, conditional	High (existing MRV of bus journeys/ticket sales)	n.a.	Construction ongoing, no timeline	Ministry of Transport	High additionality	SDGs 8, 9, 11 and 13	High costs, demand unclear	Medium (also in smaller cities)	Ongoing activities financed by AFD
Cycle paths	Inside/conditional, (Bikes not mentioned specifically)	Low (no MRV concept available)	n.a.	Construction ongoing, no timeline	Ministry of Transport	High additionality	SDGs 8, 9, 11 and 13	High costs, low mitigation volumes but high SD impact	High (also in smaller cities)	None
Electric buses and small vehicles	Inside, conditional (transport electrification is a prominent NDC policy)	High (existing MRV of bus/taxi journeys/ticket sales)	n.a.	Planned, no timeline	Ministry of Transport	High (first of its kind, high capex)	SDGs 8, 9, 11 and 13	Relatively small volumes, market potential unclear	High also in smaller cities (especially taxi, rideshare, urban delivery)	None

Measure	Role within NDC (conditional, unconditional, inside, outside)	Quantifiability of the effects	Emissions reduction target	Timeline	Key institutions relevant for Article 6 implementation	Additionality	Contribution to SDGs	Cost efficiency and Article 6 market demand	Replicability or transferability to other cities	Potential conflicts between involved institutions
Koshe landfill	Inside, conditional (waste management is a prominent NDC policy)	High (existing CDM project)	96,884 tCO_2e annually	Ongoing, no timeline	Ministry of Housing and Urban Development	High additionality	SDGs 3, 6, 8, 9, 11, and 13	Low cost, market potential unclear	High	Existing CDM project could transition to Article 6

1.3.2 Uganda

National strategies

At a national level, the most relevant climate policy in Uganda is the National Climate Change Policy (2015), which guides all climate change interventions in the country. The comprehensive strategy divides actions into adaptation and mitigation priorities by sector, as seen in Table 7.

Table 7: Adaptation and mitigation priorities in Uganda

MITIGATION PRIORITIES	
Sector	**Goal(s)**
Forestry	With a view to protecting and promoting carbon sinks: Continue and step-up efforts targeted at effective forest management. Make a deliberate departure from "business as usual" by formulating sectoral policies that address issues associated with increased unit productivity in plantation forestry. Promote and develop afforestation and reforestation programmes in non-forested areas and intensify afforestation and reforestation efforts in other areas.
Land use and land-use change	Promote and enforce urban and rural planning of settlements. Control and monitor land development and other land-use changes in a sustainable manner so as to better manage GHG sources and sinks.
Reduced Emissions from Deforestation and Forest Degradation+ (REDD+)	Continue to actively promote joint REDD+ efforts involving the public and private sectors.
Wetlands	Promote a balance between conservation and sustainable use of wetlands to reduce GHG emissions.
Agriculture	Mainstream climate change mitigation issues, promote and improve the management of natural resources in order to ensure resilient, productive and sustainable agricultural systems with reduced GHG emissions.
Energy generation	Support and accelerate the implementation of the Renewable Energy Policy (REP) in order to the promote and develop new clean energy technologies and reduce GHG.
Energy utilisation (demand side)	Promote conservation and efficient utilisation of energy to reduce GHG emissions especially at consumer levels (industries, households, commercial and institutional buildings). Encourage the use of alternative fuels instead of heavily relying on biomass.
Transport	Promote the development, approval and effective implementation of a long-term national transport policy and plan that will take GHG mitigation concerns into account. Effect a gradual shift to the use of less carbon-intensive fuels (including compressed natural gas, ethanol and liquefied petroleum gas) in vehicles instead of relying heavily on gasoline and diesel fuels. Promote modes of transport that take into account GHG emission reduction.

MITIGATION PRIORITIES	
Waste management	Promote sustainable use of solid and liquid wastes for energy generation and other uses, such as fertilisers (after sorting).
Industrial sector	Promote cleaner production processes in industries to contain the increase in GHG emissions.
Cross-cutting priorities: technology transfer and the large-scale diffusion of clean, low-carbon technologies	Put in place functioning institutions that can manage and coordinate issues related to the transfer, deployment and diffusion of technology, including the promotion of the capacity development necessary to support the implementation of clean and low-carbon technologies. Encourage technological development to address the problem of climate change in sectors of economic development with high emissions.

ADAPTATION PRIORITIES	
Sector	**Goal**
Agriculture and livestock	Promote climate change adaptation strategies that enhance resilient, productive and sustainable agricultural systems. Promote value addition, improve food storage and management systems in order to ensure food security at all times as a factor of resilience.
Water	Support on-going efforts to ensure that climate change concerns are integrated into national efforts for sustainable and long-term conservation, access and effective utilisation and management of water resources.
Fisheries and aquaculture	Strengthen efforts to promote integrated fisheries resource management and improve aquaculture in order to ensure sustainable fisheries production.
Transport and works	Develop and ensure integrated planning and management of transport and other physical infrastructure that build on insights from climate predictions.
Forestry	Ensure sustainable management of forestry resources so that they can continue to provide global services including mitigating climate change while supporting the sustainable development needs of communities and the country.
Wetlands	Promote long-term wetland conservation and restoration of degraded wetlands so that they can continue to provide global services including mitigating climate change while supporting the sustainable development needs of communities and the country.
Biodiversity and ecosystem services	Effectively address the challenges posed by climate change impacts on biodiversity and ecosystems so as to ensure ecosystem health and provision of ecosystem services that are crucial to sustainable and resilient development.
Health	Strengthen adaptive mechanisms and enhance early-warning systems and adequate preparedness for climate change related diseases.
Energy	Promote sustainable energy access and utilisation as a means of sustainable development in the face of uncertainties related to climate change.
Wildlife and tourism	Ensure conservation of wildlife resources and plan for improved resilience of tourism resources and infrastructure to climate change.
Human settlements and social infrastructure	Promote urban planning and development of human settlements that are resilient and robust enough to withstand climate change–related risks and hazards.

ADAPTATION PRIORITIES	
Disaster risk management	Ensure disaster mitigation and adequate preparedness for climate change induced risks, hazards and disasters.
Cross-cutting priority: vulnerable groups	Give special attention to improvements of the resilience of vulnerable groups to climate change.

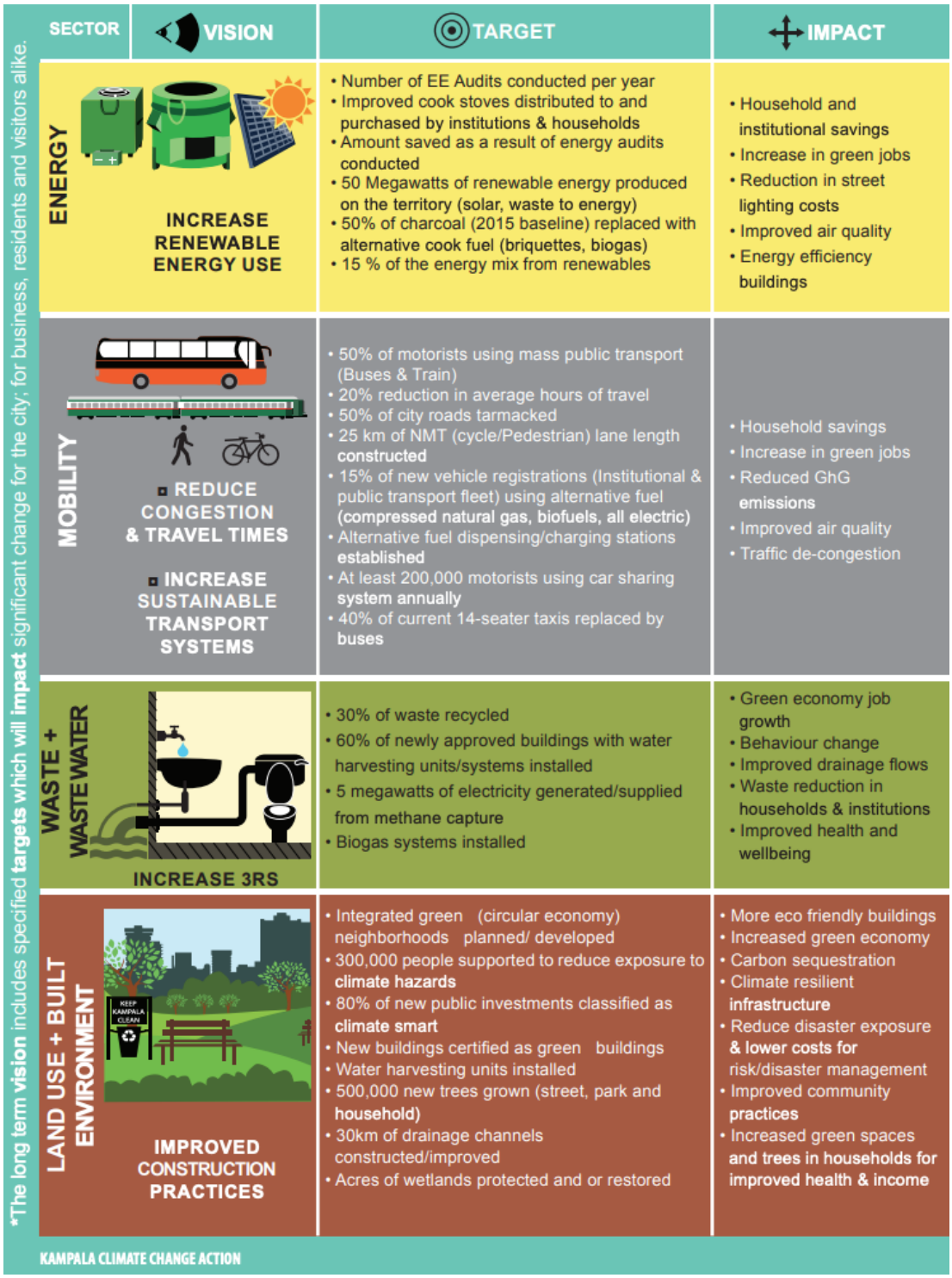
Source: Ministry of Water and Environment (2015)

Though the strategy further delineates subgoals for each sector, it does not provide numerical targets or elaborate on planned projects.

Strategies in Kampala

Kampala, on the other hand, has released the Kampala Climate Change Action Strategy (KCCA 2016), which includes much more detailed steps towards meeting NDC goals, as seen in Figure 10.

Figure 10: Mitigation goals by sector in Kampala



Source: KCCA 2016

The KCCA Strategy also breaks down current and planned interventions by sector. Though most priority actions involve education, updating policy and carrying out studies, several implementation strategies are highlighted, as seen in Table 8.

Table 8: KCCA priority actions by sector (implementation-related only)

Sector	Action	Actor(s)
Energy	Conversion to all solar street lighting	KCCA
	Efficient cookstove pilot replication in schools/markets	KCCA
	Install renewable energy on public buildings	KCCA, Partners
	Waste to energy project from landfills, industrial waste, wastewater, sewage	KCCA p/p, Development partners, NWSC
Mobility	Developing public transport mass systems (BRT/NMT/light rail/cable)	KCCA, Ministry of Works
	Introduction of fleet conversion to mixed fuels	KCCA
Land use/built environment	Zero carbon and positive energy pilot in neighbourhood/village	KCCA, community
	Wetlands conservation, protection and restoration	KCC, Ministry of Water, NWSC, NEMA
	Construction and widening of drainage channels	KCCA, Development partners
	Creation of ecoparks to promote eco tourism and green spaces	KCCA, Ministry of Tourism

Source: KCCA 2016

Of the national strategies highlighted in Table 7, some sectors are not as relevant for Kampala. For example, agriculture and fisheries contribute very little to the overall GHG emissions from the city, and therefore should not be made a priority. As discussed in Section 1.1.2, the main emissions contributors in Kampala are the **transportation sector and household emissions, mainly a result of charcoal cooking**. Transport is particularly important given its expected emissions increase, as shown in Figure 6. By 2030, transportation is projected to contribute more than 31% of emissions in Kampala, making it a critical sector for mitigation (KCCA 2015).

Opportunity in the transportation sector

Highlighted in the Energy and Climate Profile of the KCCA are the upcoming bus rapid transit (BRT) and electric light rail transit (LRT) projects. These would be ideal projects for Article 6 activities, promising clear mitigation benefits with measurable outcomes. The BRT system has no current funding secured, but a feasibility study was financed by the World Bank. The light rail project is currently more advanced. A memorandum of understanding has been signed between Uganda and the China Civil Engineering Construction Corporation for the initial phase of construction. Such mass transit projects are expected to reduce fuel consumption substantially (also contributing to improved air quality in the urban area). Currently, 75.5% of national petroleum consumption comes from the transport sector, which represents 67% of direct GHG emissions in the energy sector in Uganda (KCCA 2015). The city region's average passenger demand was forecasted at 236,045 passengers per day in the next 20 years, and the BRT would be able to reduce transportation emissions by 20-30% in the city (KCCA 2015).

KCCA has also developed the Multi-Modal Urban Transport Master Plan for the Greater Kampala Metropolitan Area (GKMA) through the Second Kampala Institutional and Infrastructure Development Project (KIIDP2). The plan proposes the development of a mass rapid transit

(MRT) network, including light rail, buses and cable cars to be completed in several stages until 2040. It aims to replace non-sustainable modes of transport, such as cars and boda-bodas, with more sustainable means, improving mobility by reducing travelling times, reducing road accidents and fatalities, and reducing energy use, air pollution and emissions (KCCA 2018c).

The KCCA also estimates that improvement of road infrastructure, good driving practices and restrictions on the age of second-hand vehicles imported could reduce energy consumption by 20% in Kampala, and 25-30% in the Greater Kampala Metropolitan Area (KCCA 2015). In the KCCA's opinion, switching to blended fuel would also be a feasible project that would reduce emissions 5-20%.

Many eco-mobility projects are currently being promoted, including car sharing, but an important consideration is the number of people currently employed in the existing transport sector. Boda-boda drivers, as well as related repair businesses, are a significant employer in the city (KCCA 2015). For this reason, the KCCA notes that any related interventions will need to be undertaken with consultation of affected stakeholders.

The Kiira Motors Corporation is a state-owned auto manufacturer, but is not explicitly included in any government climate plans. However, the Kiira Vehicle Technology Innovation Program has designed three concept electric vehicles: the "Kiira EV", Africa's first electric Vehicle, the "Kiira EV SMACK", Africa's first hybrid electric vehicle and the "Kayoola Solar bus", Africa's first solar electric bus (Movin' On Lab 2018). Kiira Motors Corporation received the 2016 Frost and Sullivan Visionary Innovation Leadership award in Sustainable Mobility. However, it seems the company has not continued any other notable sustainability initiatives.

Opportunity in the household sector

As noted previously, 80% of households in Kampala use charcoal for cooking. Energy-efficient cookstoves have been a focus of PoAs and development assistance projects in East Africa for some time. The KCCA has highlighted the potential for mitigation in its Energy and Climate Profile, determining that the use of energy efficient stoves could reduce energy consumption by 20-40% (KCCA 2015). In addition, the draft Kampala Disaster Risk and Climate Change Resilience Strategy (2019) suggests, as one of its actions, the development of a proposal for an incentive program to reduce carbon emissions from households through the purchase of energy-efficient stoves.

However, the Energy and Climate Profile also notes that switching to low carbon intensity fuels at a household level may not be feasible in the near future, though the exact barriers are not discussed. Most of the emissions in the tertiary and residential sectors are biogenic, making them very difficult to reduce (KCCA 2015). Additionally, there are important social implications with the charcoal market, which provides significant formal and informal jobs in Kampala. Households and small businesses also have significant financial limitations in procuring new equipment. Improving energy efficiency in charcoal production can significantly lower emissions and would also be an interesting Article 6 activity. However, implementation of such programs is highly challenging (from organisational and financial viewpoints) and also takes place outside city boundaries. It is therefore not in the focus of measures looked at in this study.

Overall, household emissions are a very important sector, contributing greatly to urban emissions. Though widespread uptake will be challenging, the KCCA acknowledges that "improvement in the use of biomass has to be considered as a priority" (KCCA 2015, p 68). Demand for charcoal and related GHG emissions are expected to increase, negatively affecting air quality. Primary mitigation options include developing more efficient cookstove installations, alternative sources of energy and briquettes and eco-stoves. Any projects in this sector will have to be evaluated carefully, however, as feasibility is potentially limited.

Opportunity in the waste sector

Though waste comprises a relatively small proportion of urban emissions, many of these projects offer significant financial and environmental benefits and are therefore a focus on many KCCA pilot projects. The local government noted multiple times the potential revenue and jobs that could be associated with methane capture from landfills (KCCA 2015). Though the emissions contributions may be relatively small in comparison to transport or household cooking, waste generation is expected to increase in coming years, and the sector may be a prime example of 'low-hanging fruit', in terms of probable project feasibility and impact.

Other relevant opportunities

Though city street lighting is also a relatively low-impact sector, the current solar street lighting project in partnership with the AFD is suitable to Article 6. As of 2015, only 15% of the city's 1,200km road network was fitted with streetlights, with less than 8% properly functioning (KCCA 2015). Replacement of all existing streetlights in the city is expected to reduce energy use by 40% and reduce costs by 60%. Such projects should be prioritised, offering the much-discussed 'triple-bottom-line' benefits. The streetlights also raise income through advertising, though vandalism is an ongoing issue.

Examination of current and planned measures and policies that are suitable for urban Article 6 activities

Table 9: Criteria for urban Article 6 activities

Measure	Role within NDC (conditional, unconditional, inside, outside)	Quantifiability of the effects	Emissions reduction target	Timeline	Key institutions relevant for Article 6 implementation	Additionality	Contribution to SDGs	Cost efficiency and potential Article 6 market demand for allowances	Replicability or transferability to other cities	Potential conflicts between involved institutions
Light rail transit (LRT)	Inside, conditional	Easily quantified	n.a.	Planned, no implementation date set	Ministry of Works	High additionality	9, 11, 13, 15	High cost efficiency	High potential (already implemented in Addis)	Job loss for taxi and boda boda drivers
Bus Rapid Transit (BRT)	Inside, conditional	Easily quantified	20-30% reduction in urban transportation emissions	Feasibility study complete; no final implementation date set	Ministry of Works, KCCA, Uganda National Roads Authority	High additionality	9, 11, 13, 15	High cost efficiency	High potential	Job loss for taxi and boda boda drivers
Standard Gauge Railway	Inside, conditional	Easily quantified	n.a.	Construction beginning 2022/2023, opening planned for 2025	Ministry of Works	Low additionality	8, 9, 11, 15	High cost efficiency	n.a.	Interaction between multiple involved countries
Non-motorised transport strategy	Inside, conditional	Not easily quantified	n.a.	Proposed, no timeline	KCCA	High additionality	3, 11, 13, 15	Low cost efficiency	Potential for replicability	Job loss for taxi and boda boda drivers

Measure	Role within NDC (conditional, unconditional, inside, outside)	Quantifiability of the effects	Emissions reduction target	Timeline	Key institutions relevant for Article 6 implementation	Additionality	Contribution to SDGs	Cost efficiency and potential Article 6 market demand for allowances	Replicability or transferability to other cities	Potential conflicts between involved institutions
Solar street lighting	Inside, conditional	Easily quantified	40% reduction in street light energy use	Planned, no timeline	KCCA	Moderate additionality	7, 9, 11, 13, 15	High cost efficiency	Potential for replicability	No conflict foreseen
Market eco-stoves	Inside, conditional	Moderate quantifiability	20-40% in energy consumption	Proposed, no timeline	KCCA	High additionality	3, 11, 13, 15	Low cost efficiency	High potential	Conflict with current stove producers
Biogas recovery	Inside, conditional	Easily quantified	n.a.	Proposed, no timeline	KCCA	High additionality	7, 11, 13, 15	High cost efficiency	High potential (already implemented in Addis)	No conflict foreseen

Note: The most promising ongoing or planned projects are analysed in this table, which is not an exhaustive list.

1.4 Summary

1.4.1 Ethiopia

Ethiopia aims to reduce GHG emissions by circa 56 Mt CO_2e in 2030 under the unconditional NDC, which equals a reduction of 14% of GHG emissions under the BAU scenario. Ethiopia calls for international technical and financial support to achieve its remaining mitigation target, i.e., 277.7 Mt CO_2e by 2030. The livestock sector shares the largest share of GHG emissions, followed by the LUCF sector. The two sectors represent more than 89% of total BAU GHG emissions by 2030, followed by the energy sector (10.7%) and waste sector (9.1%) (GoE 2021b). The revised Ethiopia NDC was developed based on the 10-year Development Plan (2020/21-2029/30) and the CRGE strategy.

There is limited data on Ethiopia's cities' GHG emissions profiles in order examine emissions across various cities. In Addis Ababa, reports show that the transportation sector is the highest emitter of GHG emissions, accounting for about 68%; followed the waste (20%) and building (12%) sectors.

Section 1.2 presented Ethiopia's experience in the international carbon market. Under the Kyoto Protocol, the country registered nine CDM activities: two single projects and seven PoAs with a total of 16 CPAs. So far, CER issuance has been achieved from four PoAs, accounting for a total of over 750,000 CERs. The section also discussed Addis Ababa's carbon market experience. The city hosts four CPAs focusing on dissemination of improved cook stoves to households and one single CDM project in the landfill gas activity type. However, these activities have not issued CERs credits to date.

Ethiopia's updated NDC shows the country's commitment to participating in new carbon market mechanisms. Ethiopia is partaking in relevant initiatives, including JCM, MATS and Ci-Dev programs, that could strengthen its readiness for Article 6 activities of the Paris Agreement. Moreover, Ethiopia has joined the East African Alliance on Carbon Markets and Climate Finance (EAA) in order to expand its capacity and exchange regional carbon market experiences.

In Section 1.3, key urban climate protection strategies and policies were discussed. Ethiopia hopes to transform its cities to a more resilient, safe and healthy environment. The country has developed different urban policies and strategies towards this objective, including the 10-Year Development Plan, Urban Wastewater Management Strategy, Climate Resilient Transport Sector Strategy and Non-Motorised Transport Strategy. In similar efforts, Addis Ababa has developed different strategies, for instance, the Addis Ababa Resilience Strategy and the Addis Ababa Non-Motorised Transport Strategy. In addition, the section highlighted Addis Ababa's ongoing GHG mitigation efforts— for example, the construction of 200km of cycle tracks by 2028, a 600km pedestrian network, LRT and bus rapid transit projects and development of the Koshe dump site. The section concludes in examining feasibility and potential benefits of various projects under Article 6 carbon market mechanisms. Overall, there is limited public information on the ongoing projects; hence relevant stakeholders will be approached to fill the information gap.

1.4.2 Uganda

Climate change will disproportionately affect African countries, and immediate adaptation and mitigation interventions are increasingly important. Uganda's business-as-usual (BAU) scenario estimates emissions of 77.3 million tons of carbon dioxide equivalent per year in 2030. The Ugandan NDC aims for a 22% reduction in emissions in 2030 compared to BAU, but is

conditional on 70% financing from international sources, with a domestic contribution of 30%. As discussed in Section 1.1, the most relevant national policy focused on climate change is Uganda's National Climate Change Policy (NCCP), adopted in 2015. On a local level the Kampala Climate Change Action Strategy is the leading policy, following the NDC goal of 22% emission reductions by 2030.

The importance of urban centres in climate change mitigation is clear.

GHG emissions per capita

There is significant difference between GHG emissions per capita in the capital city as compared to the national average.

- Kampala: 2.4 tCO_2e/resident
- Greater Kampala: 1.75 tCO_2e/resident
- Uganda: 1.5 tCO_2e/resident

Source: KCCA 2016

In Section 1.2, previous activities and agreements related to Article 6 of the Paris Agreement were explored, focusing on Uganda's significant number of PoAs and apparent success as a CDM host country, generating more than 13 times the amount of CERs as Ethiopia. Uganda is also involved in other prominent initiatives, including GGGI, Ci-Dev, Carbon Market Foundation and the GIZ Global Carbon Markets Programme, for which it serves as the host country.

In Kampala, a **majority of urban emissions are a result of the transport and household cooking sectors,** due to the high use of charcoal and personal motorised transport. These sectors are currently major focuses of mitigation projects such as light rail and bus transit, efficient cookstoves and other pilots. However, the influence of existing jobs could make these areas much more difficult to impact than waste, another area of focus. There is significant potential revenue, job creation and GHG emission reductions related to biogas recovery in landfills, which has already been implemented in Addis Ababa.

In Kampala, significant emissions have already been avoided via the use of hydropower, limited cooling and low electricity demand. In this respect, the major differences between emissions profiles in Kampala and the national level need to be considered. Kampala has very low emissions from LUCF and agriculture, due to the urban nature of the area, while these sectors are the main contributors to national emissions. Additionally, Kampala is home to a majority of the country's motorised vehicles, significantly shifting the energy mix with a large percentage of petroleum.

The feasibility and potential benefits of various projects in Article 6 markets has been summarised in Section 1.3, highlighting projects with high cost-efficiency (such as light rail and bus transit), easily quantifiable outcomes (such as solar street lighting) and high potential for replicability (such as e-stoves). A major limitation in this assessment is the availability of information on the status and feasibility of such projects. Further analysis would likely require consultation with the responsible authority to clarify timelines for planned projects.

2 Identification of key players

2.1 Overview of relevant national institutions for Article 6 implementation

2.1.1 Ethiopia

The Climate Resilient Green Economy (CRGE) Facility is the main institution in Ethiopia dedicated to mobilising and disbursing climate finance from various sources. While the **Ministry of Finance (MOF)** is a financial wing of the Facility, **the Environment, Forest and Climate Change Commission (EFCCC)** is responsible in managing programmatic and technical aspects, including the national measurement, reporting and verification (MRV) system and Nationally Determined Contributions (NDC) accounting and reporting. Each ministry has a focal person at the CRGE, and most experts have some exposure to carbon markets. The EFCCC, **Ministry of Water, Irrigation and Electricity (MOWIE)** and **Development Bank of Ethiopia (DBE)** are among key national institutions with relevant carbon market experience.

The EFCCC is Ethiopia's designated national authority (DNA) for the Clean Development Mechanism (CDM). Moreover, EFCCC is mandated to lead UNFCCC negotiations including on Article 6, as well as negotiating bilateral agreements on implementing Article 6 activities. **The EFCCC Planning Directorate** is the main body responsible for sustainable development goals (SDG) reporting, which also applies to carbon market activities under the CDM, although it is not yet decided if the Planning Directorate would keep this role for Article6.

DBE is the only public sector Coordinating/Managing Entity (CME), currently operating two CDM PoAs for off grid electrification and clean cooking with support from the World Bank's Carbon Initiative for Development (Ci-DEV n.d. a; UNFCCC 2018a; UNFCCC 2019). These mainly operate in rural areas, have both successfully issued CERs, and are set to be transitioned to Article 6 in the context of the Ci-DEV Standardised Crediting Framework (UNEP DTU 2021a).

