E-Mobility at FCDO

A landscape review

FRONTIER TECH HUB

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Introduction

PURPOSE

This landscape review is a part of a Deep Dive series of the FT Tech Hub (FT).

FT has supported numerous pilots in the electric vehicle / e-mobility space and we want to take stock on where momentum was created, where challenges were had, and where the sector will go in the future.

We write this piece as we prepare for the 8th call for proposals on FT and as FCDO considers its next strategic direction across international technology broadly and e-mobility specifically.

Here, we lay out the recent investments FCDO has made in the e-mobility space, our findings across these investments, and recommendations for further research and discussion.

This piece is a companion to a webinar series on the same topic where we hope to explore the discussion items that emerge from this landscape review.

Research Questions and methodology

RESEARCH QUESTIONS

For this landscape review we first consulted with e-mobility champions within FCDO to frame the research questions and guide our work. These consultations yielded the following set of research questions:

- What projects have FCDO supported?
- What level of investment was made for each (i.e. small grants vs big investments)?
- Where (geographically) have investments been made?
- What types of interventions have they supported (e.g individual innovations versus infrastructure).
- What scale of support / intervention have they offered.
- What types of support was offered (e.g. coaching, grant funding, research)
- What outputs, outcomes and impact were achieved over the course of FCDO implementation?
- What outcomes and impact has been achieved by FCDO supported interventions, beyond the lifecycle of FCDO support?
- Where has capital come from - equity, what kind of capital. Did FCDO de-risk investment?
- What has FCDO funded that has gone on to unlock other funding?
    - Where has that capital come from?

METHODS

To identify programmes and answer the above research questions, we conducted a scan of publicly available information on key UK aid programmes in e-mobility, using tools such as DevTracker and Google searches of programme sites, via key search terms including “e-mobility”, “electric vehicles”, and “transport”, among others.

Results were narrowed down by reviewing programme documents to eliminate programmes which did not clearly contain an e-mobility component. The final list of programmes was mapped to each research question in an analysis table. Common sources included the programmes’ most recent Annual Review, and other publicly available documents.

Following the desk review, further details and gaps in the information were addressed through consultations with key FCDO and BEIS stakeholders connected to the programmes

Key findings from the landscape review

THE FCDO E-MOBILITY LANDSCAPE

E-mobility investments identified for this landscape review sit across FCDO and Department of Business, Energy, and Industrial Strategy (BEIS), and are primarily delivered through the follow large scale programmes:

1. High Volume Transport Applied Research Programme (HVT)
2. Climate Compatible Growth (CCG)
3. UK Partnering for Accelerated Climate Transitions (UK PACT)
4. Transforming Energy Access (TEA)
5. Powering Renewable Energy Opportunities (PREO) – delivered via TEA
6. Pioneering a Holistic Approach to Energy and Nature-based Options in MENA for Long-term Stability (PHENOMENAL)
7. Sustainable Energy for All (SE4ALL)
8. Sustainable Mobility for All (Sum4All)

Sum4All, SE4All, and PHENOMENAL are international coalitions where UKAID contributes as a programmatic funder, while the rest are programmes 'owned' by UKAID.

Outside of these key programmes, we identified some FCDO and BEIS investments in e-mobility, which were either-

1. Small-scale targeted grants e.g. Provision of Consultancy Services for UK NITI Aayog electric mobility accelerator programme for the British High Commission, New Delhi - an approximately £60,000 investment; or
2. Larger programmes where e-mobility was not a major focus area, but which may have made some small investment in e-mobility e.g. Within Efficiency for Access – an £18 million programme - where some R&D fund investments have been made in e-mobility through the Low Energy Inclusive Appliances programme, which mainly focusses on sustainable healthcare, household, and agricultural appliances; or
3. Newer programmes which began within the last year, and thus do not have much information available at this stage, e.g. Global Facility to Decarbonise Transport, a multilateral World Bank Trust Fund opened in March 2022, focusing on sustainable and low carbon transport. BEIS is providing £4m as a founding donor to support GFDT's early delivery.

A deep dive into FCDO's key e-mobility investments

For the purpose of this review, we chose to dive deeper into the aforementioned eight key programmes, due to their larger level of investment and prioritisation of e-mobility, to answer the research questions. The investments are organised by size of the overall investment.

Note that for the purpose of this analysis, the e-mobility specific investments were not unpicked from the overall programme figures reported here.

