Development of electric mobility in Angola

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AFRICAN DEVELOPMENT BANK GROUP

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Executive summary

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In many countries public sector has introduced measures to stimulate the market uptake of electric vehicles through financial and non-financial incentives. While incentives generally entail an increase in public spending, they also create opportunities for the development of a market that brings with it vast benefits from many points of view.

Two types of incentives apply:

- Fiscal incentives aim at reducing the purchase price differential of e-vehicles compared to ICE models (as well as their operative costs) and foster the development of charging infrastructures.
- Non-financial incentives constitute measures to further increase the overall attractiveness of electric mobility. These include restrictions on access to the city for certain types of particularly polluting vehicles, as well as the possibility of using fast lanes for electric vehicles, free access to parkings and access to certain restricted traffic zones.

Internationally, the lack of charging infrastructure is considered a key barrier to the transition to e-mobility, sometimes more relevant than the differential in purchase prices between electric and ICE vehicle models. Financial and non-financial incentives and regulatory measures set-up by governments can constitute the fundamental element in breaking the 'vicious circle' of lacking infrastructures and limited diffusion of electric mobility. In fact, public initiative can contribute to create a 'critical mass' of charging infrastructures able to improve user's perception of e-vehicles (reducing for example the well-known 'range anxiety'), as well as e-vehicle responsiveness to mobility needs.
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Private initiative by investors, international investment funds, entities and international organisations play a key role in promoting the transition to electric vehicles.

In recent years, many start-ups have been launched in East Africa. In Uganda some examples are Zembo company and Bodawer. The first, by 2021, introduced 100 electric motorbikes and 18 charging points, three of which are completely powered by solar energy. The second is converting ICE Boda-Bodas into electric-powered vehicles. In Kenya companies such as Nairobi Stima Mobility and Powerhive are investing in battery swapping services.

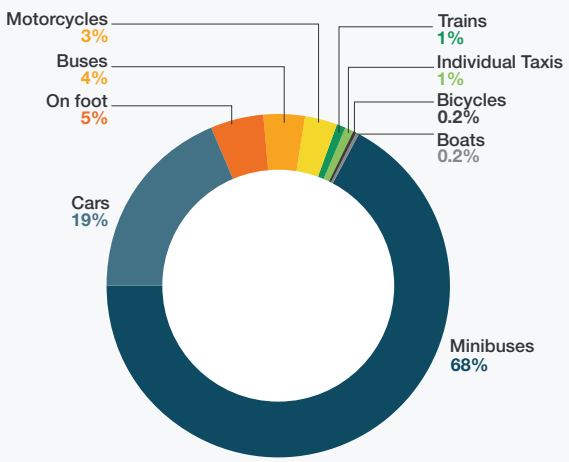
Public and private initiatives are intended to coexist at least during the first phases of market development, although public support is not identical for all market segments. Some brands of e-mopeds, for example, have purchase prices substantially aligned to those of ICE vehicles and incentives are therefore less strategic in inducing a shift towards electric mobility (in this case, it is rather a matter of complete user information about technical characteristics of the e-vehicle). On the other hand, this is not the case for e-motorcycles, three-wheelers, e-cars, e-buses and e-trucks with up-front costs generally higher than ICE models.

Transport and mobility

As shown in , in Luanda 68% of daily displacements for work, leisure and study purposes are made by minibuses . These means of transport mainly connect peripheral areas with the city center.

Cars follow with 19%, while only about 5% of commuting is made by public transport (buses, boats, trains), as for travelling on foot. Motorcycles account for about 3%, while the remaining is shared between bicycles and individual taxis.
Some forms of electric mobility are already existing in Angola.

Figure 1. **Modal share in Luanda in 2015**



It is worth highlighting the experience of T'Leva start-up, which has attracted investors for the deployment of electric cars, that transported 40 000 people in Luanda in 2020. T-Leva is in partnership with the Chinese electric vehicle manufacturer Ledo Holding.