While it remains unclear which role existing CDM activities will play for Article6 (pending UNFCCC negotiations, and national decision-making in light of the unconditional NDC target), existing CDM project proponents may evolve into important Article 6 stakeholders as well. At city level, **Addis Ababa City authority** has been a CDM project proponent for the "Methane Capture and Flaring from Addis Ababa Repi open dump fill'' project since 2013 (UNEP DTU 2021b). This is crucial, as there is replication potential in other major cities in Ethiopia. However, the project has not yet requested the issuance of any CERs (as per CDM registry), even though the fixed 10-year crediting period already ends in 2023. This raises significant questions about the success of the operations and/or the capacity of the project proponents to navigate CDM requirements e.g., with regards to monitoring reports and recruiting DOEs.

Moreover, the public agency Ethiopian Leather Development Institute has registered a CDM project in 2016, with a crediting period ranging from January 2019–2028. This project has not requested any CER issuance yet and is scheduled to be implemented mainly over the implementation period of Ethiopia's updated NDC, and should therefore be evaluated for its potential to transition to Article 6.

At a regional level, EFCCC is representing Ethiopia in the Eastern Africa Alliance on Carbon Markets and Climate Finance (EAA) to strengthen its preparedness to the new generation of market mechanisms under Article 6 of the Paris Agreement.

EFCCC also operates a **Carbon Market Committee**, established in 2018 in order to prepare for Article 6, and is committed to strengthen Ethiopia's participation in carbon market mechanisms. The Committee comprises five directors from the EFCCC's Environment Commission Directorate, Resource Mobilisation Directorate, Project Monitoring and Evaluation Directorate,

Forestry Commission Directorate, Climate Change Commission Directorate and Policy Law and Standard Directorate. In addition, EFCCC hosts Article 6 committee members representing directorates from the Resource Mobilisation and Project M&E Directorate, Forest Sector, Policy, Law and Standard Directorate, REDD+ Secretariat and MRV Directorate.

The following table presents key actors related to urban Article 6 implementation in Ethiopia.

Table 10: List of stakeholders relevant in urban Article 6 activities

	City administration	Regional/national authorities	National financial sector	International development partners	NGOs and Research Institute	Others (including "project developers")
Urban transport	Addis Ababa Road and Transport Bureau Addis Ababa City Roads Authority Ethiopia Railways Corporation Addis Addis Ababa City Plan and Development Commission (AACPDC) Addis Ababa Urban Age Task Force Addis Ababa City Administration Environmental Protection & Green Development Commission	Ministry of Transport Ethiopian Industrial Parks Development Corporation (IPDC) Ministry of Urban Development and Construction	Ministry of Finance Commercial Bank of Ethiopia Private Banks (Awash, Dashen, Hibret, Abysinya, etc.)	WB (Transport Systems Improvement Project (TRANSIP)) UN Habitat: Scaling Up Safe Street Designs in Ethiopia Agencé France de Development (AFD): financing BRT in Addis	Institute for Transportation & Development Policy (ITDP)- focus on expansion of the city's BRT system Transformative Urban Mobility Initiative (TUMI)- pilot project on Bike Sharing System	WRI (study on electric buses) Taxi / rideshare associations (e.g. "Ride") Automobile manufacturers e.g. Hyundai/Marathon motors Bamboo labs: produces wheelchairs and bicycles made out of bamboo for the local market
Buildings including heating/cooling	Addis Ababa City Administration	Ministry of Urban Development & Housing (MUDH)				

	City administration	Regional/national authorities	National financial sector	International development partners	NGOs and Research Institute	Others (including "project developers")
		Ethiopian Airlines Ethiopian Industrial Parks Development Corporation (IPDC)				
Public infrastructure (buildings and street lighting)	Addis Ababa Road and Transport Bureau Addis Ababa City Roads Authority	Ethiopian Industrial Parks Development Corporation (IPDC) Ministry of Urban Development and Construction Ministry of Water, Irrigation and Energy Ethiopian Electric Utility Ethiopian Construction Design and Supervision Works Corporation	Ministry of Finance Commercial Bank of Ethiopia Private Banks (Awash, Dashen, Hibret, Abysinya, etc)	WB (Transport Systems Improvement Project (TRANSIP)	The Ethiopian Institute of Architecture, Building Construction and City Development- Addis Ababa University	
Local energy production		MOWIE		GIZ - Energising Development (EnDev) Ethiopia		Project Gaia Inc.: focusing on ethanol cookstoves. It has 2 CPAs in Addis Ababa
Waste sector	AA City Administration/ Addis Ababa Water and Sewerage authority (AAWSA), potentially city	Ministry of Urban Development and Construction	Ministry of Finance Commercial Bank of Ethiopia	UN Habitat (Reppie-Koshe landfill)	Horn of Africa Regional Environment Centre and Network- Addis	

	City administration	Regional/national authorities	National financial sector	International development partners	NGOs and Research Institute	Others (including "project developers")
	administrations in major cities across the country	Federal Job creation Commission Federal Micro and Small Enterprises Development Agency	Private Banks (Awash, Dashen, Hibret, Abysinya, etc) Micro and Small Enterprises (MSEs)		Ababa University (HoA-REC&N-AAU)	
Wastewater treatment	Leather Industry Development Institute (LIDI), other cities/industries	Ministry of Urban Development & Housing (MUDHo) Ethiopian Industrial Parks Development Corporation (IPDC)				
Nature-based solutions (green areas/walking/biking, river/wetland rehabilitation	Addis Ababa City Administration River Basins and Green Development and Administration Agency					

2.1.2 Uganda

The **Climate Change Department** (CCD) **of the Ministry of Water and Environment** (MWE) is the key institution in Uganda related to climate change. CCD is responsible for coordinating Uganda's NDC implementation and serves as a DNA supervising CDM activities in the country. CCD plays key role in the international negotiations process on Article 6 and will be the key Ugandan institution for supervising Article 6 implementation, as well as being responsible for the authorisation of activities that can generate ITMOs. **MWE** is also a Direct Access Accredited Entity at the Green Climate Fund (GCF) as well as the National Implementation Entity for the Adaptation Fund.

The **National Planning Authority (NPA)** is responsible for ensuring climate change-related actions are integrated in the sectoral plans across different institutions operating in Uganda.

Ministry of Finance, Planning and Economic Development (MoFPED) is in charge of mobilising the financial resources required to implement climate actions and serves as GCF NDA.

The **Ministry of Energy & Mineral Development (MEMD**) is responsible for the energy access sector and energy sector investment plans.

Uganda hosts **UNFCCC's Regional Collaboration Center (RCC)**, which is located at the regionally operating East Africa Development Bank.

The **National Disaster Risk Reduction Department** at the Office of the Prime Minister could also be an important stakeholder.

Policy Committee on Environment: The Committee is responsible for strategic policy guidance on environment in Uganda. The purpose of the Committee includes:

providing guidance in the formulation and implementation of environmental and climate change policies, plans and programmes;

liaising with the Cabinet on issues related to the environment;

advising on legislative proposals and standards on the environment;

providing guidance on harmonisation of government policies with respect to the environment, natural resources, water and climate change; and

performing any other function that may be assigned to it by Cabinet (Republic of Uganda 2019, p.24).

The Committee consists of: the Prime Minister, who shall be the chairperson, and ministers responsible for: water and environment; agriculture, animal industry and fisheries; finance, planning and economic development; education, science, technology and sports; health; lands, housing and urban development; **local government**; gender, labour and social development; tourism, wildlife and antiquities; trade, industry and cooperatives; works and transport; energy and mineral development; internal affairs; defence and veterans affairs; information, communications technology and national guidance (Republic of Uganda 2019).

National Advisory Climate Change Committee: responsible for providing climate change technical input to the Policy Committee on Environment. The committee is chaired by the Minister for Water and Environment and will bring together technical representatives from the various government departments at the national level, along with representatives from private-sector associations, civil society, academia and district authorities (Republic of Uganda 2015).

National Climate Change Commission: established under the Ministry of Water and Environment to act as a national coordination centre for climate change. The Commission has the following key responsibilities:

Acting as an information clearinghouse on climate change concerns;

Providing policy and strategic advice on climate change;

Supporting awareness raising, communication and outreach on climate change;

Ensuring the integration of climate change concerns into overall national planning through coordination with the relevant ministries, departments and governmental agencies;

Providing secretarial services to the Policy Committee on Environment (PCE) in regards to climate change matters only (since the Secretariat of the PCE is NEMA), the National Climate Change Advisory Committee and the CDM Designated National Authority;

Monitoring the implementation of the Climate Change Policy and its Implementation Strategy;

Serving as the National Focal Point for the United Nations Framework Convention on Climate Change (UNFCCC) (Republic of Uganda 2015, p.41).

Ministry of Finance, Planning and Economic Development (MoFPED): responsible for coordinating development planning; mobilisation of public resources; and ensuring effective accountability for the use of such resources for the benefit of all Ugandans.

National Environment Management Authority (NEMA): semi-autonomous institution, established in May 1995 as the principal agency in Uganda charged with coordinating, monitoring, regulating and supervising environmental management in the country.

Ministry of Local Government: coordinates the implementation of the decentralisation policy.

In Kampala, the **Kampala Capital City Authority** is a key institution in coordinating and managing the city's climate change projects.

Table 11: List of stakeholders relevant in urban Article 6 activities

	City administration	Other local authorities	Regional/national authorities	National financial sector	International development partners	NGOs and Research Institutes	Others (including "project developers")
Urban transport electrification	Kampala Capital City Authority (KCCA) Directorate of Engineering and Technical Services; Risk Management; Strategy Management and Business Development; and Physical Planning	Uganda Road Sector Support Initiative	Ministry of Works and Transport, Uganda National Roads Authority Uganda Transport Development Agency (UTRADA) Ministry of Energy and Mineral Development		UN-Habitat The Energy and Environment Partnership Trust Fund (EEP Africa) – clean energy financing facility hosted and managed by the Nordic Development Fund (NDF) UNEP World Bank GEF	ITDP- focusing on BRT system, mapping Kampala's informal minibus taxis, and cycling advocacy First African Bicycle Information Organization (FABIO), a local NGO empowering Ugandans using bicycles; focus also on e-mobility Uganda Sustainable Transport Network Uganda Local Government Association (ULGA)	Bodawerk Zero Emission Motorcycle Boda (Zembo) Taxi / rideshare associations Cities and Infrastructure for Growth (CIG) Uganda Kiira Motors Ultimate Cycling Uganda

	City administration	Other local authorities	Regional/national authorities	National financial sector	International development partners	NGOs and Research Institutes	Others (including "project developers")
						Makerere University's Centre for Research in Transport Technologies (CRTT) IEA	
Private buildings including hot / cold	KCCA Directorate of Physical Planning; Directorate of Engineering and Technical Services; Risk Management; Strategy Management and Business Development		Ministry of Lands, Housing and Urban Development National Building Review Board National Planning Authority			ULGA	
Public infrastructure (buildings and street lighting)	KCCA Directorate of Engineering and Technical Services		Ministry of Works and Transport		AFD	ULGA	Kampala City Solar Street Lighting Project (R20)

	City administration	Other local authorities	Regional/national authorities	National financial sector	International development partners	NGOs and Research Institutes	Others (including "project developers")
Local energy production	KCCA – mandate does not explicitly include energy management		Ministry of Energy and Mineral Development The Energy Efficiency and Conservation Department (EECD) Electricity Regulation Authority (ERA) Uganda National Renewable Energy and Energy Efficiency Alliance (UNREEEA) Uganda National Roads Authority		Japan International Cooperation Agency (JICA)- focusing on grid electricity UNDP BMU	East African Centre for Renewable Energy and Energy Efficiency (EACREEE) Climate Action Network (CAN) ULGA Makerere University	Zembo: focusing on e-mobility UpEnergy Group: E-Cooking Program in Urban areas Uganda Electricity Transmission Company
Waste sector	KCCA Directorate of Engineering and Technical Services	Kampala Pollution Control Task Force (PTF)	Ministry of Water and Environment (MWE) National Environment		SIDA World Bank	ULGA	Asante Waste Management Kampala Waste Treatment and Disposal PPP – IFC

	City administration	Other local authorities	Regional/national authorities	National financial sector	International development partners	NGOs and Research Institutes	Others (including "project developers")
			Management Authority (NEMA)				
Wastewater treatment	KCCA Directorate of Engineering and Technical Services; Risk Management; and Physical Planning	Kampala Pollution Control Task Force (PTF)	National Water and Sewerage Corporation (NWSC) Ministry of Water and Environment (MWE), Directorate of Water Resources Management (DWRM)		AfDB KFW AFD EU-ITF EIB	ULGA WaterAid Uganda	

2.2 Recommendations on further dialogue with relevant national institutions as part of the project

The following are key institutions identified to be contacted for development of case studies. The selection is based on the interviews conducted with the Designated National Authority (DNA) Office and Addis Ababa City Resilience Project Office, as well as prioritised case-study sectors.

2.2.1 Ethiopia

Transport sector

The Addis Ababa Road and Transport Bureau (AARTB) is responsible for managing transportation projects around the city. This institution is important to understand the city's long-term vision and proposed interventions in reducing GHG emissions from the transport sector. AARTB provides political leadership and general oversight toward implementation of Addis Ababa's non-motorised transport strategy (2019-2028).

The Addis Ababa City Transport Authority (AACTA) will be another key institution to understand Addis's transport regulations, including operations, and regulates public and freight transport, building public transport facilities, routes and freight terminals. Furthermore, AACTA sets and enforces fare rates for all public (city buses and LRT) and private operators (mini-buses), as well as assigning routes for city buses (ACBE, SMTE and Alliance Bus).

The Transport Project Management Office (TPMO) is a technical project implementation unit under the AACTA. It manages Addis's BRT system planning, design and implementation, responsible for all corridors and items related to BRT.

Sheger Mass Transit Enterprise (SMTE) is an express-bus service recently implemented to make inner city bus service efficient and effective. SMTE is responsible for providing buses for the newly planned BRT system.

Ethiopian Railway Corporation (ERC) is responsible for running Addis Ababa's LRT system. ERC will be a bridge to understand the LRT's current gaps and opportunities.

Public buildings

The **Housing Development & Administration** Agency is responsible for participating in and strengthening institutions involved in housing construction and building economical condominium houses. The Agency could be a key contact to further discuss rooftop PV for own consumption in Addis Ababa.

Ministry of Water, Irrigation and Electricity is a relevant institution at a national level related to energy projects.

The **Ministry of Health of Ethiopia** is a federal government ministry of Ethiopia, responsible for public health concerns, and could be an important player in any potential health sector initiatives.

2.2.2 Uganda

Transport sector

Within the transport sector, the **Kampala Capital City Authority** is the key actor coordinating ongoing and proposed projects. The KCCA is responsible for drafting the city's climate action plan and is involved in many of the potential Article 6 projects, including the LRT and BRT systems, as well as the non-motorised transport strategy.

The **Ministry of Works** and **Uganda National Roads Authority** are also involved in these projects and could be additional partners.

The **Ministry of Energy and Mineral Development** is also involved in electromobility projects. The department's mandate is to "establish, promote the development, strategically manage and safeguard the rational and sustainable exploitation and utilisation of energy and mineral resources for social and economic development" (2021). The ministry is currently cooperating with the UNEP and IEA on a boda-boda project in the city.

Alternatives to charcoal

In this sector, the **Kampala Capital City Authority** is again the main local actor. The KCCA is involved in the market eco-stoves project that has been proposed, and would be key in ensuring widespread implementation in Kampala. The KCCA has been involved in past stove projects in city markets and is experienced in PoA implementation. All other actors that could be identified are international agencies.

3 Case studies

Based on the analysis of local structures and priorities, as well as interviews held with stakeholders from Addis and Kampala, two case studies for potential Art. 6 activities have been identified in each of the cities:

- E-mobility in Addis;
- Green cooling in health facilities in Addis;
- Bus rapid transport system in Kampala; and
- Clean cooking in Kampala.

Each of the case studies first analyses the current situation and barriers preventing a switch to less emission-intensive alternatives, then suggests the possible scope of the urban Art. 6 activity, potential policy instruments and the role of relevant stakeholders, and finally assesses the emission reduction potential, required financing and ITMO prices, summarising potential ways forward.

3.1 E-Mobility in Addis

Background

As has been highlighted in the first section of this report, transportation is a key sector to address climate change in Ethiopia and in particular in Addis. The city accounts for 70% of registered vehicles in the country. **The transport sector in Addis accounts for approximately 11.26 million tCO_2e, or about 78% of the city's total emissions**. Road transport shares around 51% of the total Addis GHG emissions, followed by the aviation sector (26%). In Ethiopia, the total number of cars is estimated at 1.1 million, of which 219,699 vehicles are small automobiles (Capital 2022). Currently, the fleet is growing at about 14% annually. If growth continues on the same linear basis, by 2030 there will be over 2.5 million cars in the country.

Despite the heavy tax on imported cars, the number of cars in Ethiopia has been rapidly increasing. Around 110,000 cars were imported in 2016, i.e., a 50% increase compared to the preceding two years. Around 85% of imported cars in Ethiopia have an average age of 20 years (UNECA 2020; Kebede 2021) and most of these cars are highly polluting (Addis Ababa City Administration 2018). In 2019, Ethiopia had a total of 24,700 motorcycles, 383 three-wheelers, 27,357 buses (< 12 seats) and 16,698 buses (> 11 seats) (Ethiopian Federal Road Transport Authority cited in Kebede et al. 2022). In addition, there are around 1,700 taxis and 460 public buses for federal and Addis Ababa city administration employees, as well as for public service employees in the Oromia special zone around Addis Ababa (Ministry of Transport 2020).

Under the business-as-usual (BAU) scenario, the total amount of greenhouse gas (GHG) emissions from the transportation sector at a national level is estimated to be around 41 million tons of CO_2 by 2030 (Ministry of Transportation 2020).

A number of initiatives aim at reducing congestion and promoting sustainable transportation. Since the end of 2018, the German International Climate Initiative (IKI) has been funding an EUR 5 million project "Growing smarter – sustainable mobility in East Africa," aiming to facilitate the promotion of public- and non-motorised transport and smart urban planning in

Addis Ababa, Nairobi, Kigali, Kampala and Dar es Salaam. Addis Ababa is improving walking and cycling infrastructure in the city to curb the growing use of personal vehicles. The Non-Motorised Transport Strategy outlines a holistic set of measures to expand the use of non-motorised modes. Over the next ten years, the city plans to develop a citywide walking and cycling network that makes sustainable modes of transport safe, convenient and easy to use. Important infrastructure and social centres, such as the large open-air market "Merkato", the prominent Churchill Avenue in the city centre and key routes as e.g., from the city's Piazza area to Ras Mekonen Bridge, will be in the focus (IKI 2021a).

The Ministry of Transport's 10 Years Perspective Plan (2020-2030) aims to reduce GHG emissions from the transport sector by introducing different measures, ranging from expanding public transpiration to promoting e-mobility. The Ministry plans to introduce 4,850 electric buses and 148,000 small electric vehicles by 2030 (Ministry of Transport 2020, p. 63).

In the last decade, a number of electric vehicles supposed to be manufactured in Ethiopia have been announced. In 2010, manufacturing of the Solaris Elettra in Addis Ababa was announced, with a price of USD 12,000-15,000. However, this never materialised. In 2015, Global Electric Transportation Ltd. announced an electric car assembly plant with a capacity of 40,000 vehicles/year (Walta 2015), but then didn't execute. Finally, and most promising, Marathon Motor Engineering, a joint venture between Hyundai Motor Company and Olympic Champion Haile Gebrselassie, started producing the electric Hyundai Ioniq in Ethiopia in 2020 (Kuhudzai 2020).

In June 2021, a pre-feasibility study for the "Ethiopia Bus Rapid Transport-BRT B2 Line E-Mobility Project" in Addis was launched, supported by the Government of Ethiopia (GoE's) and the French Development Agency (AFD). The pre-feasibility study will assess the financial and economic opportunity of shifting the baseline choice of vehicles from diesel Euro II/III emissions standard to low-carbon buses. The findings of the study will inform GoE's decisions on future BRT routes and concepts (GGGI 2021).

Despite all these efforts, a key market segment in the transport sector— the two- and three-wheelers— have not yet been targeted. Ethiopia had 24,700 two-wheelers and 383 three-wheelers in 2019 (Ethiopian Federal Road Transport Authority cited in Kebede et al. 2022).

Key barriers faced by e-mobility in Addis

The key barriers to a widespread use of electric vehicles are **limited financial resources coupled with higher investment costs for electric vehicles** compared to conventional ICE-vehicles.

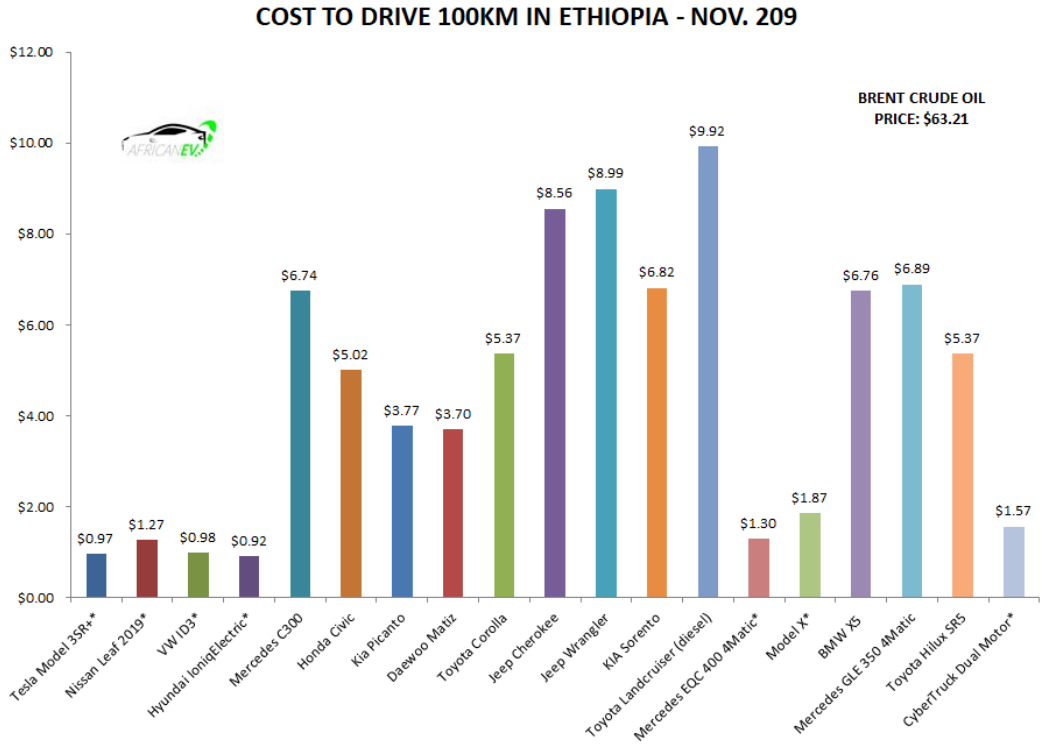
It is important to note that Addis' transport sector covers several market segments:

- Two- and three-wheelers (both private use and as taxis);
- Private cars;
- Taxis (cars);
- Mini-buses providing taxi-services;
- Public passenger buses; and
- Light Duty Vehicles (LDVs).

Those market segments have different characteristics, affecting key aspects such as travel distances (km/yr), annual greenhouse gas emissions (tCO_2e/yr) and ability to pay for new vehicles. Hence, different incentives and policies will be required for the different market segments.

It is also important to note that, while investment costs for electric vehicles are higher compared to internal combustion engine (ICE) vehicles, operation and maintenance costs of electric vehicles are substantially lower than those of ICEs. This is due to low electricity tariffs and less need for maintenance of electric motors. The Nürtingen Institute for the Automotive Industry (IfA) estimates that maintenance and repair costs for electric vehicles are around 30% lower than those of a comparable vehicle with an internal combustion engine. A study conducted by AfricanEV in 2019 compares the cost of travelling 100km with a Hyundai Ioniq, Nissan Leaf, VW ID.3 and Tesla Model 3 in Ethiopia to classical ICE vehicles, as seen in Figure 11.

Figure 11: Travel costs of electric vehicles in Ethiopia (Nov. 2019)



Source: Kuhudzai 2020

Hence, the key issue that needs to be addressed for boosting e-mobility is the **investment barrier**. Taxi owners/operators need to be enabled to afford higher prices for EVs compared to ICE vehicles, and can then benefit from a significant drop in fuel costs.

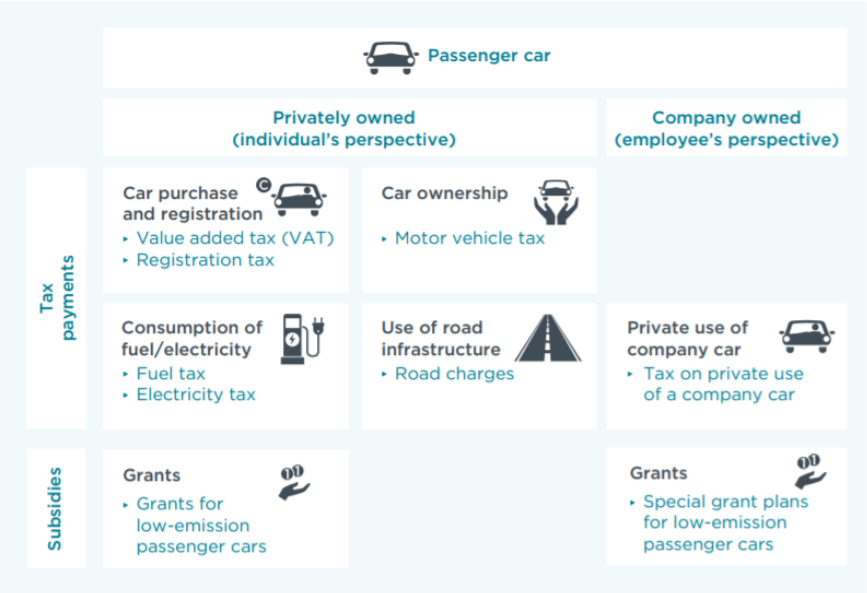
In addition, sufficient **charging infrastructure** needs to be built to ensure smooth operation of electric vehicles. On December 28th, 2021, Marathon Motors opened the first electric vehicle charging station in Ethiopia. It can charge vehicles within 15 minutes for a 300 km drive. However, a significant number of charging stations and other charging systems is required for mass use (Capital 2022).

Potential policy interventions

Various policy instruments aiming to promote e-mobility have been tested and implemented around the world. The following policy instruments are amongst the most common ones, and could also be applied in Addis:

- Direct subsidies for purchase of e-vehicles (special grants for electric vehicles)
  - Either as a (capped) percentage of the purchase price of the electric vehicles, or as lump-sums.
  - Can be differentiated by vehicle type, e.g., two-wheelers, three-wheelers, small passenger cars or mini-buses.
- Reduced taxes (see Figure 12), e.g.:
  - On car purchase (vehicle registration tax, VAT)
  - On car ownership (motor vehicle tax)
  - On use of road infrastructure (road charges, parking slots)
  - Consumption of fuel (electricity)
- Zero- or low-interest loans for encouraging e-vehicle purchases
- Incentives for build-operate-transfer (BOT) schemes
- Public investments in e-mobility infrastructure (charging stations, special, cost-free parking slots for electric vehicles)
- Lowered or zero electricity costs for e-charging

Figure 12: Overview of typical vehicle taxes



Source: Wappelhorst et al. 2018

The optimal design and combination of policy instruments depends on the market segment(s) under consideration and requires an in-depth analysis, which goes beyond the scope of this study.