Transforming Energy Access (TEA, 10 years, £225M)

is a research and innovation programme supporting early-stage testing and scale-up of innovative technologies and business models which focus on affordable and clean energy in developing countries. The programme aims to improve clean energy access for 25 million people and leverage £1.3 billion from public and private funding towards clean energy technology research and innovation. TEA is delivered by a core group of partners such as Carbon Trust, and hundreds of downstream partners. The programme has 6 core components –

1. Stimulating Technology Innovation (supporting the development and demonstration of new technologies for developing countries)
2. Accelerating Enterprise-led Innovation in Technology Business Models (TIME) (energy innovations at household, business, and off-grid utility scale)
3. Clean Energy Partnerships (addressing barriers in priority sub-sectors, coordination gaps, last-mile delivery, etc.)
4. Developing Local Skills and Expertise (focussing on capacity building in Africa)
5. Energy Storage Challenge (researching opportunities for different battery storage technology in supporting energy access)
6. Research Programme Delivery Consortium (delivery oversight and management across TEA components, including dissemination, reporting and evaluation)

Powering Renewable Energy Opportunities (PREO, up to £100 million through TEA programme)

a demand-led programme focussed on enabling businesses and communities in sub-Saharan Africa to access clean energy and build climate resilience, by stimulating partnerships, innovation and learning.

PREO is funded in part through the TEA programme and provides several core offerings, including grant support of £100,000 - £300,000 to ~25 action learning projects; partnership building services; strategic and market intelligence services; technical assistance to partners on Productive Use of Energy (PUE) related initiatives, as well as a knowledge hub serving as a repository for PUE enterprise development.

Pioneering a Holistic Approach to Energy and Nature-based Options in MENA for Long-term Stability (PHENOMENAL, 5 years, £60 million)

is focused on tackling climate and biodiversity issues, and building adaptation and resilience in the region, with a key aim to scale up International Climate Finance. FDCO co-invests with the European Bank for Reconstruction and Development (EBRD) specifically for the High Impact Partnership on Climate Action (HIPCA), launched at COP26.

FCDO provides grant funding to a subset of programmes under HIPCA, two of which have been focused on e-mobility directly. Other funding such as on Green Hydrogen in Egypt, has a tangential e-mobility component. The programme is seeing increasing interest and upcoming investment in e-mobility.

Climate Compatible Growth (CCG, 4 years, £38 million)

is a research consortium of universities as well as the Climate Parliament, supported by FCDO. CCG's main objective is to provide evidence to assist countries to efficiently deploy infrastructure capital and to develop national strategies for clean, sustainable growth.

Through in-country and international partnerships, the programme offers research support, as well as public goods, such as open-source tools, models, and datasets – accessible to all countries.

High Volume Transport Applied Research Programme (HVT, 5 years, £18 million)

is a research initiative funded by FCDO, focussed on generating evidence and knowledge on sustainable transport development in LMICs. The programme focusses on key road and rail networks that serve as transport corridors connecting regions and cities across Africa and Asia, conflict-affected states, and research uptake and capacity building.

The programme frequently collaborates with other research-focussed programmes such as CCG, SUM4ALL and SE4ALL. HVT has made smaller innovation research investments, some of which have focussed on e-mobility, looking at 2-3 wheelers, water fuel technology, logistics of charging networks, and e-buses, among others.

UK Partnering for Accelerated Climate Transitions (UKPACT, 4 years, £17 million)

is BEIS' flagship technical assistance programme, which focuses on countries with high emissions and supports them in implementing their ambitions for emissions reduction in line with international commitments.

The programme involves four key components – (i) Country Programmes (grant-funded capacity building projects); (ii) Green Recovery Challenge Fund (grant funding for projects around greening the economic response to COVID-19); (iii) Skill-shares (from a roster of over 200 UK and public sector bodies), and (iv) Secondments (placement of expert individuals into key institutions in priority countries. UK PACT supports cities across Africa, Asia, and Latin America to develop a range of sustainable mobility projects that increase awareness, knowledge and capacity in partner countries to enhance public transport electrification and transition towards a low carbon freight sector.

Sustainable Energy for All (SE4ALL, variable funding through in-kind investments and FCDO/BEIS support)

is an international organisation working in close partnership with the UN, country governments, the private sector, financial institutions and philanthropies, to accelerate action towards SDG 7 – access to affordable, reliable, sustainable and modern energy for all by 2030. Within SE4ALL, the Energy Efficiency for Sustainable Development programme is focussed on the transport sector, particularly on energy efficiency and sustainable mobility.