The overall fleet of T'Leva (whose core is linking drivers and passengers through app) is of about 500 EVs with leasing of vehicles to the drivers. On average T'Leva vehicles travel 25-30,000 km per week, with an average trip of 10.5 km per car. Drivers can decide if charging vehicles at home or at 9 fast-charging stations deployed in Luanda (charging takes about 15-20 minutes). According to the T'Leva General Manager, barriers to the development of electric mobility in Angola are constituted by the following:

- Charging infrastructures. A wide deployment of electric mobility could imply an instable electricity supply with eventual shortage for people in specific neighbourhood of the city;
- People education. Change in people's attitudes and behaviour requires awareness raising and is not an automatic and swift process;
- Road conditions. Technical problems in the presence of heavy rains, with batteries getting wet, have been experienced;
- Oil companies. Companies are not supportive and try to slow-down electric transition.

For what concerns the sale of electric cars in Luanda by Chinangol/Leo Holding, customers are provided with a charger and a two-year warranty for maintenance.

Figure 2. **T'Leva start-up**

The National Strategy for Electric Mobility

Angolan government developed a National Strategy for electric mobility (currently in the process of approval) to align the country with the best international practices regarding sustainable mobility and the preservation of the environment. The main goals of the strategy are the following:

- Reduction of GHG emissions;
- Cost reduction of oil import;
- Development of activities and creation of jobs related to e-mobility;
- Availability of financial sources from reduction of import of oil products.

The implementation of the national strategy is structured according to three phases:

- Pilot phase (until 2027) – It should include the construction of minimum infrastructure, procurement of vehicles, adoption of the necessary incentives for electromobility and implementation of the initial phases of the Luanda surface metro project;
- Growth phase (until 2030) – It should envisage the extension of basic infrastructures and the adoption of solutions successfully tested in the pilot phase;

- Consolidation phase (from 2031 onwards). It should represent a market maturity stage, when e-vehicles, infrastructures and operators are integrated, with well defined mobility and business models throughout the national territory.

General enabling strategies

Strategy 1

In order to implement electrically powered mass transit service a phased implementation scheme, initially focusing on Luanda capital city and later expanding to the entire country, is adopted. In particular this should be constituted by: Deployment of the electric metro network (as envisaged in the General Metropolitan Master Plan of Luanda-PDGML) within Luanda (through a phased implementation); Introduction of electric (or hybrid) buses as a replacement for vehicles already servicing Avenida Marginal and Nova Marginal; Replacement (in the longer term) of all diesel rail services by electric ones.

Strategy 2

The strategy suggests to employ small e-vehicles such as taxis and minibuses, starting with pilot projects in selected municipalities, by focusing on contexts where there is already a significant use of this kind of vehicles. In particular the strategy should be constituted by: Pilot projects with e-taxis and e-minibuses; Accompanying measures (i.e. reserved lanes, restricted areas); Leasing arrangements; Subsidies for charging stations and mobile phone apps.

Strategy 3

Creation of fiscal incentives and regulation to encourage the shift from ICE to EVs in the purchase/lease and operation of private vehicles as well as to encourage investments by private companies in infrastructure facilities. In particular the strategy should be constituted by: Incentives to reduce EV's purchase price and registration; Incentives to deploy charging infrastructures at new existing buildings; Incentives to foster the participation of the private sector in the deployment of charging infrastructures.

Strategy 4

The electricity supply network should be adequate to the demand from collective transport modes and other EV fleets (minibuses, taxis and private cars). The strategy aims to: Monitor the electricity generation and supply network; Assess the electricity consumption required by the electric vehicles to be implemented; Encourage the charging of electric vehicles in residences, condominiums and businesses; Increase power generation through alternative energy sources, such as solar and wind power, to cover any shortfall resulting from the introduction of electric vehicles.

Advices for the implementation of the electric mobility strategy.

The following general advices are formulated to contribute to a smooth deployment of the Angolan strategy:

- Definition of targets for the strategy implementation phases;
- Pilot implementation. Setting-up of pilot projects to assess the response of the Angolan population to the transition towards electric mobility, with specific attention on mini-buses service;
- Micro mobility. Inclusion of micro mobility into national strategy activities;
- Education and training. Implementation of training courses aimed at strengthening knowledge and skills of current and future workers, in order to maximise the net benefits of electric transition;
- Private sector involvement. Public sector support and cooperation with private sector in order to foster and accelerate the transition.

Quantitative targets should be defined throughout all phases of strategy implementation (pilot, growth and consolidation). Examples of targets are constituted by: Minimum target of phase-out of fossil fuel vehicles; Minimum market penetration rate of EV's at national and urban level; Minimum amount of modal share for EVs in public and private transport.