Nevertheless, in the following paragraphs, we summarise a high-level concept for an Article 6 activity in Addis' transport sector, which can be elaborated in more depth if local stakeholders are interested in pursuing the concept further.

Proposed scope and structure of the Article 6 activity

The objective of the proposed Article 6 activity is to initiate and expand use of e-mobility in Addis. With renewables close to 90% of installed generation capacity (IRENA 2021), grid electricity for charging EVs (and also for stand-alone PV-charging stations) results in significantly lower greenhouse gas emissions than diesel or gasoline. The use of electric vehicles will not only reduce GHG-emissions but also local air pollution, which is increasingly becoming an issue in Addis.

As discussed above, Addis' transport sector can be differentiated into several market segments. Aiming to sustainably transform the whole motorised transport sector in the city, the Article 6 activity should be open to all these different segments. At the same time, the different market segments will require different solutions and incentives. In order to achieve such broad yet flexible coverage, we suggest an approach similar to "Programmes of activities (PoAs)" under the UNFCCC's Clean Development Mechanism (CDM). A PoA serves as an umbrella, under which a coordinated set of actions, policies or measures can be implemented with common rules and reduced transaction costs. Under a PoA, an unlimited number of "component project activities (CPAs)" can be added. Amongst other things, this can have the following advantages:

- Market segments and target groups can be integrated step-wise, considering priorities and experience with previous activities and based on available funding;
- Engagement of individual actors can be simplified;
- Emission reductions can be continuously scaled up since new activities/market segments can be added at a later stage;
- Calculation of emission reductions follows the same standards, so one can use the same or similar tools; and
- Monitoring and verification can be undertaken by using same software/tools.

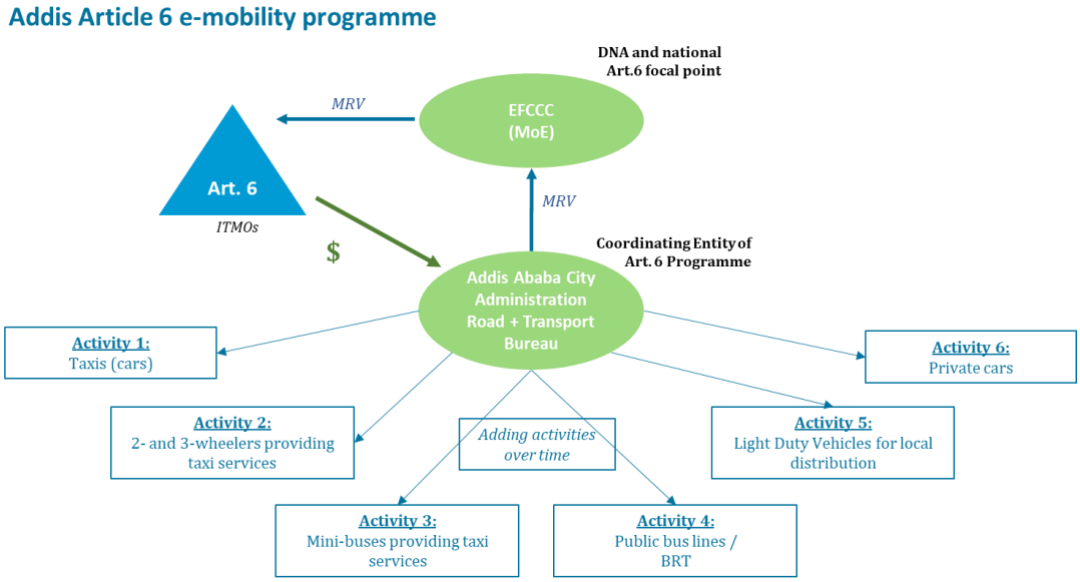
In the context of Article 6, the *Addis Article 6 e-mobility programme* would be coordinated by one single, authorised entity – starting with one market segment (e.g. mini-buses providing taxi-services). Over time, it would be possible to add other market segments (e.g. two-/three-wheelers) and/or ownership structures while applying the same rules and avoiding re-inventing the wheel. This will minimise transaction costs for all stakeholders involved and make the Article 6 programme more attractive to international donors and investors.

As a practical example, a digital MRV platform could be established at the programme level, which could then be used by all activities in different transport market segments for determining achieved emission reductions.

A number of domestic actors will be involved in the coordination, financing and operation of the *Addis Article 6 e-mobility programme*, including the Environment Forest and Climate Change Commission (EFCCC), the Addis Ababa City Administration Road and Transport Bureau and – depending on the type of policy interventions – the Development Bank of Ethiopia (e.g., through loans), as well as the Ministry for Transport and the Ministry of Finance.

As the Addis Ababa City Administration Road and Transport Bureau is responsible for the transport sector in Addis, it would be a natural candidate for taking the role of the coordinating entity of the *Addis Article 6 e-mobility programme*, while the EFCCC is the pre-defined DNA and national focal point for Article 6. Figure 13 visualises the approach and the proposed roles in the context of the programme.

Figure 13: Proposed structure for the Addis Article 6 e-mobility programme



Source: Authors

Example: Electrification of taxi services in Addis

One example of a possible activity under this programme would be the electrification of taxi services in the city. Public transport in Addis Ababa is provided by high-capacity buses operated by the publicly owned Anbessa City Bus Services Enterprise (often with a nominal capacity of 100 passengers), and by minibus and modified taxis (pick-ups converted to carry passengers) with a capacity of 4-11 passengers. The estimated number of minibuses and modified taxis operating in Addis Ababa varies by source: PPIAF (2005) estimates the number at just over 7,500 mini-buses and taxis, with approximately 1.2 million passengers daily. In contrast, Woldeamanuel (2007) assumes approximately 14,000 taxi-vehicles: 12,283 cars with 12 seats and 1,800 small taxis with four seats.

Emission reduction potential

Considering the constant growth of the transport sector in Addis since the early 2000s, we assume a total of 15,000 mini-buses and 5,000 small taxis to derive an initial estimate of the emission reduction potential of this Article 6 activity. These numbers need to be verified and updated as part of a more detailed analysis. High-capacity buses are not considered.

Assuming an average travel distance per vehicle of 200 km/day and an average consumption of 12 litres of gasoline per 100km, small taxis and mini-buses emit approximately 400,000 tCO_2e per year.

If, by 2025, the proposed *Addis Article 6 e-mobility programme* achieves replacement of 20% of these ICE-vehicles, and assuming that electric vehicles emit 89% less CO_2 (the share of renewable energy in Ethiopia's electricity production), then the emission reduction potential is

about 80,000 tCO_2e in 2025. If, by 2030, the proposed *Addis Article 6 e-mobility programme* achieves replacement of 70% of ICE-vehicles, then emission reductions amount to **280,000 tCO_2e in 2030.** Assuming a yearly increase of EV-replacement by 10% between 2025 and 2039, the cumulative emission reductions over the 15-years period amount to about **4,500,000 tCO_2,** as seen in **Error! Not a valid bookmark self-reference.**2.

Table 12: Emission reduction potential – electrification of taxi services in Addis (initial estimate)

	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Replacement by Evs	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00
ER (tCO2)	79,523	119,285	159,047	198,808	238,570	278,331	318,093	357,855	397,616	397,616	397,616	397,616	397,616	397,616	397,616
Total until 2030	1,073,564														
Total until over 15 years (2033)	4,532,827														

Source: Author's calculation

Policy interventions of the Addis Article 6 e-mobility programme

As discussed earlier, the key barriers for rapid switch to e-vehicles are: i) higher investment costs and ii) quick, easy and reliable re-charging opportunities.

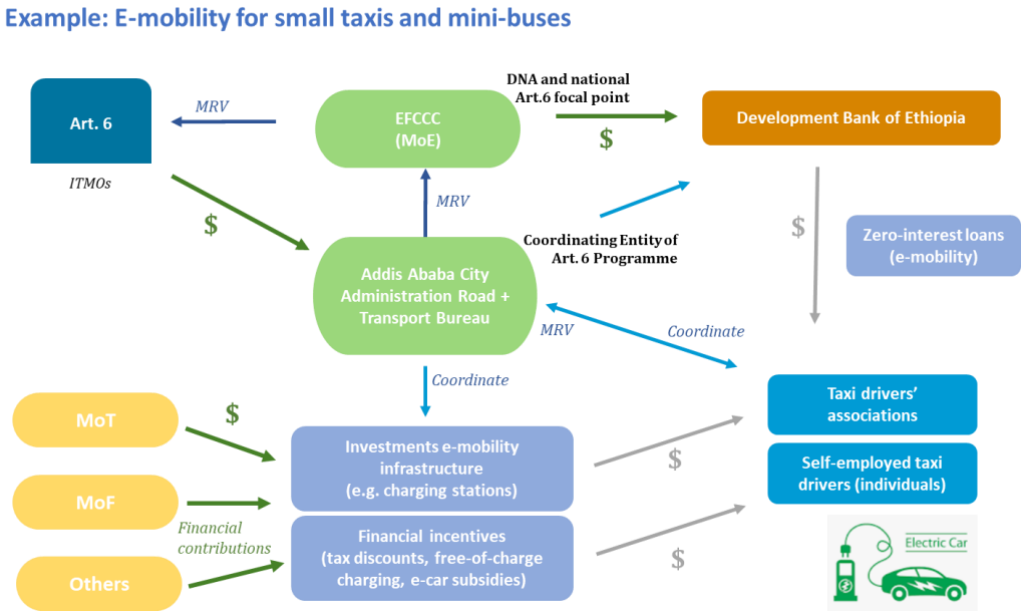
The proposed *Addis Article 6 e-mobility programme* should apply a combination of the following measures and policies to promote the switch to electric taxis:

- Price-premiums should be introduced to reduce the cost difference between electric vehicles and ICE vehicles, thus making a switch more attractive for owners/operators of taxis;
- Zero- or low-interest loans for electric taxis/mini-buses should be used to incentivise an early switch;
- Tax benefits can be provided for electric taxis/mini-buses;
- Public investments should be made in level 3 charging stations (quick-chargers) as required infrastructure to allow for transformation towards e-mobility. We estimate that about 700 – 1,000 charging stations would be required to service all 20,000 mini-buses and taxis (if charging takes place exclusively at public charging stations); and
- Further economic incentives can be provided by offering free-of-charge or low-cost charging stations.

As mentioned above, operation and maintenance costs of electric vehicles are lower than those of ICE vehicles. A signification reduction of fuel costs can be achieved in countries with low electricity costs, and can **be a key motivator for taxi operators to switch to electric vehicles – simply because they spend less money at fuel stations on a daily basis**. Introducing a smart system of subsidies and low-cost loans for making the investment possible, and combining this with low-/zero-cost recharging options can be sufficient achieve a transformation of the sector.

Figure 14 visualises how different policy instruments can be combined, how this can be structured under an Article 6 programme, and what potential roles of key stakeholders could be. The proposed structure is to be discussed with the relevant stakeholders in Addis and Ethiopia.

Figure 14: Potential organisational structure - Article 6 e-mobility taxis



Source: Authors

The **Addis Ababa City Administration** would take the role of the Coordinating Entity of the *Addis Article 6 e-mobility programme*, meaning that it would oversee and coordinate all participants (taxi drivers, owners and operators). Participants need to report all relevant data, such as kilometres driven and information on charging quantities and types to the Coordinating Entity in order to benefit from the e-mobility incentives and programmes. Optimally, all MRV-activities would be facilitated by digital tracking tools that automatically transfer collected data (km driven, charging-stations used and kWh utilised from each charging station) to a central MRV platform that then automatically calculates emission reductions.

The Addis Ababa City Administration would also be in charge of establishing and operating a reliable network of fast-charging stations for taxis, as this is a precondition for the acceptance of electric vehicles by taxi drivers/operators. In addition, it would coordinate – jointly with the **MoT** and **MoF** – the introduction and implementation of financial incentives for e-taxis.

Financial Institutions such as the **Development Bank of Ethiopia** can provide low- or zero-interest loans, enabling taxis owners to make the investments. The loans could be backed up by Article 6 revenues. It is important to note that taxi operators will have a higher ability to pay interest and debt as they save fuel costs.

The **Environmental Protection Authority (EPA)** (formerly called Environment Forest and Climate Change Commission (EFCCC)) in its role as DNA and national Article6 focal point will act as an interface with international carbon markets to help promote the *Addis Article 6 e-mobility programme* internationally and find ITMO-buyers, as well as donors that are willing to support the programme, e.g. through financing more detailed feasibility studies and economic analysis.

Taxi operators and EV-producers need to be integrated adequately. The **Addis Ababa Taxi Association, Public Service Workers' Transport Service Enterprise and the Addis Ababa Taxi Drivers Association** can act as important multipliers. The most important EV-producer in Ethiopia is **Marathon Motors**, already producing three models of EV passenger cars. Optimally,

electric mini-buses will be produced domestically in order to maximise economic benefits for the country and its society. The required production capacities will have to be established. In the long run, exports to other regional markets could become attractive as well.

Initial cost estimate for small taxis

It must be noted that the estimates below are of very preliminary nature, based on publicly available cost information. If Ethiopian stakeholders have an interest in further pursuing the proposed *Addis Article 6 e-mobility programme*, a more detailed feasibility study needs to be conducted based on real local data.

When looking at cost and revenue implications, it is important to take the perspective of different key actors. Taxi owners/operators are the most relevant stakeholder group, as they need to be convinced of switching to EVs. Another highly important actor is the city authority of Addis and the government of Ethiopia, as they will need to build the relevant charging infrastructure to enable the transport sector's transformation to e-mobility.

CAPEX occurring for taxi operators/owners

Taxi owners/operators would face higher investment costs for new electric vehicles compared to ICE vehicles. The numbers below are for small taxis (up to four passengers); mini-buses need to be analysed separately.

Based on literature comparing CAPEX of Hyundai IONICQ Trend (EV) with those of a Hyundai i30 1.4 T-GDI (ICE), we assume the additional CAPEX for EVs to be in the range of 10,500 USD (low CAPEX scenario) and 35,000 USD (high CAPEX scenario) (The Mobility House 2022). Saved fuel costs are calculated at 4,700 USD/yr for a daily trip of 200km (The Mobility House 2022). This assumes that regular electricity prices have to be paid for charging EVs. In addition, we assume reduced maintenance cost of 150 USD/yr (which is conservative).

The analysis shows that operating an EV is more economically attractive than an ICE-taxi. In the low CAPEX-scenario, the higher purchase price is levelled out by saved fuel costs after only 2 years. Over a 15-year period, a positive NPV of 63,000 USD results (without discount factor), as seen in Table 13.

Table 13: Cost and revenue analysis for small taxis (low CAPEX scenario)

Small taxis (USD)	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Additional CAPEX new EV compared to new ICE (per vehicle)	- 10 509									
Saved fuel cost per EV (USD/yr)		4 765	4 765	4 765	4 765	4 765	4 765	4 765	4 765	4 765
Saved maintenance costs per EV (USD/yr)		150	150	150	150	150	150	150	150	150
Annual balance	- 10 509	4 915	4 915	4 915	4 915	4 915	4 915	4 915	4 915	4 915
Total balance	- 10 509	- 5 594	- 678	4 237	9 153	14 068	18 984	23 899	28 815	33 730
Discount rate	0									
NPV (15 years)	**$63 222,60**									

In the high CAPEX-scenario, the higher purchase price is levelled out by saved fuel costs after seven years. Over a 15-year period, a positive NPV of USD 39,000 results (without discount factor) (see **Error! Reference source not found.**).

Table 14: Cost and revenue analysis for small taxis (high CAPEX scenario)

Small taxis (USD)	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Additional CAPEX new EV compared to new ICE (per vehicle)	- 35 000									
Saved fuel cost per EV (USD/yr)		4 765	4 765	4 765	4 765	4 765	4 765	4 765	4 765	4 765
Saved maintenance costs per EV (USD/yr)		150	150	150	150	150	150	150	150	150
Annual balance	- 35 000	4 915	4 915	4 915	4 915	4 915	4 915	4 915	4 915	4 915
Total balance	- 35 000	- 30 085	- 25 169	- 20 254	- 15 338	- 10 423	- 5 507	- 592	4 324	9 239
Discount rate	0									
NPV (15-years)	**$38 731,60**									

Hence, the key success factor is to design a loan-/grant-scheme enabling taxi-operators/owners to afford the higher CAPEX of EVs.

Costs for charging infrastructure

As mentioned above, the city authority of Addis and/or the Government of Ethiopia would need to invest in reliable quick-charging stations as a system enabler. Assuming CAPEX for a level-3 charger of USD 27,500 and annual operation costs (OPEX) of 20% of CAPEX, a total investment of USD 24 million would be required for the operation of the charging infrastructure to enable replacement of all small ICE taxis by EV taxis over 15 years (as seen in Table 15).

Table 15: Costs for building and operating e-charging stations for small taxis

Infrastructure investments (USD)	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	Total
# Charging stations required	*50*	*75*	*100*	*125*	*150*	*175*	*200*	*225*	*250*	*250*	*250*	*250*	*250*	*250*	*250*	*250*	
CAPEX: EV-charging infrastructure	- 1 375 000	- 687 500	- 687 500	- 687 500	- 687 500	- 687 500	- 687 500	- 687 500	- 687 500	100 000	100 000	100 000	100 000	100 000	100 000	100 000	
Total CAPEX	- 1 375 000	- 2 062 500	- 2 750 000	- 3 437 500	- 4 125 000	- 4 812 500	- 5 500 000	- 6 187 500	- 6 875 000	- 6 875 000	- 6 875 000	- 6 875 000	- 6 875 000	- 6 875 000	- 6 875 000	- 6 875 000	
OPEX (20% of total CAPEX)	- 275 000	- 412 500	- 550 000	- 687 500	- 825 000	- 962 500	- 1 100 000	- 1 237 500	- 1 375 000	- 1 375 000	- 1 375 000	- 1 375 000	- 1 375 000	- 1 375 000	- 1 375 000	- 1 375 000	
Total cost	**- 1 650 000**	**- 1 100 000**	**- 1 237 500**	**- 1 375 000**	**- 1 512 500**	**- 1 650 000**	**- 1 787 500**	**- 1 925 000**	**- 2 062 500**	**- 1 275 000**	**- 1 275 000**	**- 1 275 000**	**- 1 275 000**	**- 1 275 000**	**- 1 275 000**	**- 1 275 000**	**- 23 225 000**

One funding approach would be aiming to recover those costs through Article 6 ITMO sales. As an alternative, one might explore an internal funding scheme, in which taxi operators/owners pay an annual fee for using the EV-charging infrastructure. This fee must be significantly lower than annual fuel savings in order to keep the incentive for e-taxis.

Table 16 below assumes an annual flat-fee of USD 500 per EV for being able to use the dedicated EV-chargers. From the taxi operator's point of view, this will lower the EV's NPV from USD 63,000 to USD 56,000 in the low CAPEX-scenario (Table 16), and from USD 39,000 to 31,000 in the high CAPEX-scenario (Table 17) – but the shift to electric vehicles will still be very attractive from a financial perspective.

Table 16: Cost and revenue analysis for small taxis – after EV-charging fee (low CAPEX-scenario)

Small taxis (USD)	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Additional CAPEX new EV compared to new ICE (per vehicle)	- 10 509									
Saved fuel cost per EV (USD/yr)		4 765	4 765	4 765	4 765	4 765	4 765	4 765	4 765	4 765
Saved maintenance costs per EV (USD/yr)		150	150	150	150	150	150	150	150	150
Fee for EV-charging infrastructure (USD/yr)		-500	-500	-500	-500	-500	-500	-500	-500	-500
Annual balance	- 10 509	4 415	4 415	4 415	4 415	4 415	4 415	4 415	4 415	4 415
Total balance	- 10 509	- 6 094	- 1 678	2 737	7 153	11 568	15 984	20 399	24 815	29 230
NPV (15 years)	**$55 722,60**									

Table 17: Cost and revenue analysis for small taxis – after EV-charging fee (high CAPEX-scenario)

Small taxis (USD)	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Additional CAPEX new EV compared to new ICE (per vehicle)	- 35 000									
Saved fuel cost per EV (USD/yr)		4 765	4 765	4 765	4 765	4 765	4 765	4 765	4 765	4 765
Saved maintenance costs per EV (USD/yr)		150	150	150	150	150	150	150	150	150
Fee for EV-charging infrastructure (USD/yr)		-500	-500	-500	-500	-500	-500	-500	-500	-500
Annual balance	- 35 000	4 415	4 415	4 415	4 415	4 415	4 415	4 415	4 415	4 415
Total balance	- 35 000	- 30 585	- 26 169	- 21 754	- 17 338	- 12 923	- 8 507	- 4 092	324	4 739
Discount rate	0									
NPV (15-years)	**$31 231,60**									

At the same time, these annual fees will create significant additional revenues for the city authority of Addis and the Government of Ethiopia, leading to a positive NPV of USD 5 million (15 years, not considering discount factors) (see Table 18). In other words, the annual fees can be sufficient to allow for cost-neutral operations of the charging infrastructure.

Table 18: Costs for building/operating e-charging stations for small taxis – after EV-charging fee

Infrastructure investments (USD)	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	Total
# Charging stations required	*50*	*75*	*100*	*125*	*150*	*175*	*200*	*225*	*250*	*250*	
CAPEX: EV-charging infrastructure	- 1 375 000	- 687 500	- 687 500	- 687 500	- 687 500	- 687 500	- 687 500	- 687 500	- 687 500	100 000	
Total CAPEX	- 1 375 000	- 2 062 500	- 2 750 000	- 3 437 500	- 4 125 000	- 4 812 500	- 5 500 000	- 6 187 500	- 6 875 000	- 6 875 000	
OPEX (20% of total CAPEX)	- 275 000	- 412 500	- 550 000	- 687 500	- 825 000	- 962 500	- 1 100 000	- 1 237 500	- 1 375 000	- 1 375 000	
Total cost	**- 1 650 000**	**- 1 100 000**	**- 1 237 500**	**- 1 375 000**	**- 1 512 500**	**- 1 650 000**	**- 1 787 500**	**- 1 925 000**	**- 2 062 500**	**- 1 275 000**	**- 23 225 000**
# Small taxis replaced by EVs	*1 000*	*1 500*	*2 000*	*2 500*	*3 000*	*3 500*	*4 000*	*4 500*	*5 000*	*5 000*	
Revenues: fees for EV-charging infrastructure		**500 000**	**750 000**	**1 000 000**	**1 250 000**	**1 500 000**	**1 750 000**	**2 000 000**	**2 250 000**	**2 500 000**	**28 500 000**
Cash flow	- 1 650 000	- 600 000	- 487 500	- 375 000	- 262 500	- 150 000	- 37 500	75 000	187 500	1 225 000	
Discount rate	0									-	
NPV (15 years)	**$5 275 000**									-	

Again, it should be noted that these calculations are based on several assumptions that should be verified in a more detailed analysis. Based on the outcomes of this, one can decide the optimal design of policy instruments, fees and contributions of Article 6.

Conclusions

The research undertaken for this case study indicates that the proposed Article. 6 activity could result in significant benefits for: i) the climate, due to a large-scale reduction in emissions (4.5 million tons CO_2e over a 15-year-period); ii) the economic well-being of taxi owners/operators, as they would be enabled to increase their net-earnings, and iii) the health of Addis Ababa's population by reducing local pollution from the transport sector.

As the initial quantitative assessment of required investment (CAPEX, OPEX) and avoided costs (fuel, maintenance) shows, **savings from avoided fuel costs are so substantial** that – over a 15-years period – they are sufficient to make a shift to electric vehicles both economically attractive for taxi owners and cost-neutral for governmental institutions building and operating required quick-charging infrastructure. The key challenge is to overcome the investment barriers that come with the high upfront costs of electric vehicles and charging infrastructure. This can be achieved by financing mechanisms where the funding agency/bank provides a loan to taxi owners. ITMO revenues could be used to either as securities, or for investing in renewable energy and/or grid infrastructure that may be needed to provide and expand reliable, zero-carbon charging services.

Such approaches would need to be explored in more detail, in close collaboration between local actors and national and international funding agencies/ITMO buyers.

3.2 Green cooling in Addis Ababa health facilities

Background

Ethiopia launched its updated National Electrification Plan (NEP 2.0) in March 2019, where it set an ambitious goal of reaching universal electricity access by 2025. Access to electricity varies greatly across rural and urban areas. While about 96% of urban households are connected to the grid, only 27% of rural households have access to electricity. In Addis Ababa, around 99.9 % households have access to electricity, mainly through grid connection (GoE 2019b). Ethiopia's major share of electricity generation comes from renewable sources, mainly hydropower. However, urban areas, including Addis Ababa, experience frequent and long power outages. For instance, between July 2015-June 2016, Addis Ababa experienced daily electricity outages for an average duration of over one hour. Major reasons for the blackouts are poor physical condition and low capacity of the transmission and distribution lines and shortfall in supply (Meles 2020). Given that hydropower is the dominant source of power generation in Ethiopia, adverse climate change impacts and variability pose a risk for the reliability of hydroelectric power generation and supply.

This also poses challenges for the health sector; the national Expanded Programme for Immunisation plan (2016-2020) states that hospital cooling machines malfunction due to lack of maintenance associated with shortage of trained technicians and limited spare parts availability. According to the immunisation plan, kerosene and grid electricity are the two key sources of energy. Solar is the least utilised energy source (GoE 2015a). The Cold Chain Rehabilitation Plan (2014-2018) aims to strengthen the health sector's cold chain capacity by replacing kerosene cooling machines with solar-powered cooling machines (GoE 2015a).

Article 6 green cooling in health facilities programme

Addis Ababa hosts the largest number of health facilities in Ethiopia, including health centres, general hospitals (serving 1-1.5 million people) and specialised hospitals (serving 3.5-5 million people (WHO 2017). The city envisages becoming a medical tourism hotspot. Currently, Addis hosts 101 public health centres. Health centres are the lowest level of health institutions, serving up to 40,000 people in the urban areas, and are designed to provide basic services, including preventive, promotive and basic curative services (WHO 2017). Addis also hosts 13 hospitals, which are managed by the Addis Ababa city administration office and the federal government (Addis Ababa Health Bureau 2022). The city has also launched the construction of the Roha Medical Campus, which planned to have five hospitals built on the campus in 2021.

The hospitals are intended to be built based on green hospital principles. A green hospital is defined as a hospital which is committed to utilising sustainable and efficient designs, uses green building materials and products, recycles, reuses materials, reduces waste and produces cleaner air while enhancing patients' wellbeing (Tabish 2011). Despite such ongoing efforts, health facilities in Addis Ababa experience frequent power outages, which lower quality of medical services, may lead to complications during surgeries and other forms of treatment and poses dangers to medicines that require cooling (Addis Standard 2013). Furthermore, these facilities suffer from inadequate cooling infrastructures. For instance, a study conducted on the assessment of storage conditions of 11 public hospitals in Addis Ababa shows that 45% of stores went more than 12 years without amendments. Around 18% of stores didn't have adequate protection from sunlight, whereas more than 90% didn't have frozen storage of either -20°C or -70°C. While all of the stores had cold storage of 2-8°C, three stores did not have consistent power supply and generators (Habtamu & Kelemework 2017). Similarly, another study assessing cold chain quality of public hospitals in Addis Ababa shows that cold chains run

into critical challenges due to refrigeration failure, power outage and overheating of vaccines during transportation (Tessema 2017).