The core focus areas within transport are (i) energy and mobility nexus; (ii) sustainable urban mobility; (iii) vehicle fuel economy; (iv) electrification and e-mobility; and (v) sustainable shipping. SE4ALL works closely with programmes like Sum4ALL and HVT to produce research and evidence on these core focus areas.

Sustainable Mobility for All (Sum4ALL, variable funding through in-kind investments and FCDO/BEIS support)

is a global coalition of 56 organisations and companies working to transform the future of transport and mobility. The coalition is a unique global centre of technical expertise and a repository of global policy knowledge and resources on sustainable mobility. Sum4All delivers on three key objectives – (i) thought leadership; (ii) global advocacy; and (iii) country action.

The programme collaborates with SE4ALL, HVT, and CCG, among others, to produce and disseminate knowledge and research around sustainable mobility.

Where does Frontier Tech fit in?

The [Frontier Tech programme] is an FCDO funded programme which sits under the Research and Evidence Division (RED). The current phase of the programme, Phase II, has been running since Dec 2019, with a total budget of £21,418,015.

The programme's Livestreaming component focusses on piloting the application of frontier technologies in addressing development challenges. In particular, the programme supports innovative tech in development and testing pathways to scale and sustainability.

Frontier Tech has supported three e-mobility pilots, all based in Africa, since 2018. Note that these pilots situate learning at the fore, but the mechanism for learning is through grant investments and experimentation with small scale implementation activities rather than traditional research:

Electric Motorcycle Taxis in Rwanda

The pilot tested the hypothesis that if electric motorcycles were successfully introduced, and taken up by, the Rwandan moto taxi market, they can decrease transport costs for customers, improve livelihoods for drivers, and reduce carbon emissions. The pilot was implemented by Ampersand Rwanda Ltd.