The implementation of pilot projects involves the identification of a set of criteria for the selection of hosting cities. These should include the duration of the permitting processes required for the deployment of the infrastructure and the selection of suitable municipalities to achieve specific objectives. In addition, the involvement of local stakeholders is crucial to identify the specific needs and expectations of the population in order to prevent possible resistance.

It is believed that one of the most promising pilot projects would be constituted by the implementation of services by minibuses operating in the metropolitan areas of Luanda, linking peripheral and central areas of the city. Such a pilot project, in fact, would give the opportunity to test technical and organisational solutions within the most relevant segment of local collective transport, while the high demand volume could constitute guarantee for the deployment of a profitable service.

Both for this and other pilot projects, 'battery swapping' should be tested as operational solution besides the use of charging points. In fact, this approach could constitute the best solutions for services and uses not compatible with charging times at charging points.

Angolan government should consider to add the micro mobility in the National strategy.
The main potential of micro mobility in urban contexts is linked to the possibility to solve the so-called 'first and last mile' issue, arising when stations/stops mass public transport are located far from origin and destinations of people's journeys.

Micro mobility would perfectly align with the specific need highlighted by the PDGML of strengthening public transport by improving its accessibility, through an improvement of initial and final parts of people's journeys. In this context, the PDGML recognises a strategic role to walking and cycling and e-bikes and e-scooters (both as sharing services and private means) would therefore qualify as effective mobility options, provided that road safety conditions are duly guaranteed.

Private sector investments in the deployment of e-vehicles and charging infrastructure services are of paramount importance to ensure a strong and financially sustainable electric transition. Angolan government should try to mobilise private-sector initiatives both through international financing and partnerships with international vehicle manufacturers. Cooperation with private subjects should be fostered within Public Private Partnership (PPP) schemes, especially for medium-large scale activities. This would require the setting-up of a preliminary PPP framework in the first phases of the national strategy, which should be later consolidated. The PPP framework should define:

- Procedures;
- Rules of implementation;
- Responsible institutions for the implementation.

Angolan government should consider, the launch of training programmes for workers in order to adequately prepare them to the diffusion of electromobility. At the same time, attention should be paid to the quality of technical education delivered at schools and universities and eventually integrate the educational offer to strengthen technical competences.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1. Intro-duction

The government of Angola is committed to support the development of electric mobility and in this respect is going to approve a National Strategy which embraces key aspects of electric transition, including technical and economic domains. The Strategy is duly accompanied by an adaptation of the national legal and regulatory framework disciplining different aspects of electric mobility and is compliant with successful international good practices at international level in supporting the market uptake of electric vehicles.

In the next sections review of international good practices in relation to market incentives, financing and charging infrastructure provision is presented, besides an overview of the country with description of geographical, economic and mobility conditions.

The National Strategy for the development of electric mobility is therefore described, with focus on its main characteristics. This is accompanied by an analysis of the aspects that need particular attention for a successful implementation, with identification of some specific measures to consider and the formulation of general recommendations.

2. Benchmark analysis

2.1 Public market incentives and initiatives

In many countries public sector has introduced measures to stimulate the market for electric vehicles through financial and non-financial incentives. While incentives generally entail an increase in public spending, they also create opportunities for the development of a market that brings with it vast benefits from many points of view.

For what relates to the vehicle-side, fiscal incentives aim at reducing the purchase price differential of e-vehicles compared to ICE models as well as their operative costs. Up-front costs are recognised as one of the main barriers to the adoption of e-vehicles (Muehlegger et al., 2021; Malina, 2019).

Non-financial incentives constitute measures to further increase the overall attractiveness of electric mobility. These include restrictions on access to the city for certain types of particularly polluting vehicles, as well as the possibility of using fast lanes for electric vehicles, free access to parkings and access to certain restricted traffic zones.

From the angle of charging infrastructures, public incentives and investments can constitute the fundamental element in breaking the 'vicious circle' of lacking infrastructures and limited diffusion of electric mobility. In fact, public initiative can contribute to create a 'critical mass' of charging infrastructures able to improve user's perception of e-vehicles (reducing for example the well-known 'range anxiety'), as well as e-vehicle responsiveness to mobility needs.

In addition, measures are also implemented to support the transition towards electricity production from renewable energies (e.g. solar energy).