With the outbreak of Covid 19, reliable energy access in health service centres is more critical than ever for a city like Addis, with more than 5 million people. Given that COVID-19 vaccine products are temperature-sensitive and must be stored and handled correctly to ensure efficacy and maximise shelf life, access to an uninterrupted energy source is crucial to ensure public health.

With increasing adverse climate change impacts, excessive reliance on a single source of power (hydropower in the Ethiopian case) is not an ideal option to ensure energy security. For example, since Addis Ababa is almost fully connected with grid-electrification, national off-grid electrification interventions focus on rural areas (GoE 2019b). However, such an approach oversees the frequent outages in Addis and the subsequent GHG emissions associated with the use of off-grid power generators powered by diesel and kerosene.

Replacing existing diesel and/or kerosene generators which are used in public health facilities with solar cooling machines, e.g., refrigerators and freezers, could be relevant for an Article 6 pilot and promise quantifiable mitigation benefits that can reduce GHG emissions.

Figure 15: Example of a solar-powered freezer/refrigerator

Source: Alvin 2017

Such intervention would support Ethiopia in improving its health services while honouring its commitments to the Paris Agreement. Ethiopia's updated NDC aims to increase the proportion of health facilities with a safe energy source from 76% to 100% by 2030 (GoE 2021).

Proposed scope and structure of the Article 6 activity

The Article 6 green cooling in health facilities programme aims to strengthen sustainable energy access in Addis Ababa. The programme has the following key objectives:

Deployment of off-grid solar cooling technologies, e.g., refrigerators and freezers in public health facilities;

Replacing existing diesel/kerosene generators with green cooling technologies, significantly reducing GHG-emissions from health facilities;

Overcoming market penetration of solar cooling technologies and investment and infrastructure barriers; and

Broadening the energy supply basis; i.e., reducing dependency on grid electricity.

Potential policy instruments

The Ministry of Health and Addis Ababa City Administration Health Bureau could impact GHG emissions from health facilities either directly, through regulation - e.g., city-wide building codes or energy efficiency standards for cooling and other services-, or indirectly through financial incentives. Article 6 could help overcome financial limitations. The additional revenue from Article 6 could provide incentives for the deployment of off-grid solar technologies. The following policy instruments are considered relevant in the context of Article 6:

Incentivising off-grid solar technologies

Off-grid solar cooling technologies have not well-penetrated the market; hence prices are high. Article 6 can become a new source of finance by generating additional revenues that can be used for co-funding of policy instruments, such as:

- Tax reductions for off-grid solar technologies; or
- Low-/zero-interest schemes for operators of hospitals (and/or other investor or user types).

In addition, a governmental awareness-raising programme could be launched to promote the use of energy-efficient cooling and off-grid solar technologies through hospitals (and potentially other consumer types).

Stakeholders and potential roles in the Art. 6 programme

Overview of relevant stakeholders

Different local actors may be involved in the deployment of solar cooling machines, including the Ministry of Health, Ethiopian Electric Power (EEP), Ethiopian Electric Utility (EEU), Ethiopian Authority Agency (EAA) and Addis Ababa Health Bureau.

The **Ministry of Health** provides and regulates a comprehensive package of health services, formulates development programs and evaluates their implementation. The ministry has several responsibilities, including providing support for the expansion of health infrastructure, supervising the administration of federal hospitals and collaborating on the capacity-building activities of the federal university hospitals, which are located in Addis Ababa.

The **Environmental Protection Authority (EPA)**, which used to be called Environment, Forest and Climate Change Commission (EFCCC), is the designated national authority (DNA) for the

Clean Development Mechanism (CDM). It is mandated to lead UNFCCC negotiations, including on Article 6, as well as negotiate bilateral agreements on implementing Article6 activities. The EFCCC's Planning Directorate is responsible for sustainable development goals (SDGs) reporting, although it is not yet decided if the Planning Directorate would keep this role under Article 6. The EFCCC manages programmatic and technical aspects, including the national measurement, reporting and verification (MRV) system and Nationally Determined Contributions (NDC) accounting and reporting.

The **Ministry of Water and Energy**, previously referred as the Ministry of Water, Irrigation and Energy (MoWIE), is the main ministerial body in charge of energy policy and execution. It ensures the development of energy generation, transmission and distribution. The ministry plans, leads, co-ordinates, and monitors Ethiopia's overall energy strategy and development. It is also the supervising authority for the EEA, EEP and EEU.

Ethiopian Electric Power (EEP) is a state-owned electricity generator. It owns and operates Ethiopia's hydroelectric dams. It is responsible for the construction, upgrading and operation of generation and transmission lines. EEP is the electricity transmission entity in Ethiopia. It builds, owns and operates electricity transmission lines on the national grid. EEP is the main off-taker for independent power projects. It sells bulk electricity to the distribution entity, EEU (Thomson Reuters 2020).

Ethiopian Electric Utility (EEU) provides electricity across the country. The utility purchases the energy it distributes from the EEP, largely with funds that it collects from its customers on a monthly basis.

The **Ethiopian Energy Authority (EEA)** is responsible for regulating the electricity sector, including with regards to energy efficiency and conservation. The EAA promotes competitiveness in the energy sector and ensures efficient, economical and fair supply of energy.

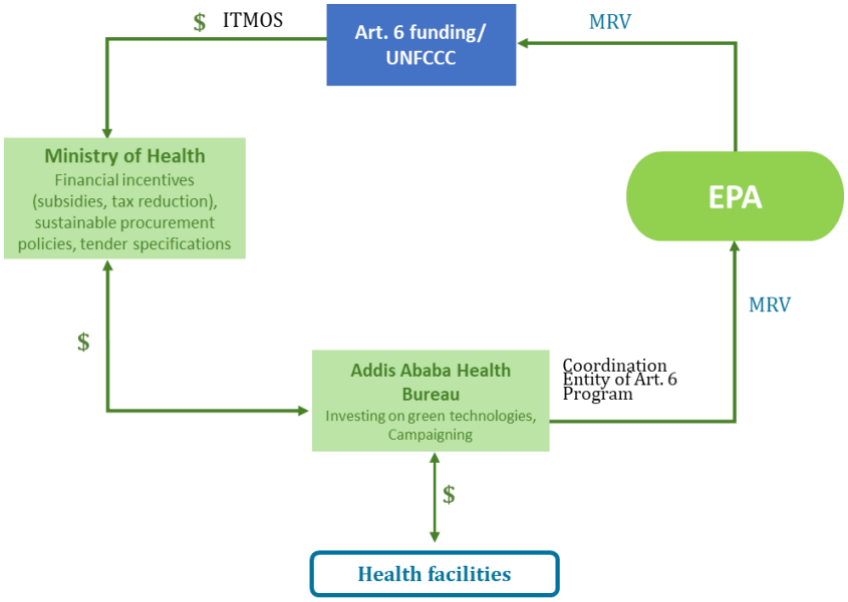
On a local level, the **Addis Ababa Health Bureau** is a key institution in the health sector. The Bureau has the responsibility to organise, coordinate and regulate public health activities and services in the city of Addis Ababa. The Bureau has direct administrative jurisdiction over several public hospitals in Addis Ababa.

In the context of Article 6, the EPA is a key institution serving as the country's national focal point, the official contact for UNFCCC correspondence. EPA hosts a Carbon Market Committee, which is comprised of five directors from the Environment Commission Directorate, Resource Mobilisation Directorate, Project Monitoring and Evaluation Directorate, Forestry Commission Directorate, Climate Change Commission Directorate and Policy Law and Standard Directorate.

Possible stakeholder roles and flow of funding

Numerous national and local stakeholders would be involved implementing the Art. 6 programme, taking care of project coordination, communicating emissions reductions data, international and national contracts, etc. While different roles are possible and need to be agreed on between stakeholders, Figure 16 provides an overview of possible stakeholder roles that can be a starting point for discussion.

Figure 16: Stakeholder roles



Source: Authors

MoH: introducing regulations on the use of solar cooling machines in health facilities, including refrigerators and freezers. As part of this effort, the Ministry could introduce specific procurement policies and tenders. Article 6 funding could be directed to the Addis Ababa Health Bureau. The MoH could also provide financial incentives for replacing diesel generators.

The Addis Ababa Health Bureau could be a project coordinator. Receiving the Article 6 financial sources from the MoH, the Bureau could disburse the funding to public health facilities. The Bureau would also be responsible for overseeing, monitoring and reporting relevant information to EFCCC.

EPA: national focal point for Article 6-related activities. The Commission could provide information on emissions reductions data to the UNFCCC.

Emission reduction potential

For assessing the emission reduction potential of the potential Art. 6 programme, the typical energy consumption for cooling in hospitals has been investigated. Unfortunately, data availability for Addis/Ethiopia is poor, and the same applies to other African countries. Hence, data on typical energy consumption of US hospitals had to be taken in lack of better data. There, the typical energy consumption of a 50-bed hospital is 5,500 MWh/yr, and out of this, approximately 3.5% is used for cooling (E Source 2010).

Table 19: Hospital cooling device energy consumption assumptions

Assumptions		
Energy demand refrigeration per hospital/health station	193	MWh/yr
Total energy demand refrigeration (13 hospitals, 101 health posts)	21 945	MWh/yr
Operating time gen-sets	1	hr/day
kWh generated by gen-sets	914	MWh/yr

Therefore, if one assumes that diesel generator sets run approximately one hour per day in hospitals, the emission reduction potential shown in Table 20 results from replacing diesel gen-sets with renewable energy sources (operation of off-grid solar freezers/refrigerators).

Besides replacing diesel gen-sets, green cooling devices have the advantage of limiting use of harmful cooling agents. The global warming potential (GWP) of old cooling agents is often extraordinarily high – e.g., the GWP of R124a is 1530, compared to a GWP of 3 of the new cooling agent iso-butane (IPCC 2019). Some of the cooling agents leak from the systems during operation; most is released during inadequate handling after the end of the device's lifetime. In Addis, most discarded cooling devices end up in a landfill, where they rot and at some point release the cooling agents to the atmosphere. Hence, a comprehensive Art. 6 programme should not only focus on the replacement of old devices, but also focus on proper collection and recycling of cooling agents from old devices. In any case, the use of modern cooling agents with lower GWP can result in significant greenhouse gas benefits. For this high-level estimate, we assume a 20-year lifetime of cooling devices, and that on average each year 1/20th of the cooling agent load is released. Such emissions can be avoided, and the average emission reduction potential is summarised in Table 20.

Table 20: Emission reduction estimate Addis's green cooling programme

Emission reduction potential		
CO2 emissions gen-sets	791	t CO2/yr
Avoided leakage of cooling agents (requires proper recycling system!)	291	t CO2e/yr
Total	**1 082**	**t CO2e/yr**

In total, the annual emission reduction potential can be estimated as 1,000 tCO_2e/year, or 20,000 tCO_2e over 20 years.

Initial cost estimate

Assuming 8 mid-size refrigerators and 2 freezers per hospital, and half this amount for health wards, we estimate a total of 508 refrigerators and 127 freezers in Addis's health sector that could be replaced. With the assumed investment and recycling costs per device summarised in Table 21, the replacement and recycling would accumulate to about USD 390,000.

Table 21: Cost estimate for Addis's green cooling programme

Costs	#	USD/device	USD total
PV refrigerators	508	500	254 000
PV freezers	127	600	76 200
Recycling costs cooling agents		**100**	**63 500**
Saved fuel costs			- 5 519
Total			**388 181**
ITMO revenues @24 USD/ITMO (15yrs)			**389 458**

Based on these numbers, an ITMO price of USD 24 would be necessary to break even.

It must be noted though that all assumptions above are subject to high uncertainty, and would need to be validated in a more detailed study (going beyond the scope of this work).

Conclusions

Introducing green cooling devices, combined with proper recycling of old coolers, can result in significant environmental benefits. If applied in the health sector, improved cooling chains also result in significant health benefits by improving quality and reliability of medical services.

However, as the emission reduction benefits per cooling device are small, a high number of cooling devices need to be included to achieve significant total impact. This would call for a programmatic approach covering a high number of consumers. Working with hospitals and potentially other public buildings (e.g. schools, administration buildings) etc. can be a good starting point and allows for learning and introduction of processes and infrastructure (e.g. recycling and local manufacturing of green cooling technology).

In order to make the activity more interesting for potential donors, investors and ITMO-purchasing entities, the scope of the Art. 6 activity should be expanded to reach sufficient scale. Potential options for up-scaling are:

- Business centres;
- Agricultural value chains (food security, horticulture);
- Public markets; and
- Private households.

In the health sector itself, options to increase the emission reduction potential would be to expand the activity to the introduction of energy efficient lighting (if not yet implemented), and the installation of solar PV rooftops, potentially combined with battery storage as back-up.

3.3 Bus rapid transit system in Kampala

Background

To address climate change in Kampala, transportation is a key sector. Under a business-as-usual scenario, transportation is estimated to be the largest contributor of emissions, totalling 31% of total emissions by 2030, primarily due to use of old vehicles, small omnibuses (called 'matatus'), congestion and heavy reliance on imported fossil fuels (KCCA 2015; KCCA 2016). Transit in Kampala, Uganda is currently dominated by minibuses and motorbike taxis ('boda bodas'), resulting in highly congested streets and significant air pollution. A number of transit options have been proposed to reduce congestion and promote sustainable transportation, including light rail transit, bike and pedestrian lanes, car sharing pilots, promotion of non-motorised transit, and bus rapid transit.

Overall, bus rapid transit (BRT) can be an interesting option for an Article 6 pilot, offering a safe alternative to driving or using boda bodas while reducing emissions and congestion. A light rail transit system has been proposed and has already received funding and set a construction timeline, so we deem this as too advanced in the context of this project. Bike and pedestrian lanes are also important in any major city but could pose significant safety risks in early phases without sufficient infrastructure and protection for bikers— an issue on the already hectic roads of Kampala. Non-motorised transit can be important but is difficult to track and quantify. Car sharing is an interesting proposal, but may not ultimately reduce the number of cars on the road if boda boda users switch to cars.

Therefore, a bus rapid transit system is promising as a project with clearly quantifiable mitigation benefits that will reduce emissions and provide safe transit to citizens of Kampala. Unlike the light rail transit system, the bus rapid transit project has not received funding, making it an ideal candidate for Article 6. From the beginning, low-emission buses could be chosen— such as compressed natural gas (CNG)— or electric buses. CNG buses have been shown to reduce NOx emissions by 53%, total particulate matter by 85%, and carbon monoxide by 89%, as compared to diesel buses (NREL 2003). In the long run, one may even operate hydrogen buses, which would increase clean-air benefits significantly.

There is already interest from local authorities: public transit is a priority of the Kampala Climate Change Action Strategy, which aims to have 50% of citizens relying on mass public transport and 40% of current 14-seater matatus (privately owned minibus taxis) replaced by buses (KCCA 2016).

Several feasibility studies and planning documents have been drafted for a BRT-system – meaning that a certain level of data is available – but no concrete funding has been secured yet. In 2010, the World Bank partnered with the Uganda National Roads Authority to conduct a pre-feasibility study for a bus rapid transit system in Kampala, selecting three main corridors for a pilot project (seen in Figure 17) (World Bank et al. 2010). Further studies have been published by the Japan International Cooperation Agency & the Ugandan Ministry of Works and Transport (2010) and the Global Labour Institute & AFD (2020), providing a rich body of work upon which to design a potential project.

Project specifics

A bus rapid transit system (BRT) consists of dedicated road lanes that cannot be used by vehicles other than buses, ensuring buses do not sit in traffic and providing quick and efficient transit. The most recent plan – drafted in 2014 – details a 25km pilot project of three main lines along Bombo Road, Entebbe Road and Jinja Road that pass through the city centre (Spooner et al. 2020). The pilot would be operated by 165 buses, 18m long, with a capacity of 150

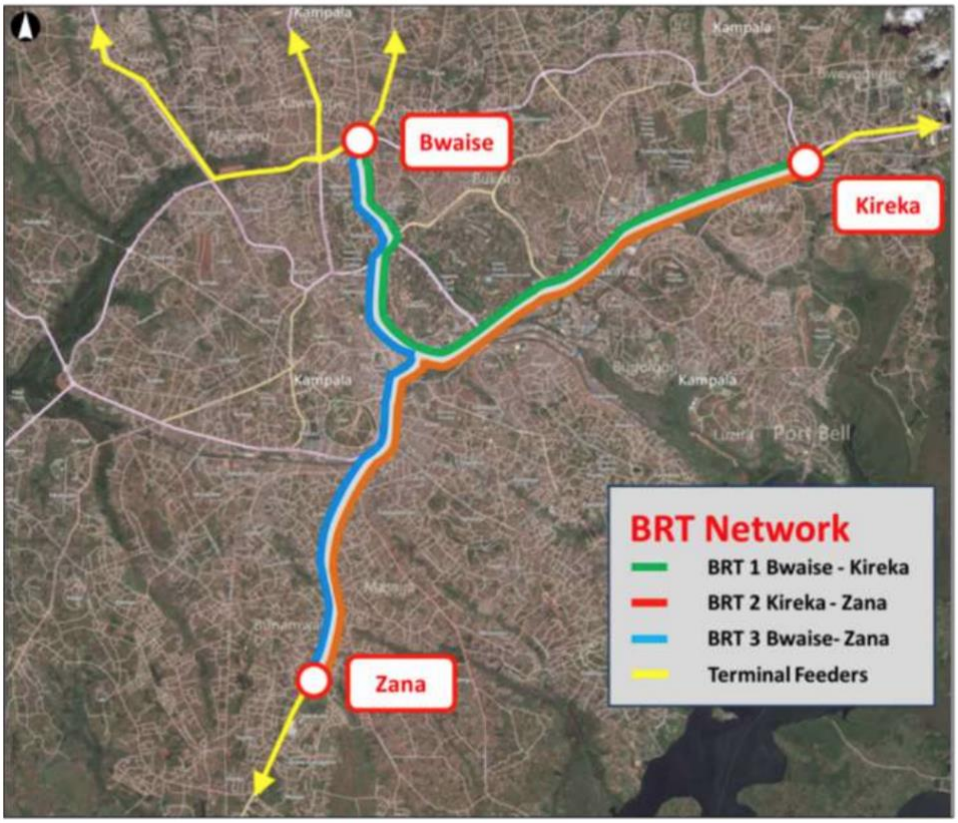
passengers each. Five additional feeder lines have already been proposed to link the main lines to outlying districts (highlighted in yellow in Figure 17). Passenger demand for this pilot has been forecast at 236,045 passengers per day in the next 20 years, bringing emissions reductions of 20-30% (KCCA 2015). A further breakdown by year was not available.

The World Bank's study was more optimistic, estimating passengers on Jinja Road alone to increase from 133,000 in 2013 to 550,000 by 2030, as seen in Figure 19 (World Bank et al. 2010). The demand will also be high on Entebbe Road (375,000 per day), Masaka Road and Bombo Road (approximately 200,000 per day). An overview of demand by route can be seen in Figure 18. The three most in-demand lines were selected for the pilot.

The cost of this three-line pilot is estimated at USD 429 million, including USD 400 million for construction of BRT infrastructure (including lanes, stations, terminals, signalling, ticketing etc.) and USD 29 million for land acquisition and resettlement (Spooner et al. 2020). **Direct operating costs** (including drivers' wages, customer service staff/conductors' wages, maintenance staff wages, fuel costs, tire costs, vehicle maintenance materials and licensing and insurance premiums) are approximated at USD 11.8 million per year for the pilot lines shown in Figure 17 (World Bank et al. 2010). **Total operating costs** (direct operating costs, systems management, vehicle fleet leasing and infrastructure maintenance) are estimated at approximately USD 21.4 million per year (as seen in Table 22).

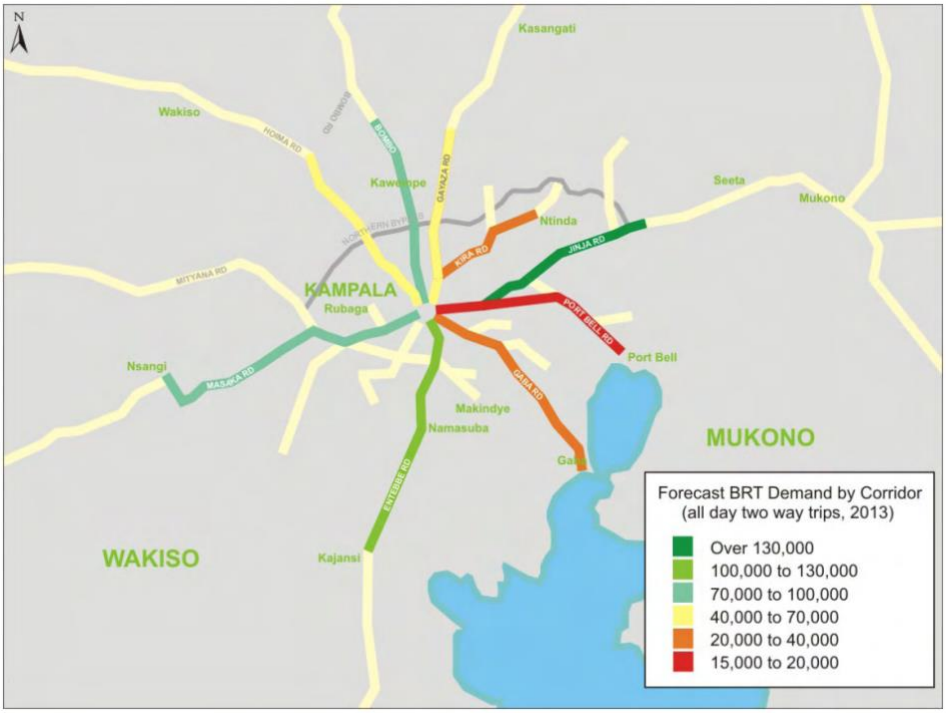
Annual revenue is projected to total USD 37.4 million, including leakage from fare evasion (World Bank et al. 2020). The pre-feasibility study therefore concludes that the pilot route can be financially feasible if targeted revenues are met, and that excess revenue could be repurposed to reduce fare prices, etc. However, there is no mention of the approximate funding that the national or local government could provide for initial construction.

Figure 17: Proposed pilot lines



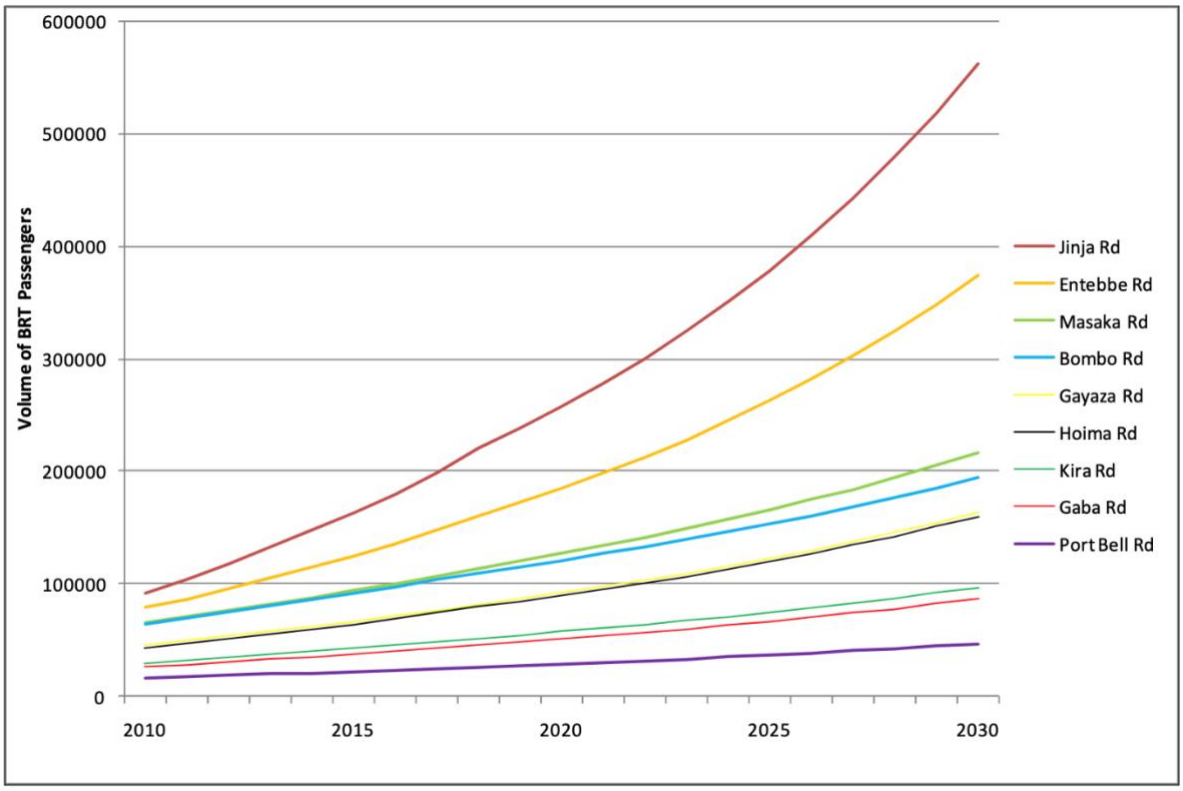
Source: Spooner et al. (2020)

Figure 18: Forecasted demand map, daily BRT passenger flows (6am-10pm)



Source: World Bank et al. (2010)

Figure 19: Forecasted demand, daily BRT passenger flows (6am-10pm)



Source: World Bank et al. (2010)

Table 22: Operating costs and revenue forecast

Cost Element	Value
Operating Costs	$11,774,449
Systems Management	$618,577
Annual repayment for vehicle fleet	$6,668,847
Infrastructure maintenance	$2,368,600
Total operating costs	$21,430,473
Annual revenue (minus 10% fare collection and leakage	$37,416,806
Gross operating margin	$15,986,333
less Operator overheads and profit (15% of net revenue)	($5,612,521)
Net Operating Surplus	$10,373,812

Source: World Bank et al. 2010

Actors

A number of domestic actors will be involved in the construction, financing and operation of the bus rapid transit system, including the Ministry of Works and Transport, Uganda National Roads Authority, Kampala Capital City Authority, Ministry of Water and the Environment and Uganda Development Bank.

The **Ministry of Works and Transport** (MoWT) is a national-level agency that exists to formulate policies, set standards, build capacity, carry out advocacy, regulate, monitor and evaluate the works and transport sector. It also provides policy and strategic guidance to certain bodies under its supervision, including the Uganda National Roads Authority, making it a necessary stakeholder in this case study. Within the MoWT is the **Uganda National Roads Authority** (UNRA), which has been involved in the planning of the pre-feasibility study, and will be an important actor going forward. The UNRA is mandated to develop and maintain the national roads network, advise the government on general roads policy, address national transport concerns and perform certain other functions. The UNRA is charged with, among other things, the selection of contractors, the supervision of construction, the scheduling of maintenance and the prioritisation of national road works, which will form the basis of its role in this project.