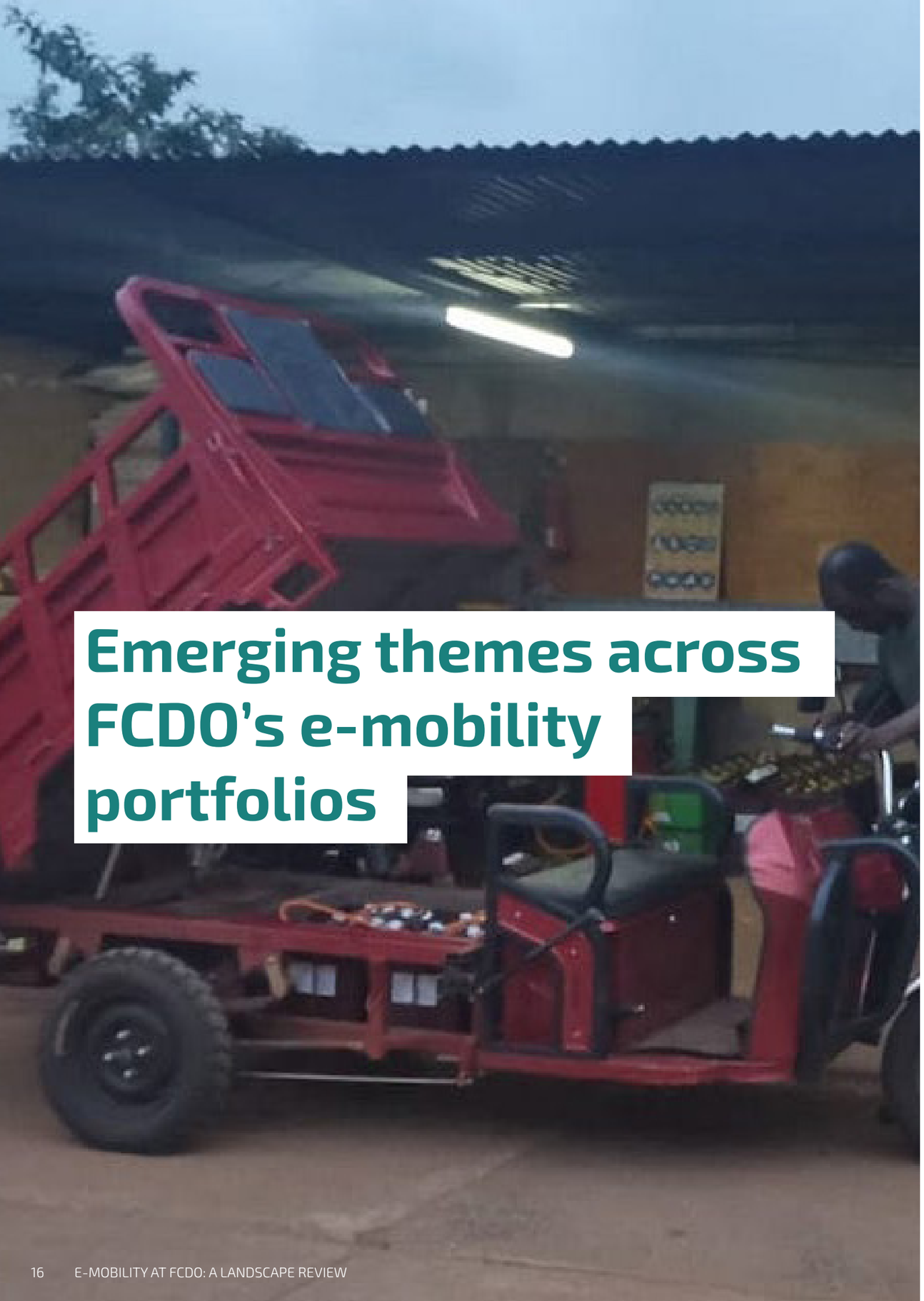
EVs and Mini-Grids in Kenya

The pilot focused on the introduction of small electric vehicles (motorbikes and tuk tuks) near Kisii, Kenya, to improve the profitability of solar mini grids in rural contexts. The pilot tested the hypothesis that with a battery-swapping model, mini grids can charge for the use of their energy and earn enough revenue to validate their inclusion, reducing payback periods and making mini-grid investments more worthwhile.

The pilot laos sought to demonstrate reciprocal benefits too, in that solar mini grids can be shown to allow the inclusion of clean, cheaper-to-run electric vehicles, because the battery swapping model eliminates the need for a charging point. Combined, developing electric vehicles and mini grids in tandem can therefore reduce the cost of mobility for rural populations, reduce the reliance on fossil fuels, and improve the business model for local mini grid systems. The pilot was implemented by Powerhive.

Electrifying Water Transport for Better Livelihoods in Senegal

The pilot is currently exploring assumptions around the potential of electric water transport - specifically the business model. Experiments will focus on battery swapping to help fishermen use the boats, using electric motors to save time and money, and exploring the benefits of solar powered boats to local incomes, creating opportunities for local technicians, as well as positive impacts on the tourism industry. The pilot is being implemented by Joko Sun Energies.



Emerging themes across FCDO's e-mobility portfolios

The geographic focus of these key programmes is truly global with numerous country-level investments spread out across the world, with high priority given to LMIC-focussed investments in Africa and Asia.

Types of Support Offered

UK aid supports a range of interventions, from start-ups or early-stage innovators to country governments and international organisations. The investments reviewed for this landscape review largely focus on four key types of support:

1. **Research and Advocacy:** Programmes like HVT, SUm4ALL, SE4ALL, and CCG primarily focus on producing research (policy or technical) which feeds into strategic local and global advocacy, diplomacy, and policy decisions.

2. **Capacity Development:** Programmes like Sum4All, UKPACT, CCG, and HVT offer capacity building of research partners, country governments, transport officials and practitioners, as well as policymakers. For example CCG provides 'data starter kits' i.e.datasets from publicly available sources for a given government to develop an energy model and do scenario planning. As part of this they do intensive capacity strengthening with country governments and research institutes enabling them to use these open datasets.

3. **Technical Assistance:** Through UKPACT, PREO, and Sum4ALL for example, these investments offer policy technical assistance, systems diagnoses, assist in selection of policy priorities, and help create roadmaps of action, testing national development scenarios, among others.

4. **Grant Funding:** Offered to country governments and private entities for all of the above, as well as for innovation, pilot and infrastructure projects. For example, HVT provides the Transport-Technology Research and Innovation for International Development Grant (T-TRIID) – a small-scale < £50,000 competitive grant open to all businesses (including micro, small and medium-sized enterprises), organisations and universities to conduct research and pilot projects in sustainability mobility. Additionally, programmes like TEA and UKPACT support large scale country infrastructure projects. TEA invests in programmes like PREO which support early to mid-stage innovators and has funded 23 private sector and non-profit enterprises to date, of which 4 were e-mobility projects.