Public and private initiatives are intended to coexist at least during the first phases of market development, although public support is not identical for all market segments. Some brands of e-mopeds, for example, have purchase prices substantially aligned to those of ICE vehicles and incentives are therefore less strategic in inducing a shift towards electric mobility (in this case, it is rather a matter of complete user information about technical characteristics of the e-vehicle). On the other hand, this is not the case for e-motorcycles, three-wheelers, e-cars, e-buses and e-trucks with up-front costs generally higher than ICE models.

India also has an incentive scheme for electric vehicles called Faster Adoption and Manufacturing of electric vehicles (FAME). This scheme provides incentives for research and development of electric vehicles as well as financial incentives for individual users and private and public companies to renew their fleets with electric vehicles. While the FAME project had the aspects of a pilot project, FAME II was launched

in 2019 with the aim of expansively increasing the demand for electric vehicles. To achieve this goal, the Indian government has earmarked $1.38 billion for 2019-2022 to encourage demand for electric vehicles and support the construction of charging infrastructure (WBCSD, 2021).

In India, wide incentives and subsidies schemes are in place. The Haryana State government, for example, applies a 30% subsidy on the electric vehicle price, by directly refunding the buyer or the possible lender (Government of Haryana, 2021).

In Indonesia the state does not directly finance the transition but has introduced strong incentives for companies to invest in the production of electric vehicles, thus stimulating the market indirectly. In particular, a «tax holiday» has been introduced that provides for the exemption of corporate income tax paid on income from main business activities, which can amount to 100% of the total corporate income tax payable. The duration of the exemption varies according to the amount of the investment made in the sector: 5 years (investment value of IDR 500 billion); 7 years (investment value of IDR 1 – 5 trillion); 10 years (investment value of IDR 5 – 15 trillion); 15 years (investment value of IDR 15 – 30 trillion); 20 years (investment value of more than IDR 30 trillion) (Mahalana A. et al., 2021).

The government of Jakarta provides fiscal incentives for electric vehicles through a 0% transfer tax for both two-wheelers and four-wheelers (Mahalana et al., 2021).

Governments in other Asian countries are also introducing measures and incentives to ease the path to electric transition. In Armenia, incentives have been introduced to cancel import taxes for electric vehicles, with ICEs paying value-added taxes of up to 32%. The same measure has also been introduced in Georgia.

In Bhutan, buyers of electric vehicles are exempted from paying sales tax, customs duty and green tax.

In Nepal, EV owners do not pay the annual vehicle tax and enjoy substantial reductions in customs fees for both private and public vehicles.