On a local level, the **Kampala Capital City Authority** (KCCA) is certainly the most important actor. The KCCA is responsible for all operations of the city of Kampala, including the city's Climate Change Action Plan, which prioritises public transit and bus rapid transit. The KCCA will be the main contact during this case study.

In the context of Article 6, the **Ministry of Water and Environment** (MWE) is very important, serving as the country's national focal point, the official contact for UNFCCC correspondence. On a national level, the MWE is responsible for promoting and ensuring rational and sustainable utilisation, development and effective management of water and environmental resources for the socioeconomic development of Uganda, and will serve as the main UNFCCC intermediary.

The final actor who will need to be involved is the **Uganda Development Bank**, Uganda's nationally-owned, primary development bank, which will provide the initial construction loan and disburse A6.4ER revenue.

Policy approaches

The still-prevailing **barrier for implementation is a lack of funding**. Though the project was proposed over 11 years ago and has the full support of the KCCA, no further steps towards implementation have been taken due to lack of financing. Given the possible net revenue from the project, such a BRT system could be self-financing once initial construction is paid off.

Article 6 could help overcome this barrier. The additional revenue from Article 6 emissions reductions could help in making the project bankable and economically viable. The following policy instruments are considered relevant in the context of Article 6.

Subsidised construction

The main part of the project is the construction of the BRT bus lanes, meaning many roads must be remodelled and new roads laid, costing over USD 400 million (Spooner et al. 2020). Therefore, subsidised construction is the main policy approach needed in this case. Article 6 revenues can help in securing loans and/or achieving bankability. Some ITMO-buyers may also be willing to make upfront-payments.

Subsidised tickets

Affordability is also a concern, and it is important to ensure all residents can access public transit. Therefore, it could make sense to subsidise tickets for low-income groups (including students, seniors, etc.). The World Bank's feasibility study proposes fares of UGX 900-1550 (USD 0.25-0.44), depending on the length of the route (2010). These rates were estimated based on surveys and in-depth interviews conducted by the study team. Current matatu and bus rates range from UGX 960-1550 (USD 0.27-0.44), the same as the suggested BRT fare (World Bank et al. 2010).

Passenger perception surveys showed the main problems current public transport users cited were low levels of comfort and safety and long journey times. Matatus have relatively low operating speeds (10-23 km/hr), while the BRT system would achieve average speeds of 25km/hr, providing a more efficient transit option for most riders (World Bank et al. 2010).

With a view to make the overall project feasible and achieve implementation, we suggest that Article 6 funding should first be used to cover construction costs. Potential excess revenues may then be used to subsidise ticket prices for selected groups. However, the World Bank study showed 73% of passengers were willing to pay an average increased fare price of UGX 200 (USD 0.06) for a trip in a comfortable and air-conditioned vehicle (the type that would be provided on the BRT service). Three quarters would pay more for a better and faster service, so offering lower fares to all passengers may not be necessary, and could endanger the business case of the bus system. Therefore, reduced fares should be offered only to particularly vulnerable groups (students, seniors, etc.). The study showed that current matatu passenger demographics span all income groups, in line with overall income distribution in Kampala. No suggestion for a reduced fare price was given in the report, but fare reductions could begin at 15-30% and increase depending on the revenue of the BRT system.

Based on these recommendations, an estimate of the annual cost of providing fare reductions can be calculated (summarised in Table 23). Daily ticket sales are projected to total 1,125,000 per day (410,625,000 per year) (World Bank et al. 2010). According to Kampala's 2019 Statistical Abstract, 46% of the city's population is youth (ages 0-19) and 2% are seniors (age 60 and above) (KCCA 2019). Since ridership is projected to mirror the general population, 48% of tickets sold will then be eligible for a fare reduction, totalling an estimated 197,688,141 tickets per year. For a 15% fare reduction (from an average ticket price of UGX 1225 to UGX 1041), the total cost of providing this reduction would be UGX 36.3 billion (USD 10.2 million). For a 30% fare reduction (from an average ticket price of UGX 1225 to UGX 858), the total cost would be UGX 72.7 billion (USD 20.3 million).

Table 23: Estimated cost of providing 15-30% fare reduction

	15% fare reduction	30% fare reduction
Estimated number of reduced tickets (per year)	197,688,141	197,688,141
Average fare price (UGX)	1041	858
Annual cost of providing reduced fares (UGX)	36,325,195,858	72,650,391,717
Annual cost of providing reduced fares (USD)	10,171,054	20,342,109

Source: Authors

Marketing campaign / environmental awareness raising

As with any major new project, a marketing campaign will have to accompany construction to make citizens aware of the benefits of the new bus sysstem and promote ridership. This campaign would optimally include awareness raising for the environmental- and health benefits of the low-emission BRT system. The feasibility study carried out by the World Bank promoted an Education and Communication Strategy, which the report specified was particularly important as there is very little prior understanding of the concept and its implications for the Greater Kampala Metropolitan Area.

Potential boda boda integration policies

Another important actor to consider is the paratransit industry (boda boda drivers, matatu drivers, etc.). Most of the opposition to this project comes from these actors, who stand to lose jobs with the addition of a bus rapid transit system (Spooner et al. 2020). These informal workers should not be excluded from the construction and implementation process, and additional policies could be implemented to provide support to these actors, such as subsidising purchase of electric (or other low-carbon) boda bodas with additional Article 6 funds. These policies/activities could be implemented as a stand-alone Article 6 activity, or be integrated into a more comprehensive Article 6 programme targeting the whole transport sector of Kampala (also see case study proposal for E-mobility in Addis).

Stakeholder roles and flow of funding

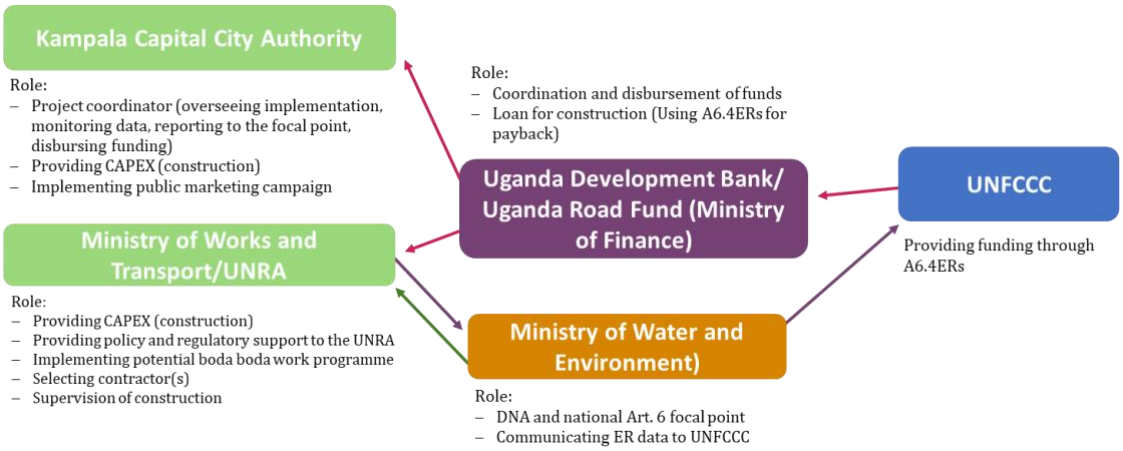
Domestic stakeholders (such as the KCCA, UNRA, Ministry of Works, etc.) should contribute to the design and potential funding of the programme to ensure local buy-in and future upkeep of the BRT system, but Article 6 may help to fill funding gaps. Since KCCA is the only local actor and a partner on the previous feasibility studies, a larger contribution than the UNRA and MoWT is proposed. However, the ultimate division will have to be discussed with stakeholders based on available budgets and intended roles in the project.

Under the initial assumptions, the Uganda Development Bank would provide (most of) the initial funding for the project through a loan, which will be repaid with revenue from ticket sales and ITMO-sales once the BRT-system is operational. The Uganda Development Bank could distribute the CAPEX funds to the KCCA, who will forward funds to the MoWT for its implementation tasks. The KCCA will monitor ridership and report emissions reductions data to the Ministry of Water and Environment, who—as the national focal point—will communicate this data to the UNFCCC, securing Article 6 revenue (see Figure 20).

Stakeholder roles

Numerous national and local stakeholders will be involved in implementation, responsible for tasks including project coordination, construction supervision, communication emissions reductions data, etc. While different roles are possible and need to be agreed on between stakeholders, Figure 20 provides an overview of possible stakeholder roles that can be a starting point for discussion.

Figure 20: Possible stakeholder roles (for discussion)



Source: Authors

KCCA: The KCCA, as the relevant local authority, could be the overall Article 6 project coordinator, responsible for overseeing implementation, monitoring data, reporting to the focal point, and disbursing funding. Since the KCCA was involved in the previous pre-feasibility study and includes a BRT system in its Climate Change Action Strategy, a role as project coordinator is fitting. A contribution towards funding for construction could come from the KCCA. The KCCA will also be responsible for designing and implementing the public marketing campaign, as well as determining ticket prices.

MoWT: The Ministry of Works and Transport could provide capital expenditures for construction. The MoWT could primarily be responsible for providing policy and regulatory support to the UNRA, which falls under its mandate. Any potential work programme with boda boda drivers could also be implemented by the MoWT as the main regulatory body for transit in the country. Within the MoWT, the Uganda National Roads Authority could also be responsible for providing funding for capital expenditures, as well as selecting contractors for construction and supervising construction, a main part of the agency's mandate.

MWE: The Ministry of Water and the Environment (as the national focal point) could be responsible for communicating emissions reductions data to the UNFCCC, since those connections and background in Article 6 implementation have already been established.

The division of funds between construction, ticket subsidisation and marketing will have to be determined based on real CAPEX, ticket- and marketing cost and approximate revenue from Article 6. Construction and land acquisition will cost USD 429 million, according to current studies (Spooner et al. 2020).

However, until the figures are clear, a preliminary division of 95% project budget directed towards construction and 5% for marketing could apply. As previously stated, ticket subsidisation could be funded through excess revenues. These proportions are taken as a starting point since construction will pose the greatest up-front cost, since tickets will only be subsidised for select groups, and can be supported through revenue after operation begins. Marketing is also a fairly small expenditure, compared to the implementation cost. A more precise division of funds can be determined once updated cost estimates for construction, a marketing campaign and final cost of ticket subsidisation are clear(er).

As far as emissions reductions are concerned, they can be estimated as the total emissions caused by currently operated taxis, minibuses and boda bodas (= "baseline emissions") minus emissions from the operation of the BRT-system (= "Article 6 activity emissions").

Current annual emissions from taxis, minibuses and boda bodas can be calculated by multiplying the number of vehicles circulating per day, their average emissions (in grams per kilometre) and the average distance they drive each day (see Table 24).

An example calculation is as follows:

$$Annual\ emissions\ from\ taxis = \frac{25{,}000\ taxis}{day} * \frac{60km}{day} * \frac{190 gCO_2e}{km} * \frac{365\ days}{year}$$
$$= 104{,}025\ tCO_2e/year$$

Following this approach, total baseline emissions are approximately 494,000 tCO_2e/year (including taxis, boda bodas and minibuses).

For estimating Article 6 activity emissions, we assume two scenarios: i) the operation of diesel buses along the BRT route and ii) the operation of electric buses. Referring to the World Bank's pilot design, we assume a total of 165 buses to be operated in the first year (e.g., 2024), and assume annual capacity additions corresponding to increasing passenger numbers – up to 330 buses in the year 2040.

Based on the approximations available for average distance the buses would travel, a diesel BRT system would emit approximately 12,600 tCO_2e/year, while an electric BRT system would emit only 700 tCO_2e/year (see Table 24). However, it must be noted that these figures are based on a number of assumptions and the World Bank's 2010 feasibility study, which is outdated and must be reanalysed if stakeholders intend to pursue the project.

For calculating the emission reduction potential, two scenarios were analysed: one in which the BRT pilot results in a 5% decrease in conventional vehicles (ICE), and one in which the pilot results in a 20% decrease in conventional vehicles. As seen in Table 24, potential emission reductions range between 12,135 tCO_2e/year (for diesel buses reducing use of alternate vehicles by 5%) and 98,096 tCO_2e/year (for electric buses reducing alternate vehicles by 20%).

Table 24: Current emissions and emission reduction potential (based on very initial assumptions)

Current emissions and potential emission reductions						
	Number of vehicles (vehicles/day)	Average emissions (g/km)	Average distance (km/day)	Annual emissions (tCO2/year)	Annual emission reductions	Annual emission reductions
Taxis	25 000	190	60	104 025	5 201	20 805
Boda bodas	250 000	70	50	319 375	15 969	63 875
Minibuses	8 000	220	110	70 664	3 533	14 133
Projected diesel BRT emissions	165	860	243	12 568	- 12 568	- 28 278
Projected electric BRT emissions	165	49	243	717	- 717	- 717
		total annual emission reductions (tCO2/year) (electric buses)			23 986	98 096
		total annual emission reductions (tCO2/year) (diesel buses)			12 135	70 535

Source: Authors' calculation based on data from Government of Kenya (2019), ICCT (2012), Spooner et al. (2020), and World Bank et al (2010).

Based on these emission reduction estimates, the emission reduction potential (increasing over time due to assumed growth in passenger and bus numbers) has been calculated for each of six scenarios:

- Diesel buses reducing alternate vehicles by 5%;
- Diesel buses reducing alternate vehicles by 20%;
- An average of these two scenarios;
- Electric buses reducing alternate vehicles by 5%;
- Electric buses reducing alternate vehicles by 20%; and
- An average of these two scenarios.

As mentioned above, emissions reductions for each scenario were then scaled up to increase each year, doubling between 2024 and 2040 as the number of buses on the road double from 165 to 330. These annual values have also been used to estimate the income from sale of emission reductions in each scenario, assuming a price of USD 25/tCO_2e (see Table 25 and Table 26). For the average diesel scenario, ITMO income would increase from USD 1 million in 2024 to USD 2.1 million in 2040. For the average electric fleet scenario, ITMO income starts at USD 1.5 million and increases to USD 3.1 million.

Net present value (NPV) was then calculated based on the estimated capital expenditures (CAPEX), operational expenditures (OPEX), operator overheads, revenue from operations and ITMO revenues (seen in Table 27 and Table 28). Values for CAPEX, OPEX, operator overheads and revenue from operations were taken from the World Bank feasibility study, with additional CAPEX of USD 71 million added for the electric bus scenarios (for purchase of the buses) and a 25% reduction in OPEX to account for fuel savings. As can be seen in Table 25, NPV totals USD -274 million for the average diesel scenario, while it stands at USD -210 million for the average electric bus scenario, due to the increased income from ITMOs. This compares to an NPV of USD -303 million (diesel buses) and USD -246 million without any ITMO-revenues.

Table 25: NPV under all six scenarios (illustrative numbers), at ITMO price of USD 25

NPV under various illustrative scenarios		
Scenario	**NPV (USD) for diesel buses**	**NPV (USD) for electric buses**
Reducing conventional vehicles by 5%	$ -295 471 855	$ -231 750 828
Reducing conventional vehicles by 20%	$ -251 932 465	$ -188 211 438
Average scenario	$ -273 702 160	$ -209 981 133
No ITMO-revenues	*$ -302 601 286*	*$ -245 842 662*

Source: Authors' calculation based on data from Government of Kenya (2019), ICCT (2012), Spooner et al. (2020), and World Bank et al (2010).

From these calculations, it is clear that sale of ITMOs can contribute to project finance, but at a price of USD 25 will not completely cover capital and operating expenses.

Following the same assumptions, an ITMO-price of USD 110 would be required to achieve a positive NPV for the case with highest emission reductions (electric buses, 20% replacement of conventional vehicles) until 2040 (as shown in Table 26).

Table 26: NPV under all six scenarios (illustrative numbers), at ITMO price of USD 110

NPV under various illustrative scenarios		
Scenario	**NPV (USD) for diesel buses**	**NPV (USD) for electric buses**
Reducing conventional vehicles by 5%	$ -271 231 789	$ -183 838 591
Reducing conventional vehicles by 20%	$ -120 268 816	$ 7 734 725
Average scenario	$ -195 750 302	$ -88 051 933
No ITMO-revenues	*$ -302 601 286*	*$ -245 842 662*

Source: Authors' calculation based on data from Government of Kenya (2019), ICCT (2012), Spooner et al. (2020), and World Bank et al (2010).

It has to be noted that these calculations can only be taken as a starting point, since they rely on weak data sources and a number of assumptions that would require more fundamental justification. An updated estimate of the number of buses required over time, number of annual passengers, and updated costs estimates must be developed to create a more dependable NPV model. Also, discount factors need to be taken into account. All this, however, goes beyond the scope of the current study.

If stakeholders are interested in pursuing this idea further, a more detailed feasibility-study needs to be conducted.

Table 27: NPV for scenario three—average emission reductions of diesel buses

Emission reduction estimate	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
# passengers/yr	205 312 500	218 144 531	230 976 563	243 808 594	256 640 625	269 472 656	282 304 688	295 136 719	307 968 750	320 800 781	333 632 813	346 464 844	359 296 875	372 128 906	384 960 938	397 792 969	410 625 000
ER (t CO2-eq)/yr	41 335	43 918	46 502	49 085	51 669	54 252	56 836	59 419	62 003	64 586	67 169	69 753	72 336	74 920	77 503	80 087	82 670
USD/t CO2-eq	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25
USD/yr	$ 1 033 375,00	$ 1 097 960,94	$ 1 162 546,88	$ 1 227 132,81	$ 1 291 718,75	$ 1 356 304,69	$ 1 420 890,63	$ 1 485 476,56	$ 1 550 062,50	$ 1 614 648,44	$ 1 679 234,38	$ 1 743 820,31	$ 1 808 406,25	$ 1 872 992,19	$ 1 937 578,13	$ 2 002 164,06	$ 2 066 750,00
Number of buses	*165*	*175*	*186*	*196*	*206*	*217*	*227*	*237*	*248*	*258*	*268*	*278*	*289*	*299*	*309*	*320*	*330*
	2024	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
CAPEX (roads, buses, other infrastructure)	- 430 000 000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OPEX		- 11 421 875	- 12 093 750	- 12 765 625	- 13 437 500	- 14 109 375	- 14 781 250	- 15 453 125	- 16 125 000	- 16 796 875	- 17 468 750	- 18 140 625	- 18 812 500	- 19 484 375	- 20 156 250	- 20 828 125	- 21 500 000
Operator overheads		- 2 975 056	- 3 150 059	- 3 325 062	- 3 500 066	- 3 675 069	- 3 850 072	- 4 025 075	- 4 200 079	- 4 375 082	- 4 550 085	- 4 725 089	- 4 900 092	- 5 075 095	- 5 250 098	- 5 425 102	- 5 600 105
Revenues from operations		19 921 875	21 093 750	22 265 625	23 437 500	24 609 375	25 781 250	26 953 125	28 125 000	29 296 875	30 468 750	31 640 625	32 812 500	33 984 375	35 156 250	36 328 125	37 500 000
ITMO-revenues		1 033 375	1 097 961	1 162 547	1 227 133	1 291 719	1 356 305	1 420 891	1 485 477	1 550 063	1 614 648	1 679 234	1 743 820	1 808 406	1 872 992	1 937 578	2 002 164
Income before tax	**- 430 000 000**	**6 558 319**	**6 947 902**	**7 337 485**	**7 727 067**	**8 116 650**	**8 506 233**	**8 895 815**	**9 285 398**	**9 674 980**	**10 064 563**	**10 454 146**	**10 843 728**	**11 233 311**	**11 622 894**	**12 012 476**	**12 402 059**
Discount rate	-																
NPV	**- 278 316 974**																

Source: Authors' calculation, based on data from Government of Kenya (2019), ICCT (2012), Spooner et al. (2020), and World Bank et al (2010).

Table 28: NPV for scenario six—average emission reductions of electric buses

Emission reduction estimate	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
# passengers/yr	205 312 500	218 144 531	230 976 563	243 808 594	256 640 625	269 472 656	282 304 688	295 136 719	307 968 750	320 800 781	333 632 813	346 464 844	359 296 875	372 128 906	384 960 938	397 792 969	410 625 000
ER (t CO2-eq)/yr	61 041	64 856	68 671	72 486	76 301	80 116	83 931	87 746	91 561	95 376	99 191	103 007	106 822	110 637	114 452	118 267	122 082
USD/t CO2-eq	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25
USD/yr	$ 1 526 022,52	$ 1 621 398,93	$ 1 716 775,34	$ 1 812 151,75	$ 1 907 528,15	$ 2 002 904,56	$ 2 098 280,97	$ 2 193 657,38	$ 2 289 033,78	$ 2 384 410,19	$ 2 479 786,60	$ 2 575 163,01	$ 2 670 539,42	$ 2 765 915,82	$ 2 861 292,23	$ 2 956 668,64	$ 3 052 045,05
Number of buses	*165*	*175*	*186*	*196*	*206*	*217*	*227*	*237*	*248*	*258*	*268*	*278*	*289*	*299*	*309*	*320*	*330*
	2024	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
CAPEX (roads, buses, other infrastructure)	- 501 179 372	3 250 000	3 575 000	3 250 000	2 925 000	3 217 500	2 925 000	2 925 000	2 895 750	2 632 500	2 632 500	2 632 500	2 606 175	2 369 250	2 369 250	2 606 175	2 132 325
OPEX		- 8 566 406	- 9 070 313	- 9 574 219	- 10 078 125	- 10 582 031	- 11 085 938	- 11 589 844	- 12 093 750	- 12 597 656	- 13 101 563	- 13 605 469	- 14 109 375	- 14 613 281	- 15 117 188	- 15 621 094	- 16 125 000
Operator overheads		- 2 231 292	- 2 362 544	- 2 493 797	- 2 625 049	- 2 756 302	- 2 887 554	- 3 018 807	- 3 150 059	- 3 281 312	- 3 412 564	- 3 543 816	- 3 675 069	- 3 806 321	- 3 937 574	- 4 068 826	- 4 200 079
Revenues from operations		19 921 875	21 093 750	22 265 625	23 437 500	24 609 375	25 781 250	26 953 125	28 125 000	29 296 875	30 468 750	31 640 625	32 812 500	33 984 375	35 156 250	36 328 125	37 500 000
ITMO-revenues		1 526 023	1 621 399	1 716 775	1 812 152	1 907 528	2 002 905	2 098 281	2 193 657	2 289 034	2 384 410	2 479 787	2 575 163	2 670 539	2 765 916	2 861 292	2 956 669
Income before tax	**- 501 179 372**	**13 900 199**	**14 857 292**	**15 164 385**	**15 471 478**	**16 396 070**	**16 735 663**	**17 367 756**	**17 970 598**	**18 339 441**	**18 971 534**	**19 603 626**	**20 209 394**	**20 604 562**	**21 236 654**	**22 105 672**	**22 263 915**
Discount rate	-																
NPV	**- 209 981 133**																

Source: Authors' calculation, based on data from Government of Kenya (2019), ICCT (2012), Spooner et al. (2020), and World Bank et al (2010)

3.4 Transition to electric cooking

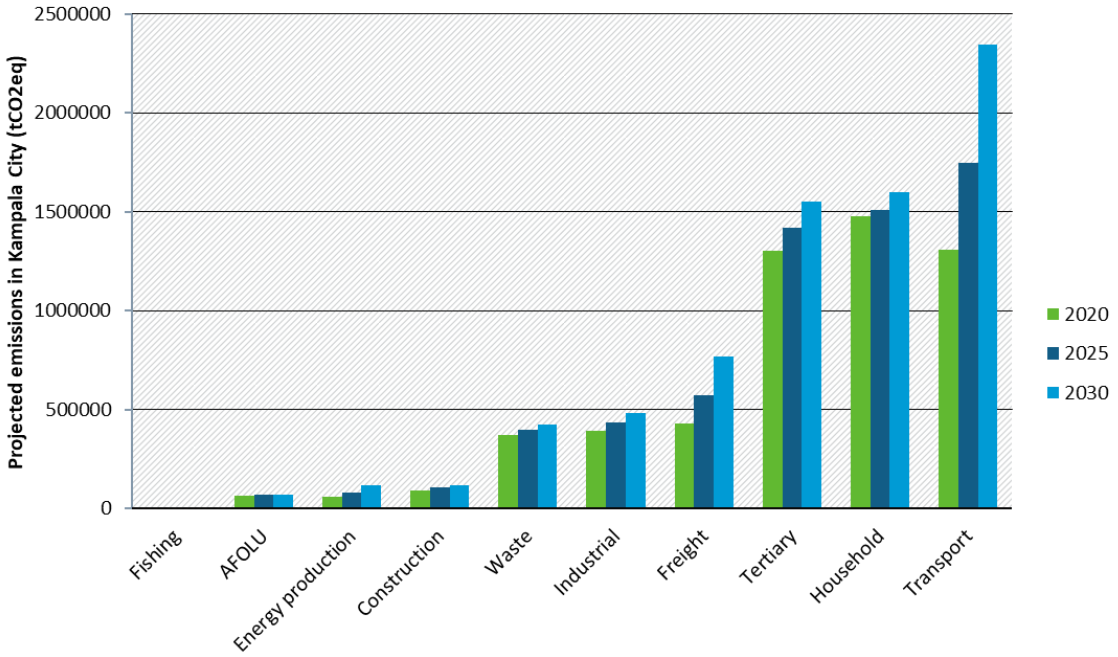
Background

The Greater Kampala Metropolitan Area (GKMA) comprises the Kampala District, Entebbe municipality and some areas of the Mukono and Wakiso Districts. It had an estimated population of 3.23 million people and 835,422 households in 2014. In Kampala city, the total population in 2014 was 1.51 million people, with 416,070 households. The estimated GHG emissions per capita in Kampala, GKMA and Uganda are, respectively, 2.4, 1.75 and 1.5 tCO_2e/resident, indicating the significance of the city centre as a major emitter in the country. The main forms of energy used in GKMA are biomass (charcoal and wood fuel), petroleum products (petrol, diesel, paraffin, liquified petroleum gas (LPG) and aviation fuel) and electricity. Biomass contributes 50% of the energy mix, while petroleum and electricity contribute 42% and 8% of the energy mix, respectively (KCCA 2016). Biomass and electricity are predominantly supplied from outside the GKMA, with charcoal mostly supplied from western, central and northern parts of the country.

Under the business-as-usual scenario, GHG emissions in the GKMA are projected to increase from 6.9 million tCO_2e in 2014 to 14.6 million tCO_2e in 2030. Overall emissions are expected to increase by 55% between 2020–2030. The household sector is currently the greatest contributor to GHG emissions in Kampala, and is estimated to be the second-greatest in 2030, after the transport sector (Figure 21) (KCCA 2016). This is predominantly as a result of the fuel types used for household cooking. Addressing household cooking is therefore a priority with regards to climate change mitigation in Kampala.