OUTPUTS, OUTCOMES, AND IMPACT IN E-MOBILITY

Research, advocacy, and uptake

FCDO's research investments including HVT, CCG, Sum4All and SE4All, have produced a range of knowledge products in e-mobility. A key publication is Sum4All's Global Roadmap of Action toward Sustainable Mobility (GRA) under which e-mobility is a key theme. As part of this, Sum4All collaborates with SE4All, HVT, and CCG to produce the GRA in Action Series of publications. Launched in 2020, these publications provide much needed granularity around tools like the Catalogue of Policy Measures, and topics like best practices for implementation. The series covers the cutting-edge topics and policy issues decision makers face today in transport.

Similarly, CCG has synthesised data from its national partnerships to produce a working paper series on e-mobility identifying 9 barriers to e-mobility integration (around upfront costs, governance, technology uptake) and offering potential solutions, as well as 18 practical actions stakeholders can take to promote enabling environments for e-mobility in Southeast Asia, such as business models, green finance, policy mix, and governance

FCDO's e-mobility investments have also produced country or region-specific evidence to add to the body of knowledge allowing country governments to move towards their goal of achieving sustainable mobility. For instance, HVT has conducted a series of scoping studies focussed on Nepal, Zambia, Pakistan, Uganda and Bangladesh - seeking to identify research priorities to help advance the transition to a low-carbon transport system in LMICs.

HVT has seen uptake of their evidence and expertise, such as recently in 2022 the Government of Ethiopia agreed upon a terms of reference developed by the HVT team for research on barriers to implementation of e-mobility in the country

Finally, the programmes have made significant contributions to advocacy and dissemination at the international level. For example HVT produced a briefing note on EVs for Climate Parliament in 2020, providing key points to consider for EVs, case studies/successful country examples, and a set of recommendations for implementation.

Meanwhile, Sum4All has helped shaped the global agenda via their discussion paper "Electromobility in the Global South: An Equitable Transition Toward Road Passenger Transport Decarbonization," which was used to rebalance the debate on e-mobility at COP26 in 2021, by elevating the perspective of countries in the Global South. CCG and Sum4All also presented a paper at COP 27, focussing on e-mobility in LMICs in Sub-Saharan Africa, emphasising how the trajectory for EVs in this setting will be different from wealthier countries.

Country Infrastructure Projects

National partnerships have been a key focus of FCDO's investments, with a focus on establishing or improving infrastructure in partner countries for e-mobility. For example, UKPACT has delivered 25+ e-mobility infrastructure projects mainly via country partnerships since 2018.

Some examples include (i) supporting Thailand in developing and subsequently adopting an electric vehicle policy that considers lessons learned from the UK; (ii) accelerating the adoption of electric buses in Colombia via technical assistance to three cities, helping them to integrate electric buses into their fleets, thereby reducing city level greenhouse gas emissions and improving local air quality; and (iii) implementing a skill-share to help the Thai government conduct effective policy impact assessment for EVs.

Similarly, through PHENOMENAL FCDO has invested £3.4 million into proof-of-concept for e-bus purchasing and surrounding charging infrastructure in Jordan. The programme has also spent £2.5 million to support the purchasing of e-taxis for Egypt's largest taxi company, assisting not only in buying the taxis but also demonstrating there is a large EV market and need in Egypt. Taxi companies are ideal to establish this proof-of-concept since they have shorter mileages but lots of them.

Innovation in e-mobility

Transforming Energy Access (TEA) has invested in programmes like PREO which has funded six e-mobility projects thus far, through early-to-mid-stage innovators in Africa. Four of the projects have been completed, including:

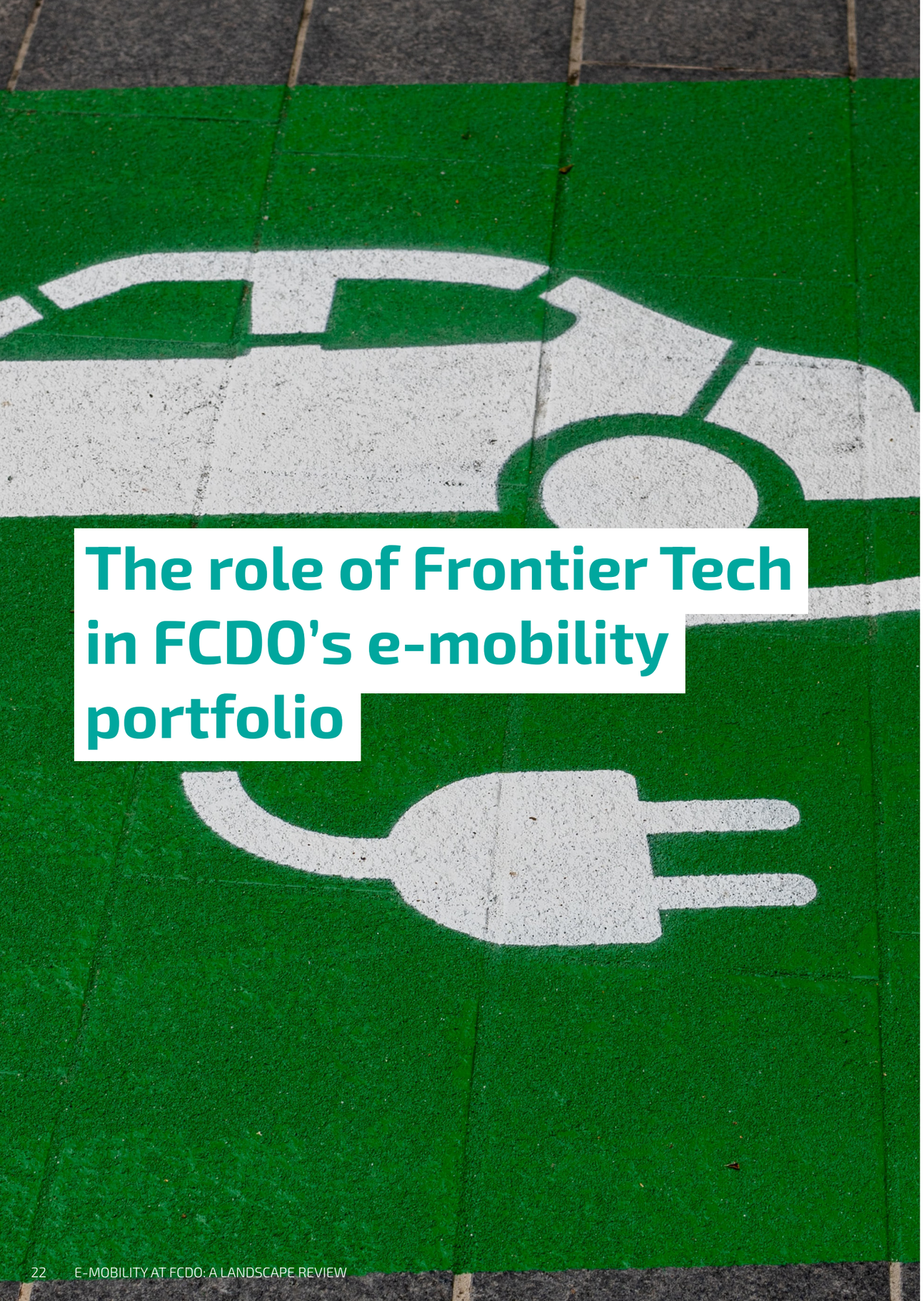
Mobile Power – a battery platform allowing 3-wheelers to rent a battery pack for transport and freighting, using mini-grid electricity.

ROAM - Researching and piloting e-mobility solutions for sustainable motorbike transportation in Kenya, as a way to improve the drivers' net income, provide environmental friendly transportation, create green jobs and accelerate the country's transition to zero emission vehicles.

Zembo (Zero Emission Motorcycle Boda)- a start-up company that provides sustainable mobility solutions for Africa. Zembo's electric motorcycles and network of solar charging stations have been revolutionising the boda boda market in Uganda since 2019.

Equatorial Power - Mobilizing Electricity for Productive End Uses and Fishermen e-mobility in Lake Victoria. The project focusses on the promotion of electric mobility for fishing in Lolwe Island of Lake Victoria. The project will pilot approximately 20 electric boats for fishing with charging hubs that will be connected to the solar mini-grid installed on the island.

In 2022, PREO funded two new e-mobility projects (i) EcoBoda i.e. electric motorbike taxis that are designed and assembled in Nairobi, and (ii) Tri, selling electric IOT-connected 3-wheelers directly to drivers in a lease-to-own-scheme.



The role of Frontier Tech in FCDO's e-mobility portfolio

One goal of this landscape review is to inform future calls of the Frontier Tech programme to ensure that its investments truly sit at the frontier.

After reviewing the FCDO landscape, we see the FT investments as small to midsize grants compared to others across FCDO. They are differentiated by being more hands-on, live experiments than the typical research products that are produced across other FCDO programmes.

It is difficult to assess whether FT pilots sit on the 'frontier' of FCDO's e-mobility portfolio or whether they are similarly situated to other investments, such as PREO's e-mobility portfolio. Future discussions pertaining to this deep dive would benefit from diving into the relative risk and certainty around investments in FT's portfolio as opposed to other portfolios at FCDO and whether FCDO should strategically place the riskier 'more frontier' investments into one programme versus another or whether each program portfolio benefits from having a range of risk.