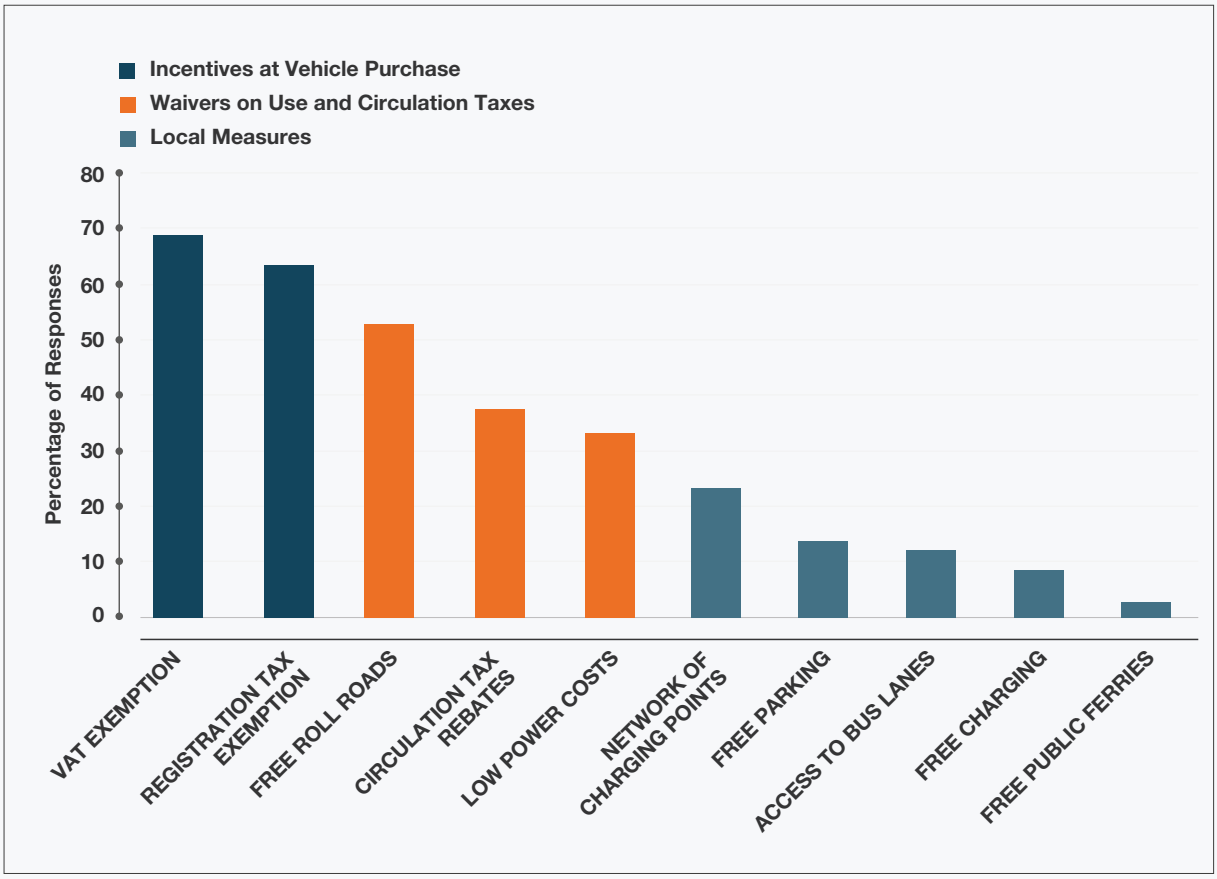
In the Philippines, no excise tax is paid on EVs, and many local governments have introduced non-financial incentives to encourage the transition choice.

In Thailand, the excise tax on locally produced EVs ranges from 2% to 10%, while the excise tax for ICE vehicles ranges from 10% to 30%. In addition to this, the Thai government has also introduced tax breaks to encourage the installation of charging points.

In Taipei, the Gogoro app started selling e-scooters in 2015. As of 2019, Gogoro has installed 700 battery exchange points located at strategic points in the city. The Taiwanese government has supported the initiative through the introduction of subsidies on e-scooters from $240 up to $1,200, as well as subsidies covering up to 50% of the expenses required to build charging and battery swapping infrastructure. Non-financial incentives from the central government and local administrations have also been applied, such as the exclusion of certain types of motorbikes in certain areas of the city, or privileged access to parking spaces for electric vehicles. However, as of 2019, the results were not as hoped for initially, with sales of electric vehicles at around 2%. This lack of interest in electric vehicles seems to be mainly due to the lack of information on the reliability of vehicles and citizens' concerns about battery autonomy and the scarce number of recharging facilities (Gruetter J. et al., 2019).
Netherlands, Belgium, the UK and Norway, governments have introduced significant tax incentives for charging infrastructure on both public roads and private property. In Norway, electric vehicle users can use charging points for free. In Belgium, the government promoted a 40% tax reduction of up to 260 € for entrepreneurs wishing to invest in charging points, with the possibility to deduct another 13.5% from corporate law taxes. In the Netherlands, the government supports the construction of charging points in private spaces by applying a discount of 550 € (UNIDO, 2020).

In Figure 3 is shown the importance attributed by Norwegian road users to different kinds of financial and non-financial incentives for electric mobility (Gruetter J. et al., 2019).

Figure 3. **Perceived Importance of Norway's support policies (%)**



Source: Gruetter J. et al., 2019.

For what concerns Africa, the adoption of electric motorcycles by users in Ghana is strictly linked to 'price perception' and therefore to the positive influence on it by government subsidies. Furthermore, it has been assumed that the introduction of state incentives increases the possibility of purchasing electric vehicles by 16.3% (Wahab et al., 2018).

Kenya and Rwanda have adopted tax incentives to encourage electric vehicle imports. Furthermore, in Rwanda, a corporate income tax rate of 15% for investors operating in e-mobility, such as energy firms, ITC and mass transport industries is applied.