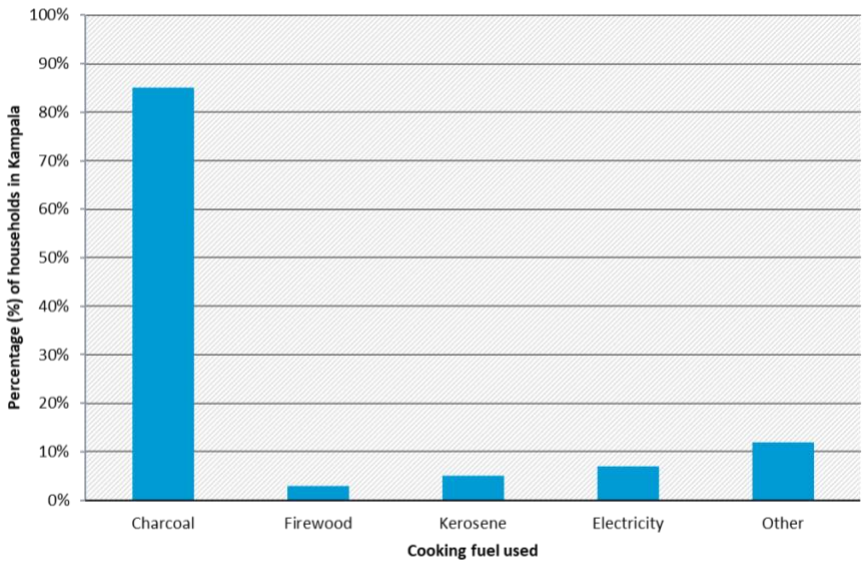
In Kampala, charcoal is the main source of energy for household cooking, with 76% of households using charcoal in 2019/2020, as opposed to other energy sources (Figure 22) (UBOS 2021). It is easily purchased at local markets or from roadside vendors, or it can be delivered directly to a residence. Households can purchase charcoal at different prices and sizes, with a sack of charcoal selling for between UGX 60,000 and UGX 100,000 (USD 17 to USD 28.5), depending on the season. Various types of charcoal stoves are also available on the local market in different price ranges. Unimproved charcoal stoves cost between UGX 4,000 and USD 5,300 (USD 1 to USD 1.50), while an improved charcoal cookstove can cost between UGX 14,000 and UGX 25,000 (USD 4 and USD 7) (SNV 2014; MECS 2020). The importance of charcoal to Kampala's local economy cannot be underestimated, as it provides employment to semi-skilled and unskilled labourers at different stages of production, transportation and distribution, as well as being the most affordable and widely-available cooking fuel (MECS 2020). As a result, efforts over the past few decades to promote alternative cooking fuels and methods have failed to deliver substantial results. Indeed, the country's National Energy Policy (2019) reports that there is less than 5% uptake of clean cooking technologies and fuels in Uganda (MEMD 2019).

Figure 21: Projected emissions by sector in Kampala city, 2020-2030



Source: authors based on KCCA 2015

Figure 22: Percentage (%) of households in Kampala using different cooking fuels in 2019/2020



Source: authors based on Uganda Bureau of Statistics (UBOS) 2021

Existing policy framework

National level

At the national level, biomass contributes 88% of total primary energy consumed as of 2019, while households comprise the largest overall energy consumer group. With regards to its international commitments, Uganda has committed through its 2016 Nationally Determined Contribution (NDC) to reduce its emissions by 22% by 2030. There is a 2021 update to the NDC underway, under which the national economy-wide emission reduction target is under technical review – but this new target is expected to be at least – if not more – ambitious than the 2016 target. In addition, it was indicated in the 2021 NDC update that "Uganda will use voluntary cooperation provided for in Article 6 in accordance with the National Climate Change Act of 2021 to demonstrate her mitigation ambition and mobilise support to promote sustainable development and poverty eradication."

The Draft National Energy Policy (2019) states that the government shall promote the uptake and sustained use of clean, modern cooking technologies, including improved cookstoves, ethanol, LPG, solar, biogas and electricity. It intends to do so through a number of strategies, including:

Developing and enforcing a comprehensive legal, regulatory and commercial framework for the clean cooking sector;

Promoting local manufacturing of clean cooking equipment, fuels and accessories;

Providing fiscal incentives, e.g., subsidies, loans and tax incentives to the clean cooking sector to encourage private sector involvement;

Supporting women as promoters, suppliers, leaders and manufactures of clean cooking equipment and resources;

Promoting financing schemes for clean cooking fuels and equipment through loans from targeted microfinance institutions, banks, SACCOs or other agencies; and

Establishing and implementing national standards, labelling and certification programs for the clean cooking sector.

City level

At the city level, Kampala has aligned its commitments with the NDC, committing to reduce emissions by 22% on the business-as-usual scenario by 2030. Further targets, as included in Kampala's Climate Change Action Strategy (2016) are:

- 50% of charcoal (2015 baseline) replaced with alternative cook fuel (briquettes, biogas)
- 20% of cooking energy generated with renewable alternatives to charcoal

Some of the planned/ongoing work in Kampala includes the following:

- Briquettes: upscaling briquette production and uptake, including certification for quality with the target to replace 50% of wood and charcoal fuel usage (private sector; KCCA/CDD grants)

- Ecostoves[4] for markets: ongoing, installation of eco-stoves in city markets
- Ecostoves for households: target to distribute 100,000 units, including set up of a participation app and distribution kiosks
- Improved cookstoves in schools: To be piloted in 10 KCCA schools (KCCA and Expertise France and Simoshi)

Potential alternatives

'Clean' alternatives to charcoal and other biomass either relate to improved efficiency biomass stoves (i.e. improved cookstoves, ICS) or stoves that rely on modern fuels (e.g. LPG) or alternative energy sources (e.g. electric or solar). GACC (2016 and 2017) undertook research to understand the trade-offs associated with different fuel options across the value chain in Uganda. Table 29 below provides a summary of different fuel types, although electricity was notably not included in the study.

Improved cookstoves (ICS)

These stoves are designed to reduce emissions by increasing combustive efficiency. They are therefore also expected to yield health benefits (due to improved indoor air quality) and reduce the total amount of biomass consumed, reducing pressure on forests and the environment. These benefits depend on sustained use, however. Stove designs vary widely in terms of style, materials used, construction techniques and performance. International standards[5] were published in 2018 outlining testing and reporting protocols to measure and evaluate emissions, efficiency, safety and durability of cookstoves in a laboratory setting. The Uganda National Bureau of Standards also published its own standard in 2007[6]; however, this standard only looks at efficiency, and not at other parameters such as emissions, durability and safety.

As of 2014, there were several Ugandan ICS manufacturers, many of whom were located in and around Kampala. Of these, only Ugastove and Green Bioenergy were able to produce stoves in quantities exceeding 5,000 per month (SNV 2014). Stoves have been imported into Uganda over the past 10 years, mainly by UpEnergy. In addition, there are a number of improved cookstove projects being implemented across Uganda by independent project developers and private sector actors. These projects generate Verified Emission Reductions (VERs) and associated carbon revenues, but are discrete actions that are not consolidated into a larger programme.

As of 2014, the average cost of ICS was UGX 26,300 (USD 7.50). When potential ICS users were asked how much they would be willing to pay for ICS, they indicated an average of UGX 16,000 (USD 4.50) for an improved wood stove and UGX 11,000 (USD 3) for an improved charcoal stove (Price 2017). Thus, cost of ICS is a major limiting factor for uptake. In addition, it has been argued that ICS are not effective enough at reducing exposure to key pollutants to low enough levels to be in agreement with WHO indoor air quality guidelines (Bruce et al. 2017). It has been suggested that, where possible, the focus should shift to 'BLEN' fuels – biofuels, LPG, electricity and piped natural

[4] Ecostoves use heat-holding volcanic rocks broken down to the size of charcoal. The rocks are heated using starter briquettes and then remain hot for hours with the help a fan blowing a continuous flow of air over them.
[5] See https://www.iso.org/standard/66519.html
[6] See http://cleancookstoves.org/binary-data/DOCUMENT/file/000/000/11-1.pdf

gas – that are clean at point of use. LPG has been highlighted as a priority in Kampala (KCCA, personal communication early 2022) and national government has set an LPG penetration target of 1 million urban households by 2030 through its SE4All Action Agenda. Transitioning households (particularly those in urban areas) to electric cooking has also been highlighted by Uganda's Ministry of Energy and Mineral Development (MEMD) as a priority, as around 90% of Kampala's electricity is renewable, sourced from hydropower. These two alternatives are described further below.

Table 29: Summary of environmental indicators for cooking fuels in Uganda

	Unprocessed Solid Biomass	Processed Solid Biomass						Liquid/Gas					
Indicator*	Firewood	Charcoal Briquettes from Wood	Charcoal Briquettes from Bamboo	Non-Carbonized Briquettes from Sawdust	Non-Carbonized Briquettes from Crop Residues	Wood Pellets	Wood Chips	Ethanol from Sugarcane	Ethanol from Wood	Biogas from Dung	LPG	*Median*	*All-fuel average***
TED (MJ/HH/YR)	39,705	78,111	76,858	45,211	21,616	14,775	19,289	38,731	12,611	10,540	39,125	*13,693*	*22,032*
NED (MJ/HH/YR)	33,752	72,159	70,905	39,259	15,664	8,823	13,337	32,779	6,659	4,588	33,173	*7,741*	*18,394*
GCCP (kg CO_2 eq/HH/YR)	4,464	7,027	2,200	508	271	2,121	2,170	540	43.7	17.8	2,007	*157*	*1,187*
BC/SLCP (kg BC eq/HH/YR)	3.80	10.0	9.79	2.84	5.00	0.12	0.65	-0.040	0.027	0.061	0.042	*0.034*	*1.79*
PMFP (kg PM10 eq/HH/YR)	12.9	37.6	37.0	10.7	23.3	0.73	6.29	0.98	0.38	0.31	1.18	*0.56*	*7.31*
FFD (kg oil eq/HH/YR)	0.033	0.047	0.11	0.18	0.24	12.8	1.50	91.9	6.36	0	923	*0.040*	*57.6*
WD (m^3/HH/YR)	0.25	1.52	1.37	16.4	24.7	1,304	1.65	411	1.66	19.0	379	*1.44*	*120*
TAP (kg SO_2 eq/HH/YR)	3.07	0.87	1.76	2.51	1.28	0.54	1.51	3.00	0.47	0.091	2.99	*0.51*	*1.01*
FEP (kg P eq/HH/YR)	0.81	0.41	0.40	0.48	0.39	0.018	0.39	0.21	1.9E-05	0	0.047	*0.0092*	*0.17*
POFP (kg NMVOC eq/HH/YR)	138	168	169	103	18.1	0.98	66.7	1.94	1.18	0.48	9.77	*1.08*	*37.7*

*TED = Total Energy Demand; NED = Net Energy Demand; GCCP = Global Climate Change Potential; BC/SLCP = Black Carbon and Short-Lived Climate Pollutants; PMFP = Particulate Matter Formation Potential; FFD= Fossil Fuel Depletion; WD = Water Depletion; TAP = Terrestrial Acidification Potential; FEP = Freshwater Eutrophication Potential; POFP = Photochemical Oxidant Formation Potential; CO_2= Carbon Dioxide; DME= Dimethyl Ether; MJ= Megajoules; NMVOC= Non-Methane Volatile Organic Compound; SO_2= Sulfur Dioxide; HH = Household; YR = Year.

**All-fuel average values calculate a straight average of the cooking fuels investigated for the country and do not consider the current weighted use of each fuel for cooking within the country.

Note: Descriptions of each environmental indicator are found in Table 2-2. Dark green represents the lowest 5th percentile fuel by impact, light green represents fuels between the 5th and 25th percentile by impact, grey represents fuels between the 25th and 75th percentile by impact, orange represents fuels between the 75th and 95th percentile by impact, and red represents fuels greater than the 95th percentile by impact. All values in the table are displayed to three significant digits. When determining percentiles (and accompanying color-coding), more significant digits were used. As a result, values that appear the same in the table may be color-coded differently.

Source: GACC 2017

Liquified petroleum gas (LPG)

This is a comparatively clean-burning, portable, sustainable and efficient fuel. It is a co-product of natural gas and crude oil production and usually consists of a mixture of propane and butane for standard heating and cooking purposes. Uganda's government sees LPG as an option for environmental mitigation and one of the ways in which to end households' dependence on firewood and charcoal. With the recent discovery of oil and gas resources, it is expected that Uganda will soon start to produce its own LPG for domestic supplies. However, until then, all the LPG being consumed in the country is imported through the Mombasa port in Kenya and the Dar Es Salaam port in Tanzania, making it one of the most expensive cooking fuel options. Commonly sold LPG cylinders for household use are 6 kg and 12 kg cylinders, and the most common stove used is the cylinder-top burner. The initial cost of the 6 kg cylinder filled with gas is around UGX 200,000 (USD 57), while the re-filling cost is around UGX 57,000 (USD 16), making it a relatively expensive option for the average household (Price 2017).

It may be noted that recent decisions of COP26 make use of fossil fuels in the context of Article 6 highly questionable.

Electric cooking

The majority of households in Kampala (57%) are connected to the national grid, yet choose to cook with charcoal and other fuel types. Since the government removed subsidies on electricity in 2012, the cost of electricity per unit has been increasing. Consumers pay an electricity tariff of around USD 0.21/kWh with a lifeline tariff of USD 0.07/kWh for the first 15 units per month. This scheme is one of the lowest lifeline thresholds in the region (e.g., Ethiopia and Kenya's lifeline tariff thresholds are 50 and 100 kWh/month, respectively) (Batchelor et al. 2019). Households in Kampala have indicated that the relatively high cost of electricity when compared with charcoal is the main reason they are not cooking meals with electric-powered stoves. A Controlled Cooking Test (CCT) carried out in Kampala in 2020 tested the energy consumption, time and cost efficiencies of a charcoal stove, LPG stove, electric hot plate and electric pressure cooker (EPC) in cooking three local dishes. Interestingly, findings showed that the EPC is the most energy- and time-efficient, as well as the least expensive option to prepare the dishes (Batchelor et al. 2019). However, cooking with electricity is currently not seen as an option by many households due to the overall cost of electricity. In response to this, Uganda's Electricity Regulator Authority (ERA) introduced a Declining Block Tariff for domestic consumers – also called the "Cooking Tariff" – aimed at encouraging cooking with electricity in homes. As of January 2022, a lower tariff (USD0.11/kWh) will be applicable for units consumed between 81 and 150 kWh. However, the market for efficient domestic electric cooking technologies is not well developed and there is still an initial investment barrier for households who may want to switch to electric cooking. The Article 6 framework could potentially provide a way to overcome this initial barrier and accelerate the uptake of electric cooking.

Key barriers faced

Some of the main barriers to a transition to clean cooking in Kampala include:

- Relatively high cost of clean cooking technologies and equipment relative to traditional biomass;

- Unreliable supply of clean cooking technologies;
- Underdeveloped market for energy-efficient modern cooking appliances;
- Public perception of electricity as the most expensive cooking option;
- Lack of financing schemes for the purchase of clean or improved cookstoves and other clean technologies; and
- Insufficient gender awareness in the promotion of clean cooking.

In order to achieve sustained use of alternative cooking fuels/technologies/methods, there need to be high quality, affordable alternatives made readily available, which also have a proven ability to prepare local dishes with traditional cooking utensils[7], while demonstrating that they are energy efficient and reduce pollution and GHG emissions. Failure to effectively meet these criteria almost guarantees that alternatives will not be adopted and used long-term, or will be used for some, but not the majority, of purposes.

Potential policy interventions

There are a number of policy instruments that have been used to promote a transition to clean cooking around the world. Below are some common measures that could be applied in Kampala:

- Direct/indirect subsidies (e.g., grants, loans, tax incentives) toward clean cooking programmes, especially in relation to supporting the upfront entrepreneurial capital needed for cookstove business development;
- Innovative financing mechanisms for consumers, such as allowing households to pay in instalments, and working with microfinance institutions to market and distribute stoves;
- Subsidies toward a stove or its component parts to enable initial adoption, with several studies emphasising that the poorest households would not have gained access to ICS without them;
- Sales offers combining free trial, time payments, and the option of returning the product to overcome barriers such as liquidity constraints and poor information about benefits and usability of health-improving technologies;
- Developing minimum efficiency standards for improved cookstoves;
- Initiatives involving pay-as-you-go LPG use and partial cylinder refills (although the latter has raised safety concerns); and
- Awareness raising programmes.

[7] The most popular dishes in Uganda are prepared by boiling or steaming. Some dishes that require boiling are matooke (similar to banana), potato, rice, cassava (starchy tuber) and beans. Wrapping foods in banana leaves to steam is a popular method which is applied to dishes such as matooke, cassava, sweet potato and posho (maize porridge) (MECS 2020).

Proposed Article 6 programme: transition to electric cooking

Given the lack of sustained widespread uptake of ICS in Uganda, as well as the fossil fuel element of LPG, it is proposed that the Article 6 programme is designed around a **transition to electric cooking**. As the majority of households (80-90%) in Kampala are connected to the electricity grid, they have ready access to clean energy for cooking. In addition, the introduction of the "Cooking Tariff" presents an opportunity to increase electricity usage in households. However, the main barriers to using electricity for cooking still exist – the perception that electricity is one of the most expensive forms of energy and the initial cost of electric cooking technology. These should be the entry points for the Article 6 programme.

The objectives of the Article 6 programme would be as follows:

- Increase uptake of electricity for cooking – with ~90% of Uganda's electricity supply being renewable, a transition to electric cooking will significantly reduce GHG emissions when compared to charcoal/wood-fuel (which have a high share of non-renewable biomass);
- Capitalise on and support the introduced "Cooking Tariff" to maximise uptake of electric cooking;
- Overcome the initial investment barrier for households; and
- Raise awareness for the benefits of clean cooking.

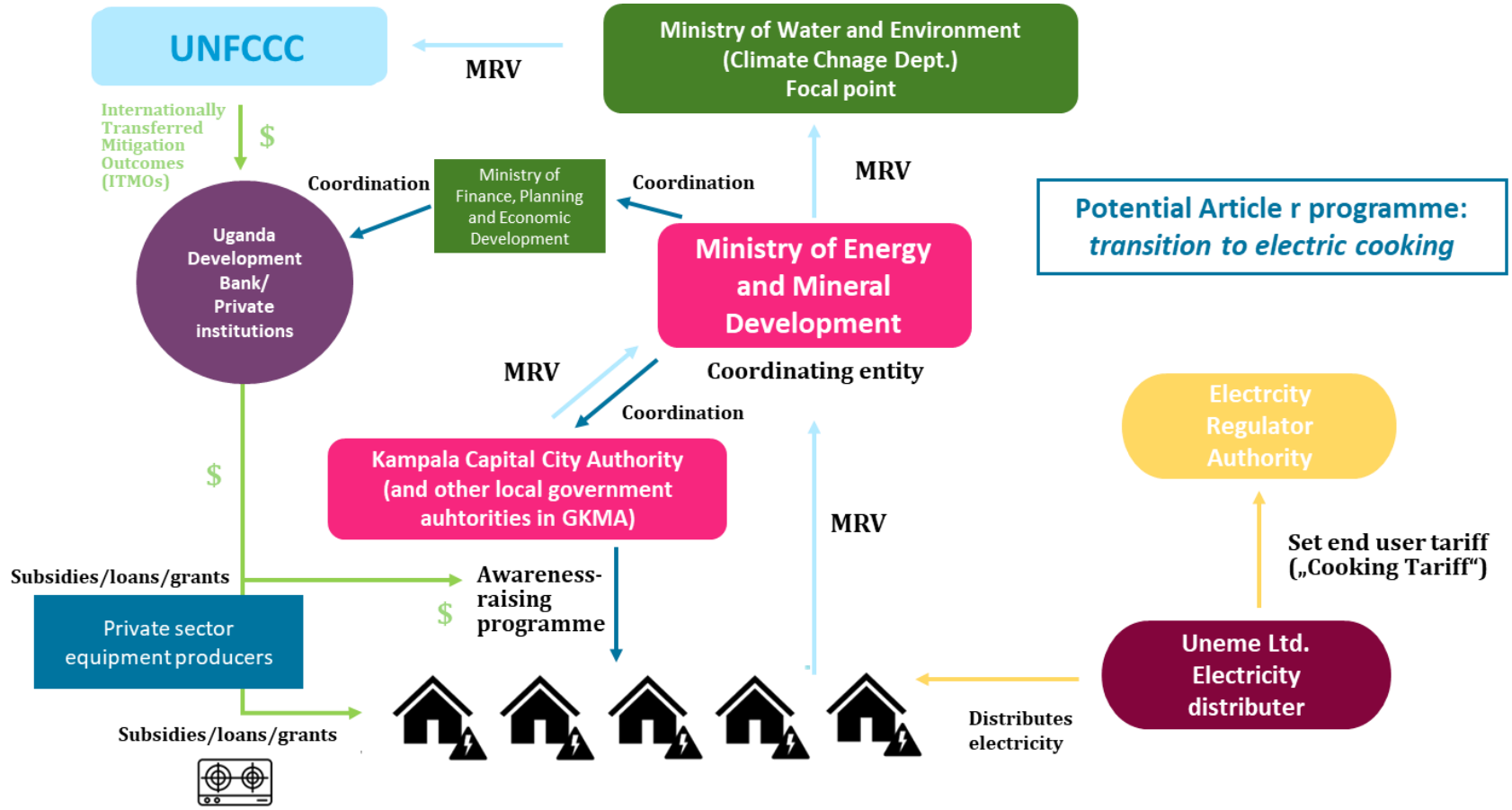
To achieve these objectives, a number of potential policy measures could be put in place. **Discounts/subsidies towards electric cooking technology** could be introduced for households – for example, grants or loans for purchasing electric cooking technology, or innovative financing mechanisms such as allowing instalment payments.

If necessary, subsidies/grants/loans could be provided to private sector producers of electric cooking technology for large-scale production and distribution under the programme. For example, electric pressure cookers with integrated meters to monitor use could be distributed to 50,000 households to enable easy monitoring of progress. This corresponds to control-group approaches commonly used for similar project types under the CDM. There could also be a role here for national minimum efficiency performance standards which appliances would need to meet to be eligible. This would require involvement of the Uganda National Bureau of Standards.

Finally, an **awareness-raising programme** could be implemented for households in Kampala to counter the public perception of electricity being the most expensive option and to increase knowledge and understanding of the health benefits of switching from charcoal to electricity.

Figure 23 below visualises the proposed approach and roles that could be played by different stakeholders that would likely be involved in an Article 6 programme focused on a transition to electric cooking.

Figure 23: Proposed structure for the Article 6 programme



Source: Authors

Stakeholders

The **Ministry of Energy and Mineral Development (MEMD)** holds the mandate for all energy access activities in the country. They could serve as the project coordinator and could be responsible for implementing the project, as well as monitoring and evaluation. This includes collecting and communicating all relevant emissions reduction data with the Ministry of Water and Environment for reporting to the UNFCCC. The **Ministry of Water and Environment (MoWE) i**ncludes the **Climate Change Department (CCD)**, the key institution for climate action in Uganda. The CCD is responsible for coordinating Uganda's NDC implementation and has overseen CDM activities in the country. The CCD would be the key Ugandan institution for supervising the Article 6 implementation and would be responsible for the authorisation of activities that can generate ITMOs under the project. They would be responsible for communicating emissions reduction data shared with them by the MEMD to the UNFCCC.

Private sector producers of electric/other cooking technologies would likely be involved in the project to produce and distribute clean cooking technologies to households in order to ensure a predetermined number of households are using standardised cooking equipment whose use and performance could be monitored for reporting purposes. This reporting could be done by tracking electricity use through **Umeme Ltd.** (Uganda's main electricity distributer), or by ensuring meters are attached to devices distributed through the programme that monitor their usage. For the latter option, Article 6 revenues could assist in backing any financial incentives/subsidies needed for the production and distribution of equipment. Similarly, **households** could be incentivised to adopt clean cooking technologies through assistance in purchasing the initial cooking setup. These measures could also be backed by Article 6 revenues, under the condition that participating households ensure their energy usage is being reported to the MEMD. In order to distribute any financial incentives, a financial institution such as the **Uganda Development Bank** or a **Private institution** would need to be involved in the programme, with the **Ministry of Finance, Planning and Economic Development (MoFPED)** also playing a coordination role.

The **Kampala Capital City Authority (KCCA)** does not hold the mandate for energy access activities, but as the local authority they would need to be closely involved in the implementation and coordination of project activities, especially with regards to awareness-raising amongst the population of Kampala. KCCA would ensure households in Kampala are aware of the new "Cooking Tariff" established by the **Electricity Regulator Authority (ERA)**, as well as the health benefits households would experience by switching from cooking with charcoal to electricity.

Other stakeholders who could be involved as and when needed include:

- **Ministry of Trade, Industry and Cooperatives (MTIC)** – responsible for formulating, reviewing and supporting policies, strategies, plans and programs that promote and ensure expansion and diversification of trade, cooperatives, environmentally sustainable industrialisation and appropriate technology development and transfer to generate wealth for poverty eradication and benefit the country socially and economically.
- **Uganda Revenue Authority (URA)** – responsible for assessing, collecting and accounting for central government tax revenue (and non-tax revenue) and providing advice to government on matters of policy relating to all revenue sources.
- **Kampala City Traders' Association (KACITA)** – business support association responsible for facilitating trade, bringing together the business community and mobilising them into a viable, organised and socially sustainable marketplace.

- **Uganda National Bureau of Standards (UBOS)** – responsible for formulating and promoting the use of standards; enforcing standards in protection of public health and safety and the environment against dangerous and sub-standard products; ensuring fairness in trade and precision in industry through reliable measurement systems; and strengthening the economy of Uganda by assuring the quality of locally manufactured products to enhance the competitiveness of exports in regional and international markets.
- **National Environment Management Authority (NEMA)** – principal agency in Uganda responsible for the management of the environment by coordinating, monitoring, regulating, and supervising all activities in the field of environment

Initial quantitative assessment

This section provides an initial estimate of the potential quantitative impacts of an Article 6 activity. We look at the emission reduction potential, associated cost and required ITMO price levels.

Estimation of the emission reduction potential

In 2019, total charcoal consumption in Uganda was 1.9 million tons/yr. In the same year, there were about 9 million households in the country (CPAR Uganda 2021). Assuming that all charcoal is used for cooking, this results in an average of 0.21 tons of charcoal per year per household. It must be noted that this number is subject to uncertainty, as there are regional differences in charcoal consumption and also past efforts to introduce improved cookstoves – such as the Kampala efficient cook stoves programme implemented by First Climate under Gold Standard certification – impact real consumption significantly (First Climate 2006; MEMD 2016).

For the purpose of this study, we assume a range of 0.15 – 0.30 tons of charcoal per year per household.

In 2019, the number of households in Kampala was approximately 564,000, with an annual growth rate of 5.2% (KNOEMA 2021).

The fraction of non-renewable biomass in Uganda is around 82% (CiDev 2020). We conservatively assume an annual replacement rate of charcoal cookers by electric devices of 4%. As circa 85% of Uganda's electricity is generated from CO_2-free hydro power, we assume that emissions intensity of electric cooking is 10% of charcoal-based cooking.

The resulting estimated emission reduction potential is summarised in Table 30 (conservative scenario) and Table 31 (optimistic scenario) below.