Looking ahead, FT pilots might benefit from some of the more rigorous research funded under programmes like HVT and CCG and might consider building in 'research sprints' to the pilot methodology so that the evidence generated holds up against other FCDO investments in e-mobility. FT should also consider its risk appetite and whether or not its investments are truly frontier compared to other FCDO programmes

Recommendations for FCDO

This landscape review suggests some possible paths forward for FCDO in the e-mobility space and questions to continue to explore. We hope this review will serve as a foundation for convenings and network events to be held in 2023 around the key questions FCDO faces in e-mobility.

FCDO has climate priorities which push aggressive timelines toward increased electrification and reduced emissions. How does FCDO support a 'just transition' into the future?

Much of the policy debate centres around the Global North, but what is the role of the Global North in supporting the Global South through this transition? How can FCDO amplify voices of leaders from the Global South to advocate for their countries? How does FCDO balance climate priorities with practical realities and unintended consequences of the green transition? Electric vehicles will cause major disruptions in the supply chain, so how do we support African countries as the used vehicle supply shifts toward electric while not exacerbating related issues such as income inequality?

There will be 2.5 million people in Africa by 2050 and 40% of Africa's emissions already come from transport. Transition to electric vehicles offers benefits to the planet and to individuals, through improved livelihoods, as well as to nations through economic growth and structural change, if the opportunity for local manufacturing is realised. What support is needed to build the capacity for maintenance and repair of vehicles and local manufacturing of batteries? What policy mechanisms and incentives are needed to support this structural change?

The economic case for electric vehicles – specifically two and three wheelers – seems strong but to what extent will they scale on their own, without the need of FCDO investment, as was the case with mobile phones? Will it prove more challenging to reach electric vehicles to the poorest and if so, where might support be needed?

770 million people in Africa lack access to electricity. What is still needed to enable energy access for all and what is the role of the Global North and FCDO specifically in enabling the transition to green electrification? What role should FCDO play, for example, in ensuring that solar is part of the scale up of e-mobility solutions? Africa imports large numbers of used vehicles from Europe and as more European used vehicles are electric, will Africa have the charging stations and related infrastructure to support these new vehicles? What are some of the availability infrastructure needs and what's the role of public and also private investment in meeting those needs? Research and small-scale investments have taught FCDO a lot about the future of e-mobility, but infrastructure may need to be a part of future work. FCDO might consider future investments to prepare for this eventuality.

Critical minerals are necessary to build electric vehicles and managing the supply of these minerals from mining rights through to production is complex. Does FCDO have a role?

How might FCDO best support regional cooperation around infrastructure? For example, Uganda has an excess supply of infrastructure but neighbouring countries have ageing infrastructure so can't take that supply. What are the opportunities to think beyond countries?

Allowing the private sector to lead by addressing the low hanging fruit risks many solutions in one crowded space that do not necessarily address everyone's needs. There is an opportunity to do things differently; to not simply convert existing transport solutions to green energy solutions but consider what the right mix of transport is - light rail and railways in addition to the two and three wheelers and cars. What are the governance and legislative levers available and what is FCDO's role in supporting Government's to use them to set direction?

How do e-mobility infrastructure investments connect to FCDO's investments in other areas, such as climate and economic development?

There is often a disconnect between innovation and growth and the timelines for securing funds, which is particularly acute for early stage companies. How might processes be better aligned with innovators' needs? As Josh Whale highlighted, "if we're treating this as a crisis, the timelines have to be a crisis and they have to be dictated by planetary atmospheric physics, not by how things used to be done before and grant funding".

However, there are incentives and capital flowing, although weighted more towards electric bus transition than two and three wheelers. What can be learnt from positive examples, e.g. in India where there's a lot of Government support and where one company which does asset financing for electric vehicles has been able to raise USD 7,000,000 in green bonds? How might FCDO increase knowledge of available funds and build capacity to access those funds amongst actors in the Global South?

There is still some risk aversion amongst public investment and donor funding has been important in the initial support to building out early charging infrastructure for some first movers, e.g. Ampersand. Is there a role for FCDO in de-mystifying electric vehicles for investors and catalysing investment in this sector, in the Global South? What is the role of supporting innovators in reaching early milestones, to de-risk future investment? What support might potential investors need to navigate the process and differentiate amongst the many start-ups in the ecosystem?

Could FCDO and others fill research gaps that might build confidence amongst investors?

There's limited diversification in where investment is going. The common thread is commercial vehicles with high operating costs relative to capital costs, for example the motorcycle taxis and light delivery trucks. The transition for four wheelers will take longer because the total cost of ownership is much higher and more public funding and subsidy will be required before private investment follows. When is project financing most useful, and how should innovators structure their financing? How can FCDO leverage the developed investment community in the UK to support e-mobility in the Global South?

How can FCDO collaborate with the private sector to leverage a more diversified stream of e-mobility investments in the Global South towards greater access for all?

Private companies and large countries are making trillions of dollars worth of investments in the electric vehicles space. With diversification can come disruption which sometimes disproportionality affects the poorest. What are the risks to lower and middle income groups of diversification of the technology and business models?

Electric solutions can offer cheaper options for drivers, which are also better for the planet. However, for lower and middle class individuals to benefit these solutions need to scale, bringing down costs and becoming available and reliable. Access to new technology is always skewed toward well off individuals, does diversification offer an opportunity to diversify and how might FCDO support lower and middle income countries to leverage opportunities? How does FCDO maximise its sway toward the just transition?

Some of the newer solutions, e.g. hydrogen, are years away from getting to market and further away from transition to the Global South. Is there a future solution for FCDO's ODA countries around hydrogen fuel, or is green electrification and new battery technology the way forward? Where might hydrogen add most value to transportation solutions, for example longer haul and rail rather than two and three wheelers? Is there a role for FCDO in supporting battery technology and development of new solutions e.g. sodium ion which may be a low cost replacement for lithium ion in some markets. What are the safety and regulatory considerations around new batteries and the way they are integrated into two and three wheelers?

If companies' diversify business models, individuals will benefit from the choice and be able to select what suits them, their behaviours and how they operate and use the vehicle. How can FCDO support local entrepreneurs in this space to develop viable business models and access the capital needed to scale?

Technology is not neutral and we know men and women travel in different ways and for different purposes. It can be more difficult to scale businesses that are specifically focusing on a subsector or serving a specific subgroup of the population. How can FCDO influence private sector consideration of equity and accessibility and for example, bring more women drivers into this space? What can we learn from FCDO supported pilots in Nepal and Nigeria that facilitated women drivers' access to e-vehicles? What is the role of FCDO in meeting the needs of users who might not be served by the private sector?

How can academic research best support pilot testing, and vice versa?

FCDO funds significant academic research in the field of e-mobility and has learned a lot. Pilot testing through grants to innovators drives additional learning. How does the current balance of FCDO's portfolio across research and implementation serve the organisation? How can the academic research produced more directly inform FCDO's investments in implementation projects? What linkages are needed between FCDO support to individual businesses and research which typically focuses on the transition and system questions for example, what's needed for the energy system if there are big increases in the number of private electric vehicles? Is there a role for FCDO to support innovators and private sector actors to fill evidence gaps to meet funders needs, de-risking investment, for example, around safety?

Innovators have much still to test and prove. FCDO can provide important backing to innovators who are testing what works and developing the business models and in parallel support academic research better suited to understanding what it means for the system, the policy implications (fuel subsidies) and political economy. For example, what does transition mean for operators in the diesel and petrol market, the shift of power and flow of funds?

Areas for future research

- The right combination of solutions across the value chain; looking across the portfolio to understand where layering solutions might amplify impact through efficiency and improve user experience.
- How charging infrastructure might be optimised beyond one use case considering user preference, connecting with other forms of transport and public transport hubs.
- Battery technology
    - New chemistries including looking at more abundant raw materials.
    - Optimisation of batteries and extending their lifetime, which can be tested now, in the field.
    - Batteries are the most expensive element of the technology and recent explorations of second use may be critical, spreading the capital expenditure cost across first and second life.
- Safety considerations including, for example, issues of quiet vehicles and the weight of batteries.
- Data on the carbon intensity of electric vehicles; the source of the energy and the manufacturing emissions.
- Validation of how big the market is and the cost point to establish a basic model.
- The impact on women of women only spaces.

There is an opportunity for FCDO to facilitate the participation of the private sector and investors in key forums to widen the debate, connecting innovators with policy makers.

We are grateful to FCDO staff who contributed their time and thoughtful reflections to make this landscape review possible. We look forward to the discussions that emerge in forthcoming events where the questions posed above can be explored in greater depth.

For further information about this Deep Dive project, please do not hesitate to contact the FT Hub.

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