Table 30: Emission reduction potential – conservative scenario (0.15 t charcoal/yr)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
# households Kampala total	564 050	593 380	624 236	656 696	690 845	726 769	764 560	804 318	846 142	890 142
% transformation to electric cooking	0,04	0,08	0,12	0,16	0,2	0,24	0,28	0,32	0,36	0,4
# electric devices	22 562	47 470	74 908	105 071	138 169	174 424	214 077	257 382	304 611	356 057
ER (t CO2/yr)	**55 457**	**116 681**	**184 123**	**258 263**	**339 615**	**428 730**	**526 195**	**632 637**	**748 726**	**875 177**
Cummulative ER (t CO2)	**55 457**	**172 138**	**356 260**	**614 523**	**954 138**	**1 382 869**	**1 909 064**	**2 541 701**	**3 290 427**	**4 165 604**

Table 31: Emission reduction potential – optimistic scenario (0.30 t charcoal/yr)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
# households Kampala total	564 050	593 380	624 236	656 696	690 845	726 769	764 560	804 318	846 142	890 142
% transformation to electric cooking	0,04	0,08	0,12	0,16	0,2	0,24	0,28	0,32	0,36	0,4
# electric devices	22 562	47 470	74 908	105 071	138 169	174 424	214 077	257 382	304 611	356 057
ER (t CO2/yr)	**112 734**	**237 192**	**374 288**	**525 002**	**690 378**	**871 533**	**1 069 661**	**1 286 038**	**1 522 026**	**1 779 080**
Cummulative ER (t CO2)	**112 734**	**349 925**	**724 214**	**1 249 216**	**1 939 593**	**2 811 126**	**3 880 787**	**5 166 825**	**6 688 852**	**8 467 931**

The estimations show that the emission reduction potential is substantial: over a 10-year period, emission reductions accumulate to 4.1 million tons CO_2e (conservative scenario), and 8.4 million tons CO_2e (optimistic scenario). In the following, we continue assuming that the conservative scenario occurs.

Initial cost estimates

As discussed above, a "Cooking Tariff" has already been introduced by the Ugandan government lately to incentivise electric cooking. We assume this tariff to be continued. Hence, key components of the suggested Article 6 programme would be:

A subsidy of investment costs (buying electric cooking devices); and

An awareness raising programme to motivate households to switch.

Based on simple web research on costs of electric cooking devices, we assume additional costs of USD 28.50 for an electric pressure cooker, and of USD 15.70 for electric cook plates. We assume a 50-50 share of devices. For the awareness raising campaign, we assume USD 250,000/yr, i.e., USD 2.5 million over a 10-year period. Table 32 summarises expected annual costs. Total cost over the 10 year-period amounts to USD 1.4 million.

Table 32: Estimated cost of the suggested urban Article 6 programme

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
# households Kampala total	564 050	593 380	624 236	656 696	690 845	726 769	764 560	804 318	846 142	890 142
% transformation to electric cooking	0,04	0,08	0,12	0,16	0,2	0,24	0,28	0,32	0,36	0,4
# electric devices	22 562	47 470	74 908	105 071	138 169	174 424	214 077	257 382	304 611	356 057
# electric pressure cookers	11 281	23 735	37 454	52 536	69 084	87 212	107 038	128 691	152 306	178 028
# electric cook plates	11 281	23 735	37 454	52 536	69 084	87 212	107 038	128 691	152 306	178 028
Additional cost electric pressure cookers (USD)	321 213	354 619	390 631	429 429	471 206	516 166	564 529	616 525	672 402	732 424
Additional cost cook plates (USD)	176 667	195 040	214 847	236 186	259 163	283 891	310 491	339 089	369 821	402 833
Awareness raising campaign	250 000	250 000	250 000	250 000	250 000	250 000	250 000	250 000	250 000	250 000
Total cost (USD)	**747 880**	**799 659**	**855 478**	**915 615**	**980 369**	**1 050 058**	**1 125 019**	**1 205 614**	**1 292 223**	**1 385 257**

Required ITMO price levels

Based on the emission reduction- and cost estimates provided above, it is possible to estimate the ITMO price required to finance the suggested urban Article 6 activity. As shown in Table 33, an ITMO price of USD 5 appears to be more than sufficient to finance the programme[8].

[8] Note that all assumptions taken would need to be verified in a more detailed feasibility study, which is beyond the scope of this work. Also, overhead and administrative costs would need to be added in line with the actual structures of the programme.

Table 33: Required ITMO prices (conservative scenario)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
# households Kampala total	564 050	593 380	624 236	656 696	690 845	726 769	764 560	804 318	846 142	890 142
% transformation to electric cooking	0,04	0,08	0,12	0,16	0,2	0,24	0,28	0,32	0,36	0,4
# electric devices	22 562	47 470	74 908	105 071	138 169	174 424	214 077	257 382	304 611	356 057
# electric pressure cookers	11 281	23 735	37 454	52 536	69 084	87 212	107 038	128 691	152 306	178 028
# electric cook plates	11 281	23 735	37 454	52 536	69 084	87 212	107 038	128 691	152 306	178 028
Additional cost electric pressure cookers (USD)	321 213	354 619	390 631	429 429	471 206	516 166	564 529	616 525	672 402	732 424
Additional cost cook plates (USD)	176 667	195 040	214 847	236 186	259 163	283 891	310 491	339 089	369 821	402 833
Awareness raising campaign	250 000	250 000	250 000	250 000	250 000	250 000	250 000	250 000	250 000	250 000
Total cost (USD)	**747 880**	**799 659**	**855 478**	**915 615**	**980 369**	**1 050 058**	**1 125 019**	**1 205 614**	**1 292 223**	**1 385 257**
ER (t CO2/yr)	**55 457**	**116 681**	**184 123**	**258 263**	**339 615**	**428 730**	**526 195**	**632 637**	**748 726**	**875 177**
Cummulative ER (t CO2)	**55 457**	**172 138**	**356 260**	**614 523**	**954 138**	**1 382 869**	**1 909 064**	**2 541 701**	**3 290 427**	**4 165 604**
USD/ITMO	5	5	5	5	5	5	5	5	5	5
USD	**277 284**	**583 405**	**920 613**	**1 291 313**	**1 698 077**	**2 143 652**	**2 630 976**	**3 163 185**	**3 743 629**	**4 375 886**
Profit/loss (w/o overheads)	- 470 596	- 216 254	65 135	375 698	717 708	1 093 594	1 505 956	1 957 571	2 451 406	2 990 630

Considering the current Article 6 market outlook, it might be possible to reach significantly higher ITMO prices. Surplus revenues could then be used to cross-fund i) either investments in better renewable electricity and grid infrastructure, or ii) other Article 6 activities with higher abatement costs, such as the Bus Rapid Transport (BRT) programme analysed as part of this study, or any other urban Article 6 programme in Kampala or Uganda.

Conclusions

The proposed Article 6 activity 'Transition to electric cooking in Kampala' can result in significant benefits for climate (reduces emissions from using charcoal produced from non-renewable biomass), health (reduced indoor pollution causing respiratory diseases), and landscapes (reduced pressure on forests).

With 4 to 8 million tons CO_2e over a 10 year-period, the suggested Article 6 activity has a high emission reduction potential, even at moderate conversion rates (4%/yr). Also, investment costs are comparatively low, so that low ITMO prices would be sufficient for re-financing the activity. Potential higher ITMO-prices may allow broadening of the activity or for cross-funding other mitigation activities in Kampala/Uganda characterised by higher abatement costs.

In addition, if this programme is successful, there is opportunity to upscale to other urban areas in Kampala as the newly-introduced "Cooking Tariff' is applied nation-wide, and the coordinating entity (the MEMD) is a national-level institution. The proposed Article 6 activity is therefore considered a viable option for Kampala and next steps, for example, the development of a feasibility study including a willingness-to-pay study could be considered.

4 Conclusion

Overall, this report developed concrete structures for the use of urban carbon market approaches under Article 6 of the Paris Agreement for Addis Ababa and Kampala, focusing on four case studies that can be developed into ITMO revenue-generating activities.

The emissions profiles of each country were first analysed, determining sectors of interest, including transportation (a major source of emissions in both cities), household cooking and the health sector. Ethiopia has committed to reduce emissions by close to 69% by 2030, while Uganda aims to reduce 22% of emissions, both compared to business as usual. Ethiopia estimates BAU emissions would total 403.5 Mt CO_2e by 2030, compared to 77.3 Mt CO_2e in Uganda. Previous activities related to carbon markets were assessed, as well as existing and planned climate action strategies to develop case studies that are in line with local agendas. Addis Ababa's GHG emissions analysis show that the transportation sector shares the largest GHG emissions, i.e., around 68%; followed by waste (20%) and building (12%) sectors. In Kampala, the majority of GHG emissions are a result of the transport and household cooking sectors, due to the high use of charcoal and personal motorised transport.

The carbon market and climate financing mechanisms experience of each country were also examined. Under the Kyoto Protocol, Ethiopia registered nine CDM activities, with a total of 16 CPAs, while Uganda was much more active, registering 24 projects and 25 PoAs (including multi-country activities), mostly related to reforestation and energy efficiency and generation. Uganda's activities have generated over 13.40 million certified emission reductions (CERs) to date (more than 13 times the amount generated by Ethiopia).

Section 1.3 presented an overview of national and urban climate change policies, focusing on key strategies such as Ethiopia's Urban Development Policy, Urban Wastewater Management Strategy, Ethiopia's 10-Year Development Plan, Ethiopia's Climate-Resilient Transport Sector Strategy and Non-Motorised Transport Strategy, Uganda's National Climate Change Policy and the Kampala Climate Change Action Strategy. These strategies were key to assess local priorities and design case studies in line with local and national goals.

Chapter 2 then focused on the identification of key players in Article 6 implementation in both cities. Both the Kampala Capital City Authority and Addis Ababa Environment, Forest and Climate Change Commission will be key stakeholders in any future Article 6 activities.

Finally, Chapter 3 presented case studies for potential urban Art. 6 activities, which were developed with input from relevant stakeholders and then discussed in interactive workshops. The following case studies were proposed, including a quantitative assessment of their emission reduction potential, their financial viability and potential organisational structure:

- E-mobility in Addis Ababa;
- Green cooling in Addis Ababa health facilities;
- Bus rapid transit in Kampala; and
- Transition to electric cooking in Kampala.

Overall, the electric cooking activity in Kampala was found to be the most promising, offering high emission reduction potential at comparatively low ITMO prices, facilitated by the high penetration of renewables in Uganda's grid. For the same reason, the proposed e-mobility programme in Addis also offered high potential. Here, the main barrier currently is the initial purchase of EVs, but fuel savings result in a short payback period. Purchase of EVs could therefore be incentivised with tax

reductions, subsidies, etc. Again, comparatively low ITMO prices would be sufficient to unlock significant emission reduction potential.

The bus rapid transit project—while a local priority—requires high ITMO prices to cover the substantial construction costs to implement such a system, reducing the financial viability. However, increased public transit options in Kampala could bring significant social and environmental benefits.

Green cooling in health facilities will only bring limited emission reductions, unless uptake is widespread. There are several options for moving beyond the health sector, i.e., targeting agricultural value chains (food security, horticulture), public markets, business centres and even private households. Those options could be explored in more detail.

Overall, this report gives detailed insight into the emissions profiles, climate policies and key players in Addis Ababa and Kampala, developing four case studies for potential development into Article 6 pilot activities. Based on stakeholder consultation and positive cost-benefit analysis, several case studies can be identified that hold significant potential for adoption in Uganda and Ethiopia, with the potential for replication across Africa and similar contexts.

The most promising case studies – electric cooking in Kampala and e-mobility in Addis – should be developed further towards implementation due to their high environmental and benefits and low costs.

List of references

Abebe, Massreshaw Assnakew (2018): Challenges of waste to energy facility in Reppi (Koshe), Addis Ababa city, in: International Research Journal of Pharmacy and Medical Sciences (IRJPMS), 1, p. 9-16

Abubaker, Iman (2020): Reclaiming the streets: Addis Ababa, other African cities launch car-free days, The City Fix, April 22, 2019, https://thecityfix.com/blog/reclaiming-streets-addis-ababa-african-cities-launch-car-free-days-iman-abubaker/?fbclid=IwAR26VVCn8Gz4W1si8qcVgwbohNHV7YhHy9X4S5x0p70ZkwTMcLzgH8E26lg (accessed March 24, 2022)

Addis Ababa City Administration (2018): Addis Ababa non-motorized transport strategy 2019- 2028, Addis Ababa City Administration, Addis Ababa

Addis Ababa City Administration Office; Global Resilient Cities Network; Addis Ababa City Resilience Project Office (2020): Addis Ababa resilience strategy, Addis Ababa

Addis Ababa City Resilience Project Office (2018): Overview of Addis Ababa, https://resilientaddis.org/about-us-3/ (accessed May 26, 2021)

Addis Ababa Health Bureau (2022): Addis Ababa Health Bueau, https://www.moh.gov.et/site/Addis_Ababa_Health_Bureau (accessed September 21, 2022)

Addis Standard (2013): Power outages in Ethiopian hospitals, October 24, 2013, https://addisstandard.com/power-outages-in-ethiopian-hospitals/ (accessed January 14, 2022)

AfDB (2017a): Enhancing sustainable development in Ethiopia through climate change mitigation and adaptation: opportunities, challenges, and requirements for Ethiopia's participation in mechanisms under Article 6 of the Paris Agreement, AfDB, Abidjan

AfDB (2017b): Ethiopia - Addis Ababa Transmission and Distribution System Rehabilitation and Upgrading Project (AATDRUP), AfDB, Abidjan

Alvin, Lily (2017): Solar powered fridges and their refrigeration cycles, Medium, April 27, 2017, https://medium.com/@Refrigeration/solar-powered-fridges-and-their-refrigeration-cycles-5c61cf628653 (accessed April 20, 2022)

Batchelor, Simon; Brown, Ed; Scott, Nigel; Sumanik-Leary, Jon (2019): Experiences of electric pressure cookers in East Africa, https://mecs.org.uk/publications/experiences-of-electric-pressure-cookers-in-east-africa-conference-paper/ (accessed September 22, 2022)

Biryabarema, Elias (2020): Uganda says Chinese firm applies to build $1.4 bln power plant on the Nile, Reuters, February 11, 2020, https://www.reuters.com/article/uganda-electricity-idUSL8N2AB4DO (accessed June 22, 2021)

BMU (n.d.): Global Carbon Market - Uganda and Partner Countries in East Africa, https://www.carbon-mechanisms.de/en/initiatives/world-map/global-list/global-carbon-market-uganda (accessed June 22, 2021)

Brescia, Dario; Hoch, Stephan; Kassaye, Ruth; Michaelowa, Axel (2021): Article 6- Institutional and Legal Framework Assessment Study, Uganda country brief, http://www.carbonafrica.co.ke/the-synthesis-report-article-6-institutional-and-legal-framework-assessment-in-eastern-africa/ (accessed September 15, 2021)

Bruce, Nigel; Aunan, Kristin; Rehfuess, Eva (2017): Liquefied petroleum gas as a clean cooking fuel for developing countries: implications for climate, forests, and affordability, Materials on Development Financing, No. 7, KfW Development Bank, Frankfurt

Butzengeiger, Sonja; Michaelowa, Axel; Weldner, Kaja; Deng-Beck, Chang; Mogyorosy, Eszter; Harrs, Jan-Albrecht (2020): Urban components under Article 6 of the Paris Agreement, UBA, Dessau-Roßlau

C40 (2016a): C40 awards the 11 best cities of 2016 for addressing climate change, Press release, November 29, 2016, https://www.c40.org/press_releases/press-release-c40-awards-the-11-best-cities-of-2016-for-addressing-climate-change (accessed May 26,2021)

C40 (2016b): Cities100: Addis Ababa - Sub-Saharan Africa's First Light-Rail Train, https://www.c40.org/case-studies/cities100-addis-ababa-sub-saharan-africa-s-first-light-rail-train/ (accessed September 21, 2022)

C40 (2020): Benefits of urban climate action: C40 cities technical assistance report 2020, https://c40.box.com/s/d4xpshxdoi7uw8sazzlboo8s9xpftgts (accessed June 7, 2021)

Capital (2022): Marathon Motor launches first electric vehicle charging station, January 3, 2022, https://www.capitalethiopia.com/capital/marathon-motor-launches-first-electric-vehicle-charging-station/ (accessed January 01, 2022)

Ci-DEV (2020): Fraction of non-renewable biomass in emission crediting in clean and efficient cooking projects a review of concepts, rules, and challenges, Final Report, Washington DC

Ci-DEV (n.d. a): Programs, https://ci-dev.org/programs (accessed September 15, 2021)

Ci-DEV (n.d. b): Uganda: rural electrification, https://www.ci-dev.org/programs/uganda-rural-electrification (accessed June 22, 2021)

Cities Alliance (2017): The climate change and energy debate in Ethiopia, Cities Alliance, Brussels

Collectors Project (2020): Case study summary- Berlin, https://www.collectors2020.eu/wp-content/uploads/2020/08/Case_Integration_Summary_Berlin.pdf (accessed September 14, 2021)

Cooling as a Service (2021): Making clean cooling simple and accessible, CaaS, https://www.caas-initiative.org/ (accessed March 24, 2022)

CPAR Uganda (2021): Uganda national household survey 2019/2020 summary report, Press release, June 3, 2021, https://cparuganda.com/2021/06/03/uganda-national-household-survey-2019-2020-summary-report/#:~:text=UBOS%20released%20the%202019%2F20,smallest%20in%20Kampala%203.4%20persons (accessed April 7, 2022)

E Source (2010): Managing energy costs in hospitals, https://www.dsoelectric.com/sites/dsoelectric/files/My%20Business/hospitals.pdf (accessed April 20, 2022)

Embassy of Ethiopia (2021): Grand Meskel Square-Addis Ababa city hall project inaugurated in attendance of PM, deputy mayor, Press release, June 13, 2021, https://ethiopianembassy.org/grand-meskel-square-addis-ababa-city-hall-project-inaugurated-in-attendance-of-pm-deputy-mayor-june-13-2021/ (accessed April 7, 2022)

Ethiopian Embassy in London (2020a): Ethiopia plants 4.1 billion trees as part of 2020 Green Legacy Initiative, Press release, August 5, 2020, https://www.ethioembassy.org.uk/ethiopia-plants-4-1-billion-trees-as-part-of-2020-green-legacy-initiative/ (accessed May 26, 2021)

Ethiopian Embassy in London (2020b): Ethiopia exports first avocados by train, Press release, August 28, 2020, https://www.ethioembassy.org.uk/ethiopia-exports-first-avocados-by-train/ (accessed April 7, 2022)

Ethiopian Monitor (2020): Addis Ababa Launches Construction of Bus Rapid Transit, June 27, 2020, https://ethiopianmonitor.com/2020/06/27/addis-ababa-launches-construction-of-bus-rapid-transit/#:~:text=ADDIS%20ABABA%20%E2%80%93%20Addis%20Ababa%20city,Construction%20project%20on%20Saturday%20Morning (accessed April 7, 2022)

European Commission (n.d.): Kampala City Lighting and Infrastructure Improvement Project (KCLIIP), https://ec.europa.eu/eu-external-investment-plan/projects/kampala-city-lighting-and-infrastructure-improvement-project-kcliip_en (accessed June 22, 2021)

First Climate (2006): Uganda: Efficient cook stoves, First Climate, Zurich

GACC (2016): Comparative Analysis of Fuels for Cooking: Life Cycle Environmental Impacts and Economic and Social Considerations: Appendix A: Detailed Environmental, Economic and Social Technical Analyses, Global Alliance for Clean Cookstoves, Washington, DC

GACC (2017): Comparative Analysis of Fuels for Cooking: Life Cycle Environmental Impacts and Economic and Social Considerations, Global Alliance for Clean Cookstoves, Washington, DC

GGGI (2020): GGGI and SEA to develop four mitigation activities generating ITMOs in energy, waste, and manufacturing, Press release, October 2020, https://gggi.org/gggi-and-sea-to-develop-four-mitigation-activities-generating-itmos-in-energy-waste-and-manufacturing/ (accessed April 11, 2022)

GGGI (n.d.): Uganda, https://gggi.org/country/uganda/ (accessed June 22, 2021)

Global Covenant of Mayors for Climate and Energy (2015): City dashboard- Addis Ababa, Brussels, https://www.globalcovenantofmayors.org/cities/addis-ababa/ (accessed May 25,2021)

GoE (2015a): Ethiopian national expanded programme on immunization, comprehensive multi-year plan 2016-2020, Federal Ministry of Health, Addis Ababa

GoE (2015b): Intended Nationally Determined Contribution (INDC) of the Federal Democratic Republic of Ethiopia, Addis Ababa

GoE (2015c): Second National Communication to the United Nations Framework Convention on Climate Change (UNFCCC), Addis Ababa

GoE (2019a): Ethiopia's climate-resilient green economy: National adaptation plan, Government of Ethiopia, Addis Ababa

GoE (2019b): National electrification program 2.0 integrated planning for universal access, Government of Ethiopia, Addis Ababa

GoE (2021a): Ten years development plan: A pathway to prosperity 2021-2030, Government of Ethiopia, Addis Ababa

GoE (2021b): Updated nationally determined contribution, Government of Ethiopia, Addis Ababa

GoE (n.d.): Ethiopia's climate resilient transport sector strategy, Addis Ababa

Gold Standard (n.d.): Impact registry, https://registry.goldstandard.org/projects?q=uganda&page=1 (accessed June 22, 2021)

Government of Kenya (2019): Performance and implementation of climate change actions Transport Sector Climate Change Annual Report: Performance and Implementation of Climate Change Actions, Ministry of Transport, Infrastructure, Housing, Urban Development and Public Works, Nairobi

Haji, Sani; Assefa, Tibebu; Bailey, Rose (2020): Addis Ababa City 2016 Greenhouse Gas Emissions Inventory Report, v.8, Addis Ababa City Administration, Addis Ababa

Hoch, Stephan; Brescia, Dario; Cowman, Tim; Weldner, Kaja; Kassaye, Ruth; Michaelowa Axel (2021a): Revitalizing Eastern Africa's institutional capacity to engage in global carbon: The synthesis report: Article 6 institutional and legal framework assessment in Eastern Africa, East African Alliance, Freiburg

Hoch, Stephan; Brescia, Dario; Kassaye, Ruth; Cowman, Tim; Mutungi, Alexandra; Aguko, Julie (2021b): Carbon marker profile-Ethiopia, Eastern Africa Alliance on Carbon Market and Climate Finance, Climate Finance Innovators-Linking carbon markets with climate change in Africa, Freiburg

Husen, Ali Idriss; Maschal, Tarekegn Mekonnen (2019): Methane gas emission and its management practices from solid waste stream, case study: Addis Ababa and its surrounding Oromia special Zone towns, in: Environ Pollution Climate Change, 2

ICCT (2012): Cost and benefits of clean technologies for bus rapid transit (BRT): Summary of results for Kampala, UNON, Nairobi

IEA (2016): Energy Technology Perspectives 2016: Towards Sustainable Urban Energy Systems, https://webstore.iea.org/download/direct/1057 (accessed July 7, 2021)

IKI (2021a): Shifting the paradigm in infrastructure investments in East Africa, https://www.international-climate-initiative.com/en/iki-media/news/shifting_the_paradigm_in_infrastructure_investments_in_east_africa/ (accessed September 21, 2022)

IKI (2021b): Linking market mechanisms and climate finance in Africa, https://www.international-climate-initiative.com/en/project/linking-market-mechanisms-and-climate-finance-in-africa-18-i-350-africa-a-africa-market-mechanisms/ (accessed June 22, 2021)

IKI (2021c): Integrating electric 2 & 3-wheelers into existing urban transport systems in developing countries, https://www.international-climate-initiative.com/en/project/integrating-electric-2-3-wheelers-into-existing-urban-transport-systems-in-developing-countries-17-i-288-global-m-electric-wheelers/ (accessed June 22, 2021)

IPCC (2019): 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Chapter 7: Emissions of Fluorinated Substitutes for Ozone Depleting Substances, IPCC, Geneva

IRENA (2021), Energy profile Ethiopia, September 2021, https://www.irena.org/IRENADocuments/Statistical_Profiles/Africa/Ethiopia_Africa_RE_SP.pdf (accessed January 5, 2022)

ITDP (2019): Ethiopia marks eleventh car-free day, December 17, 2019, https://africa.itdp.org/ethiopia-marks-eleventh-car-free-day/#:~:text=Despite%20the%20heavy%20rains%2C%20Ethiopia,%2C%20Bahir%20Dar%2C%20and%20Mekele (accessed April 11, 2022)

JCM (n.d.): Overview of the Joint Crediting Mechanism (JCM), https://gec.jp/jcm/about/ (accessed June 22, 2021)

JICA (2010): The study on Greater Kampala road network and transport improvement in the Republic of Uganda: Final report executive summary, JICA, Tokyo

JICA (2018): Signing of Japanese ODA Loan Agreement with Uganda: Contributing to better power conditions in Kampala, the capital city, through electricity transmission grid improvements, Press release, April 27, 2018, https://www.jica.go.jp/english/news/press/2018/180427_03.html (accessed June 22, 2021)

JICA (n.d.): Environmental and social considerations in development study: Project for master plan study on hydropower development in the Republic of Uganda, https://www.jica.go.jp/english/our_work/social_environmental/archive/pro_asia/pdf/uga04_01.pdf (accessed June 22, 2021)

K-CEP (2018): Global climate impact from hospital cooling, K-CEP, San Francisco

K-CEP (2020): Understanding the cold-chain challenges for Covid-19 vaccination, K-CEP, San Francisco

Kampala Climate Change Action (2015): Energy and climate profile, KCCA, Kampala

KCCA (2015): Energy and Climate Profile, https://www.kcca.go.ug/uDocs/Energy%20and%20Climate%20Profile.pdf (accessed December 2, 2021)

KCCA (2016): Kampala climate change action strategy, http://www.kcca.go.ug/uDocs/Kampala%20Climate%20Change%20Action.pdf (accessed May 19, 2021)

KCCA (2018a): Public transport a challenge: Does KCCA care?, https://www.kcca.go.ug/news/308#.YPVI9-gzbIW (accessed July 19, 2021)

KCCA (2018b): Waste recycling in Kampala on the verge of takeoff, Press release, April 5, 2018, http://www.kcca.go.ug/uDocs/WASTE%20RECYCLING%20PRESS%20STATEMENT.pdf (accessed June 22, 2021)

KCCA (2018c): Multi Modal Urban Transport Plan for GKMA, KCCA, Kampala

KCCA (2019): Statistical abstract for Kampala City, KCCA, Kampala

Kebede, Lencho; Tulu, Getu; Lisinge, Robert (2022): Diesel-fueled public transport vehicles and air pollution in Addis Ababa, Ethiopia: Effects of vehicle size, age and kilometers travelled, in: Atmospheric Environment, 13, p. 1-13

KfW (n.d.): Safe water access in Uganda and Rwanda, http://www.carbonmarket-foundation.org/safe-water-access-in-uganda-and-ruanda (accessed June 22, 2021)

KNOEMA (2021): Uganda: Charcoal, consumption by households, https://knoema.com/UNSDESD2018/un-statistics-division-energy-statistics-database?tsId=1664270 (accessed April 7, 2022)

Kuhudzai, Remeredzai (2020): 1st Ethiopian-assembled all electric Hyundai Ioniq rolls out of Haile Gebreselassie's Marathon Motor Engineering Plant, CleanTechnica, July 27, 2021, https://cleantechnica.com/2020/07/27/first-ethiopian-assembled-all-electric-hyundai-ionic-rolls-out-of-haile-gebrselassies-marathon-motor-engineering-plant/ (accessed January 15, 2021)

Lang, Chris (2020): The Swedish Energy Agency has stopped buying carbon credits from Green Resources' destructive plantations in Uganda, REDD Monitor, March 11, 2020, https://redd-monitor.org/2020/03/11/the-swedish-energy-agency-has-stopped-buying-carbon-credits-from-green-resources-destructive-plantations-in-uganda/ (accessed June 22, 2021)

MECS (2020): Cooking with Electricity in Uganda: Barriers and Opportunities, Modern Energy Cooking Services, Loughborough

Meles, Tensay (2020): Impact of power outages on households in developing countries: evidence from Ethiopia, in: Energy Economics, 91, p. 1-11

MEMD (2016): National charcoal survey for Uganda, Final report, MEMD, Kampala

MEMD (2019): Draft National Energy Policy, Ministry of Energy and Mineral Development, Kampala

MEMD (2021): Home, https://www.energyandminerals.go.ug/ (accessed September 28, 2021)

Michael, Wambi (2009): UGANDA: Carbon Trading Scheme Pushing People off Their Land, Inter Press Service, September 25, 2009, http://www.ipsnews.net/2009/09/uganda-carbon-trading-scheme-pushing-people-off-their-land/ (accessed June 22, 2021)

Ministry of Health (2020): Third National Development Plan (NDPIII) 2020/21 – 2024/25, Ministry of Health, Kampala

Ministry of Transport (2019): National Logistic Strategy (2019-2028), Ministry of Transport, Addis Ababa

Ministry of Transport (2020a): Transport sector ten years perspectives plan, Ministry of Transit, Addis Ababa

Ministry of Transport (2020b): Ethiopia's non-motorized transport strategy 2020-2029, Ministry of Transit, Addis Ababa

Ministry of Water and the Environment (2011): Uganda National climate change policy (Summary version), Ministry of Water and the Environment, Kampala

Ministry of Water and the Environment (2015): Uganda's Intended Nationally Determined Contribution (INDC), Ministry of Water and the Environment, Kampala

Ministry of Water and the Environment (2019): Uganda's first biennial update report to the United Nations Framework Convention on Climate Change, Ministry of Water and the Environment, Kampala

Molla, Habtamu; Hussien, Kelemework (2017): Assessment on storage conditions of medical laboratory commodities and KAP of store managers at government hospitals in Addis Ababa, Ethiopia, in: Journal of Multidisciplinary Research in Healthcare, 4, p. 11-21

Movin' On Lab (2018): Kiira Motors Corporation (KMC) in Uganda (East Africa) embraces the 2015 Paris climate agreement, Press release, November 27, 2018, https://lab.movinonconnect.com/s/article/Kiira-Motors-Corporation-KMC-in-Uganda-East-Africa-Embraces-the-2015-Paris-Climate-Agreement-1543272497802?language=en_US (accessed September 14, 2021)

MOWIE (2017): Urban wastewater management strategy, MOWIE, Addis Ababa

NPA (2018): Policy Paper for Presidential Economic Council (PEC): Unlocking the Economic Potential of Greater Kampala for Improved Productivity and Growth, National Planning Authority, Kampala

NREL (2003): Evaluating the emission reduction benefits of WMATA natural gas buses, https://www.nrel.gov/docs/fy03osti/33280.pdf (accessed December 7, 2021)

Price, Roz (2017): "Clean" Cooking Energy in Uganda – technologies, impacts, and key barriers and enablers to market acceleration, K4D Helpdesk Report, Institute of Development Studies, Brighton

Promethium Carbon (2019): Carbon pricing approaches in Eastern and Southern Africa, https://unfccc.int/sites/default/files/resource/Summary%20of%20East%20Africa%20carbon%20pricing%20report.pdf (accessed June 22, 2021)

Republic of Uganda (2015): Uganda national climate change policy theme: Transformation through climate change mitigation and adaptation, Republic of Uganda, Kampala

Republic of Uganda (2019): The national environment act, Republic of Uganda, Kampala

Reuters (2021): Ethiopian Airlines says ready to transport COVID-19 vaccines, March 7, 2021, https://www.reuters.com/article/uk-health-coronavirus-ethiopian-airlines/ethiopian-airlines-says-ready-to-transport-covid-19-vaccines-idUSKBN2AZ0GF (accessed June 24, 2021)

RTI (n.d.): Expanding affordable & reliable electricity services in Ethiopia, https://www.rti.org/impact/expanding-electricity-services-and-energy-access-in-ethiopia (accessed December 21, 2021)

SEforALL (2021): Raising ambitions for off-grid cooling appliances, SEforALL, Vienna

Seto, Karen; Dhakal, Shobhakar; Bigio, Anthony; Blanco, Hilda; Delgado, Gian Carlo; Dewar, David; Huang, Luxin; Inaba, Atsushi; Kansal, Arun; Lwasa, Shuaib; McMahon, James; Müller, Daniel; Murakami, Jin; Nagendra, Harini; Ramaswami, Anu (2014): Human Settlements, Infrastructure and Spatial Planning, in: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA

SGR (n.d.): Light rail transit, https://www.sgr.go.ug/light-rail-transit (accessed June 22, 2021)

Sinshaw, Waganeh; Kebede, Abebaw; Bitew, Adane; Tesfaye, Ephrem; Tadesse, Mengistu; Mehamed, Zemedu; Yenew, Bazezew; Amare, Misikir; Dagne, Biniyam; Diriba, Getu; Alemu, Ayinalem; Getahun, Muluwork; Fikadu, Dinka; Desta, Kassu; Tola, Habteyes Hailu (2019): Prevalence of tuberculosis, multidrug resistant tuberculosis and associated risk factors among smear negative presumptive pulmonary tuberculosis patients in Addis Ababa, Ethiopia, in: BMC Infectious Diseases, 19

SNV (2014): Grassroots solutions for scaling up improved cookstove access in Uganda: A Last-Mile Community Market Intelligence Report, SNV Uganda, Kampala

Spooner, Dave; Manga, Erick; Mwanika, John (2020): Kampala Bus Rapid Transit: Understanding Kampala's Paratransit Market Structure,

https://www.researchgate.net/publication/342233740_Kampala_Bus_Rapid_Transit_Understanding_Kampala%27s_Paratransit_Market_Structure (accessed December 2, 2021)

Tabish, Syed Amin (2011): Future trends in green hospitals, JayPee Brothers, New Delhi

Takouleu, Jean Marie (2021): UGANDA: The Bugolobi-Nakivubo wastewater treatment plant is finally operational, Afrik21, April 28, 2021, https://www.afrik21.africa/en/uganda-the-bugolobi-nakivubo-wastewater-treatment-plant-is-finally-operational/ (accessed June 22, 2021)

Tassie, Kassahun; Endalew, Birara; Mulugeta, Anteneh (2019): Composition, generation and management method of municipal solid waste in Addis Ababa city, Central Ethiopia: A Review, in: Asian Journal of Environment & Ecology, p. 1-19

Tekle, Tesfa-Alem (2020): Ethiopia unveils locally-assembled electric car, The East African, July 28, 2020, https://www.theeastafrican.co.ke/tea/business/ethiopia-unveils-locally-assembled-electric-car-1907430 (accessed March 24, 2022)

Tessama, Zereay; Davis, Marion (2013): Mainstreaming sustainable energy access into national development planning: the Case of Ethiopia, Stockholm Environment Institute, Stockholm

Tessema, Endale (2017): Assessment of cold chain quality management for pharmaceuticals in government hospitals in Addis Ababa, Addis Ababa University, Addis Ababa

The Mobility House (2022): TCO Cost Comparison: Electric Car vs. Petrol Which car costs more annually?, https://www.mobilityhouse.com/int_en/knowledge-center/cost-comparison-electric-car-vs-petrol-which-car-costs-more-annually#purchase-price (accessed April14,2022)

The Reporter (2021): Light railway incurs 4.6 billion Birr in losses, https://m.facebook.com/permalink.php?story_fbid=3770698839644750&id=177352718979398&comment_id=3771573706223930 (accessed April 7, 2022)

Thomson Reuters (2020): Electricity regulation in Ethiopia: Overview, October 01, 2020, https://uk.practicallaw.thomsonreuters.com/w-028-1702?transitionType=Default&contextData=(sc.Default)&firstPage=true (accessed Dec. 21, 2021)

UBOS (2021): Uganda National Household Survey 2019/2020, Uganda Bureau of Statistics, Kampala

Uganda Business News (2017): Government plans ambitious $700m light rail network for greater Kampala, September 13, 2017, https://ugbusiness.com/2017/09/politics-policy/uganda-government-plans-ambitious-700mn-light-rail-network-for-greater-kampala#gref (accessed June 22, 2021)

UIA (n.d.): Clean development mechanism project, https://www.ugandainvest.go.ug/parks/cdm/ (accessed June 22, 2021)

UNECA (2020): Road safety performance review Ethiopia, UNECA, Addis Ababa

UNEP (2019): Ethiopia enhances environmental protections through waste management, UNEP, Nairobi

UNEP (n.d.): Electric mobility projects in Africa, https://www.unep.org/explore-topics/transport/what-we-do/electric-mobility/electric-mobility-projects-africa (accessed June 22, 2021)

UNEP DTU (2021): CDM pipeline overview, https://www.cdmpipeline.org/ (accessed April 26,2021)

UNEP DTU (2021a): Paris Agreement Article 6 Pilot activities, https://www.cdmpipeline.org/publications/Article6Pipeline.xlsx (accessed July 21, 2021)

UNEP DTU (2021b): CDM Project pipeline, https://www.cdmpipeline.org/publications/CDMPipeline.xlsm (accessed July 21, 2021)

UNFCCC (2018a): Ethiopia off-grid renewable energy program, programme of activities design document form (Version 08.1), https://cdm.unfccc.int/UserManagement/FileStorage/IW5JANRXT69F0K2187SZU3CDEHMVOL (accessed July 21, 2021)

UNFCCC (2018b): Move-Ethiopia zero-carbon mobility units Program (the PoA), https://cdm.unfccc.int/ProgrammeOfActivities/Validation/DB/GWXV48HPUGYOCWJJS5QUXFW7MZCAJ2/view.html (accessed June 07, 2021)

UNFCCC (2019): Ethiopia – Clean Cooking Energy Program, Programme of activities design document form (Version 08.1), https://cdm.unfccc.int/ProgrammeOfActivities/poa_db/UOK2Q9S5GP34L7CMBRADHWZ6FITEVY/view (accessed September 21, 2022)

UNFCCC (n.d. a): Bus rapid transport system in Kampala, https://www4.unfccc.int/sites/PublicNAMA/_layouts/UN/FCCC/NAMA/Download.aspx?ListName=NAMA&Id=86&FileName=Bus%20Rapit%20Transport%20system%20in%20Kampala.docx (accessed June 22, 2021)

UNFCCC (n.d. b): CDM Programmes of Activities, https://cdm.unfccc.int/ProgrammeOfActivities/index.html (accessed June 22, 2021)

UNFCCC (n.d. c): CDM project search, https://cdm.unfccc.int/Projects/projsearch.html (accessed June 22, 2021)

UNFCCC (n.d. d): Regional Collaboration Centre Kampala, https://unfccc.int/about-us/regional-collaboration-centres/rcckampala (accessed June 22, 2021)

UNFCCC RCC Kampala (2019): The East African Alliance on Carbon Markets and Climate Finance formally launched, https://unfccc.int/sites/default/files/resource/Launch%20of%20the%20East%20African%20Alliance_final.pdf (accessed June 22, 2021)

USAID (2015): Greenhouse gas emissions in Uganda, https://pdf.usaid.gov/pdf_docs/pa00mskh.pdf (accessed May 31, 2021)

Verra (n.d.): Verra registry, https://registry.verra.org/app/search/VCS (accessed June 22, 2021)

Wall, R.; Maseland, J.; Rochell, K; Spaliviero, M (2018): The State of African Cities 2018: The geography of African investment, University of Rotterdam and United Nations Human Settlements Programme (UN-Habitat), Rotterdam, Netherlands and Nairobi, Kenya

Walta (2015): American company to build electric car assembly plant in Ethiopia, March 10, 2015, https://waltainfo.com/16143/ (accessed January 15, 2021)

Wappelhorst, Sandra; Mock, Peter; Yang, Zifei (2018): Using vehicle taxation policy to lower transport emissions: an overview for passenger cars in Europe, ICCT, Berlin

WHO (2017): Primary health care systems (PRIMASYS): Case study from Ethiopia, abridged version, WHO, Geneva

World Bank (2012): Ethiopia climate project receives Africa's first forestry carbon credits under the CDM, Press release, October 9, 2012, https://www.worldbank.org/en/news/feature/2012/10/09/ethiopia-climate-project-receives-africa-s-first-forestry-carbon-credits (accessed April 11, 2022)

World Bank (2014): Results-based aid in the energy sector- case study, World Bank, Washington, D.C.

World Bank; KCCA; Government of Uganda (2010): Pre feasibility studies for the development of a long term integrated bus rapid transit system for Greater Kampala Metropolitan Area: Final report, Kampala

Appendix: Stakeholder workshop minutes

A.1 Stakeholder workshop notes: potential for Article 6 activities in the transport and health sector in Addis Ababa

Hosted by Perspectives Climate Research & ICLEI Africa

Monday, February 28th, 2022 (9:30am-12:30pm) (GMT+3: Kampala)

Attendees:

Hosts: Sonja Butzengeiger-Geyer, Stephan Hoch, Ruth Kassaye, Erin Danford, Sarah Catto, Tarryn Quayle

1. Ayla Opatz (Allianz für Entwicklung und Klima (BMZ))
2. Betelihem Mekonnen (Ministry of Water and Energy)
3. Fantahun Gezie (Environment, Forest and Climate Change Commission)
4. Kim Schmidt (GIZ)
5. Lydia Ondraczek (GIZ)
6. Marcel Kruse (UBA)
7. Nega (name unknown)
8. Rachel Pekker (BMUV)
9. Samson Tolessa (GIZ ET)
10. Sultan George (Vita)
11. Wubshet Tadele Tsehayu (Project Gaia)
12. Yizengaw Yitayih (Ministry of Transport)
13. Yohannes Ameha (Environmental Specialist- Addis Ababa City Resilient Project Office)
14. Dagnew Hagezom (Ministry of Health)
15. Elias Asfaw (Development Bank of Ethiopia)
16. Jobir Ayalew Senbeta (Director for Environment and Climate Change, Ministry of Transport)
17. Anteneh Temesgen (MOT)
18. Gesa Schöneberg (Allianz für Entwicklung und Klima (BMZ))
19. Higu Kefale (Ethiopian Federal Minstry of Health)
20. Florian Fritzsche (GIZ)

Welcome & opening remarks (Sonja Butzengeiger)

Welcome – looking at two case studies to mobilise climate finance to transform urban activities

Background on UBA urban Article 6 project (Sonja Butzengeiger, Marcel Kruse)

Marcel Kruse: Overview of why UBA has initiated this research

Untapped global potential for mitigation in urban areas

Presentation of case study "*E-mobility in Addis Ababa*" (Sonja Butzengeiger) Incl. Q&A

Marcel: how do colleagues from Ethiopia see electric mobility – is this something already being discussed regarding buying electric vehicles? How do people see this?

Stephan: barriers to accessing carbon market during Kyoto mechanism: power market was already too "clean" because of hydropower. Therefore, one couldn't achieve many emission reductions because baseline emissions are already low. With Article 6, the fact the power sector is so clean

means that emission reductions are higher for the electric mobility sector. This is now a new era of the Paris Agreement where the carbon market can work well

Yizengaw: pointed out that the number of cars is a national number, not for Addis; taxi owners are private, don't have available finances to purchase electric vehicles – how can they purchase electric vehicles? Sonja explained the revenue stream for the project

Sonja: Development Bank could offer zero/low interest loans where taxi owners could finance purchase; or National Government would need to take a pre-financing role so the taxi owners can purchase electric vehicles; would need to elaborate further to find smart financing

Betelihem: Battery systems: needing to replace battery systems after e.g. 5 years – cost of this and of managing disposal of old batteries. MRV systems are also a challenge as well as overall management – how much will these aspects cost? Sonja: Battery waste would become an issue the more vehicles are operated; renting of batteries is an option – this would have to be negotiated with car manufacturers; in the scope of this study, we have not been able to make a detailed study into the cost of managing batteries

Sultan: ITMOs – how does the implementation happen? Consultation with Ministry of Transport – very important. Possibility to also consider private vehicles in addition to taxis, better to widen our consideration. Development Bank – what other institutions should we be considering? Private institutions have supported the Transport sector before, so these should be considered.

Elias Asfaw: pointed out that DBE couldn't finance a transport service itself. If there is a financer, DBE could manage it. It is better to include CBE/Commercial Banks for such kind of financial support.

Ashrafedin Yuya: It would be better to include the energy (water) and health sector to this initiative. For this initiative, the electric utility is under the energy sector as an institution while the health sector is the most single affected by the air pollution so that it is better to have it in the consultation. The legal framework will be another critical point. Sonja: Health benefits will of course be significant. Consider that this is a very early stage.

Anteneh Temesgen: Thanks for such interesting idea, how will be power distribution centres? Sonja: The assumption is that the existing grid would be able to serve the initiative.

Nega: Long and tired full banking and loan system may be one of the challenges for this initiative idea in Ethiopia. So make preparation and solving mechanism to this challenge. And I did not see the Ministry of Water and Energy as entity (stakeholder). Finally, Some data are more than the real like number of car in Addis, please check the data.

Sultan George: Better to widen scope to consider other private banks as well as development banks.

Samson Tolessa (GIZ): E-mobility has been raised a couple of times in the secretariat for Ethiopian-German Energy Cooperation. Florian followed up and stated they will coordinate internally and get in touch regarding the way forward.

15-minute break

Presentation of case study "*Cooling in the health sector*" (Sonja Butzengeiger) Incl. Q&A

Multiple participants asked for the presentation to be shared after the workshop

Ashrafedin Yuya: What is the scale of the project, i.e. is it in piloting mode? Generally, the idea is very nice and will be implementable. What is the relation to the NDC? Stephan: Ethiopia's NDC

explicitly indicates the intention to work within the Article 6 framework; we are still working within regulations only just agreed upon in COP26

Sultan A. George: UNICEF is the main actor for supporting the cold chain system of health facilities and technical support and better to consider. Could the scope consider the private health facilities in town? Sonja: Expanding scope is fundamental for establishing a good Article 6 activity (e.g. private sector facilities)

Higu Kefale: The big problem about this solar technology is sustainability and maintenance after installation. Can local technicians be trained on the technology? Sonja: Not only about installation, also critical to have capacities and capabilities to ensure they work properly. This can be factored in – as programme grows, would be easier to have dedicated team of technicians. Can then install service provider contracts. Stephan: in Ethiopia, not a lot of access to cooling right now, so training etc. needs to be provided in addition. Case study shows it is possible to accelerate implementation with Article 6 – this is for Addis for now, but once this is in place, can be expanded to other cities and regions, as well as other sectors such as agriculture/horticulture.

Ashrafedin Yuya: MOH has an initiative to make health facilities climate resilient. One part compatible with this is providing/expanding safe energy sources to health facilities.

Stephan: NDC update will include the cooling/health sector explicitly; option for sustainable cooling – newer concept; opportunity to jump straight into newer generation of technologies; multi-country initiative – regional collaboration potential; this requires dedication but is very important; there are a number of initiatives in place and Article 6 can play a role in this

Samson (GIZ): e-mobility/energy transition – agenda raised a few times in portfolio of projects; not a mainstream discussion yet, but can start discussion now

Next steps and closing remarks

Rachel Pekker: Two IKI projects (green cooling/Article 6 in southern Africa) – would be good to exchange and look at synergies; another one on old appliances and how they can be recycled – plan to launch alliance in this regard where exchange could be useful. **Rachel to share contacts for us to get in touch with.** Sonja: Eco-fridges project – any info on this? **Rachel will look into it if we share information**

Lydia Ondraczek: Alliances (e.g. East African Alliance); recommend to get in touch to share this potential offer so this sector and approach can be taken into account when developing strategies later on

Florian Fritzsche (GIZ): will coordinate internally – very happy to be involved

Sonja asked participants to follow up via email as to which case studies they are interested in.

A.2 Stakeholder workshop minutes: potential for Article 6 activities in the transport and cooking sectors in Kampala

Tuesday, March 1st, 2022 (9:30am-12:30pm) (GMT+3: Kampala)

Hosted by Perspectives Climate Research & ICLEI Africa

Attendees:

Hosts: Sonja Butzengeiger, Stephan Hoch, Erin Danford, Sarah Catto, Tarryn Quayle

1. Marcel Kruse (UBA)
2. Arthur Ssebbugga-Kimeze (GGGI)
3. Gloria Namazzi (GIZ)
4. Joseph Okolong (KCCA)
5. Judith Amulen (KCCA)
6. Kim Schmidt (GIZ)
7. Pius Wamala (UDB)
8. Rachel Pekker (GIZ)
9. Rebecca Nabatanzi Sserwanga (GIZ)
10. Ritah Rukundo (GIZ)
11. Simon Peter Mukasa (MEMD)
12. Solome Nakimbugwe (KCCA)
13. Usamah Kaggwa (MEMD)
14. David Kisakye Baleese (GIZ)
15. Rubayiza Isaac (MoWE)
16. Abasi Kirigwajjo (KCCA)
17. Bianca Gichangi (Eastern Africa Alliance on Carbon Markets and Climate Finance)
18. Ronnie Ssejjuko (GGGI)
19. Carol's iPhone
20. Kayemba Patrick (FABIO and ULGA)

Welcome & opening remarks

Background on UBA urban Article 6 project (Sonja Butzengeiger, Marcel Kruse)

Presentation of case study "Kampala bus rapid transit system" (Erin Danford, Sonja Butzengeiger), incl. Q&A

Stakeholders overall very engaged, many comments and questions—interest in making the project feasible and finding finance.

Consensus that blended finance/other sources will be needed since the price for positive NPV is so high.

Kayemba Patrick (National director of FABIO Uganda): highlighted lack of willingness of government to actually implement BRT as a hurdle.

Arthur Ssebbugga-kimeze: noted that assumptions for distances for boda bodas and matatus are conservative and political leadership buyin is a barrier.

Pius Wamala: Asked about outlook for anticipated tradeoffs and any alternative implementation strategies

Abasi Kirigwajjo: noted need for a more detailed feasibility study coupled with lobbying for funding

Usamah Kaggwa-MEMD: highlighted challenge of land compensation in developing infrastructure projects. Potential need to revisit 2010 USD 29m figure?

Pius Wamala: pointed out that there is currently frustration with middlemen taking a significant chunk of carbon funds, with little reaching the actual beneficiary. Arthur Ssebbugga-kimeze responded that the credits will likely be owned by MWE or MoFPED and therefore remitted to the consolidated fund

Judith Amulen: The preferred technology is electric buses and consideration could be made to have them manufactured in Uganda. Ritah Rukundo, GIZ, pointed out that this could have synergies with the current Kiira EV project.

Focus on charging infrastructure. Arthur Ssebbugga-kimeze: Jinja and Entebbe towns have committed to handing over good space (acres) for public charging infrastructure. Joseph Okolong pointed out that solar energy should be used to create charging stations in various locations in the city. Arthur Ssebbugga-kimeze: Off-grid power sources (solar parks) will ameliorate the demand for power that may be presented by the new demand for transport uses. Plus, with productive captive use, additional emissions reductions can be claimed.

Gloria Namazzi: asked which Article 6 framework would best suit this project? 6.2 or 6.4? How does this interplay with the targets in our NDC (noting that it is currently being revised)?

Pius Wamala: Proceeds should again be used for green projects

15-minute break

Presentation of case study “Alternatives to charcoal use/clean cooking” (Sarah Catto, Sonja Butzengeiger), incl. Q&A

Focus on monitoring—agreement that a pilot project disseminating 50,000 - 100,000 devices would be a good start

Focus on the importance of changing mindsets

Arthur Ssebbugga-kimeze: In the case of a smaller player huge population program like cookstoves, there are big transparency issues

Gloria Namazzi—cookstoves are low-hanging fruit and could quickly bring ER benefits, as well as co-benefits, but monitoring would be difficult

David Kisakye Baleese: Would households be willing to pay the proposed cooking tariffs? Any studies on WTP? Usamah Kaggwa responded: The study conducted shows that it would be cheaper to cook with the tariff but this requires a comprehensive awareness strategy for mindset change.

Abasi Kirigwajjo: pointed out that National Environment Mgt Authority (NEMA) could also play a role in supporting low carbon development

Arthur Ssebbugga-kimeze: 794k tCO_2e is already about the size of Bujagali, which was one of the largest ER (CDM) projects in Africa. Very positive projection.

Ritah Rukundo, GIZ: Does the study look into the technology types e.g. electric cookers with optimized energy consumption as opposed to the conventional electric cookers on the market or considering induction cookers (understanding cost implication)?

Ritah Rukundo, GIZ: As is commonly known, one of the constraints for ICS projects has been monitoring of the emission reductions of the individual units. Does the proposed pilot take this into account e.g. using sampling or remote monitoring of the units?

Rebecca Nabatanzi Sserwanga: The cook stoves idea brings the idea of inclusivity home -easy to track, even for the gender impact

Joseph Okolong: Challenge here is to extend electricity to every household.

Ritah Rukundo, GIZ: The bigger challenge is the current electricity tariff which is perceived to be high by the population. With more efficient cooking devices and mindset change, this would be a good project to roll out. Stephan Hoch responded: I think there is a role for a national minimum efficiency performance standard which appliance should meet to be eligible. Arthur Ssebbugga-kimeze pointed out that this means we should include the Uganda National Bureau of Standards as a stakeholder. Usamah Kaggwa responded: Yes, the Ministry of Energy with the National Bureau of Standards has a MEPS Programme for selected electric appliances (lighting and cooling appliances so far). A project on upscaling electric cooking would have a component for standards as well so we would be happy to explore this further. We have a collaboration with UBOS and now the East African community to harmonize MEPS for lighting and cooling appliances. I could share some of the harmonized standards that have been passed for lighting. We are starting on cooling (refrigeration and air conditioning soon).

Gloria Namazzi: There is a belief that traditional foods do not taste good when cooked using electricity. With awareness raising, this can be addressed.

Solome Nakimbugwe: There's need to upgrade infrastructure like transformers/ cables to be able to handle the cooking loads

Closing remarks/next steps

Sonja requested participants follow up via email to inform us on which case study they are interested in pursuing, as well as whether or not they would like to be involved in further work

Suggested next steps:

Willingness-to-pay study in city centre

Pre-feasibility study

Elaboration on what incentives/sell of ITMOs would mean

Alternatives for private sector players – e.g. switch from ICS to new electric appliances