In Kenya, the government is developing a policy to support the spreading of electric two- and three-wheelers and the participation of private companies. In this context financial and regulatory structures are deemed necessaries to create the right environment for business replication and incentivise private individuals to switch from ICE to electric vehicles. Tax incentives have been introduced in the 2019 Finance Act, such as the reduction of excise duty on electric vehicles from 20% to 10% (Siemens Stiftung, 2020.)

In Rwanda in 2020, the e-scooter company Ampersand asked the government for some fiscal interventions that could facilitate the adoption of electric vehicles. These include the elimination of VAT on the construction of charging infrastructures and the refund of VAT, which is expected to increase from 9 months to 30 days. Bicycle leasing company Gura, on the other hand, has called for government intervention to facilitate access to credit from commercial banks, as well as access to green financing from international companies (Bajpai J. et al., 2020).

2.2 Private initiatives and financing

Private investors, international investment funds, private entities and international organisations play a key role in promoting the transition to electric vehicles. Their interaction and cooperation with the public sector and the opportunity to capture expanding shares of the market have produced many positive experiences in the international arena.

In India, in addition to government policies aimed at encouraging the electric transition, private stakeholders have also decided to invest in the field of electric vehicles, both in terms of fleet expansion, manufacturing, battery and component production and installation of charging points.

Between 2030 and 2040, the companies Amazon, Capgemini, Dalmia Cement, JSW Cement, and Zomato have announced that 100% of their vehicle fleets will be electric.

Vehicle and battery manufacturers such as Ashok Leyland, Mahindra & Mahindra, Omega Seiki Mobility, Simple Energy, and Tata Motors have earmarked $6.5 billion for research and development and production of electric vehicles, components and batteries.

Furthermore, start-ups active in the field of electric mobility, such as Hero Electric, Magenta, and Ola Electric have raised funding of $446 million.

Financial institutions such as Axis Bank and the United Kingdom's Private Infrastructure Development Group have also provided funding of up to $200 million for the production and distribution of electric vehicles as well as for the installation of charging points (Singh R. et al., 2022).

In Africa, the Global Environment Facility (GEF) is involved in the financing of many e-mobility projects. GEF consists of 184 member governments and international institutions, non-governmental organisations and private sector partners. Its governance is built around the Assembly, the Council, the Secretariat, a Scientific Technical Advisory Panel (STAP), the Evaluation Office, 18 Agencies (such as UNEP and World Bank). Funding is mainly provided by donor states while projects are defined through four-years funding programmes.

In Côte d'Ivoire, GEF financed a project to introduce e-buses in public transport in Abidjan. This project will cooperate with the Abidjan Urban Mobility Project (AUMP), which has received $540 million in funding, including $400 million from the International Financing Institution (IFI), $90 million in commercial debt, $10 million from the Ivorian government and $40 million from private sector funds (GEF, 2021b).

In Sierra Leone GEF is involved in a project where it finances the price difference between e-kekes and conventional kekes; in this way operators will be able to purchase electric vehicles at the same price as conventional ones. For the remaining part of the purchase price, local banks will be involved and will provide loans at a lower cost than those offered for conventional kekes (GEF, 2021c).

GEF is also financing an electricity transition project in Togo. In particular, the aim is to develop a fiscal framework to encourage the spread of electric mobility. It will also include a feasibility study and the implementation of a pilot project and data collection regarding the use of some mototaxis. The project also mentions the opportunity of creating synergies with the African Development Bank regarding the potential for financing electric mobility (GEF, 2021a).

In Uganda, there are several projects aimed at developing and increasing the use of electric two- and three-wheeled vehicles, as well as electric bicycles. Several start-ups have been founded for this purpose. Among them, Zembo company, by 2021, introduced 100 electric motorbikes and 18 charging points, three of which are completely

powered by solar energy. Vehicles are imported from China and assembled in Uganda. Bodawer company is converting ICE Boda-Bodas into electric-powered vehicles, while Ultimate Cycling Uganda and the non-governmental organisation FABIO are active in supporting the up-take of e-bikes.

In addition, a financing company called Tugende has launched a new programme in the field of mobility that aims to provide low-interest loans for all those who intend to buy electric vehicles.

An overview of international actors providing funding for the deployment of e-mobility is reported in Source: World Resources Institute, 2021.

Figure 4. **Funding sources for large-scale transportation investments, including e-buses**

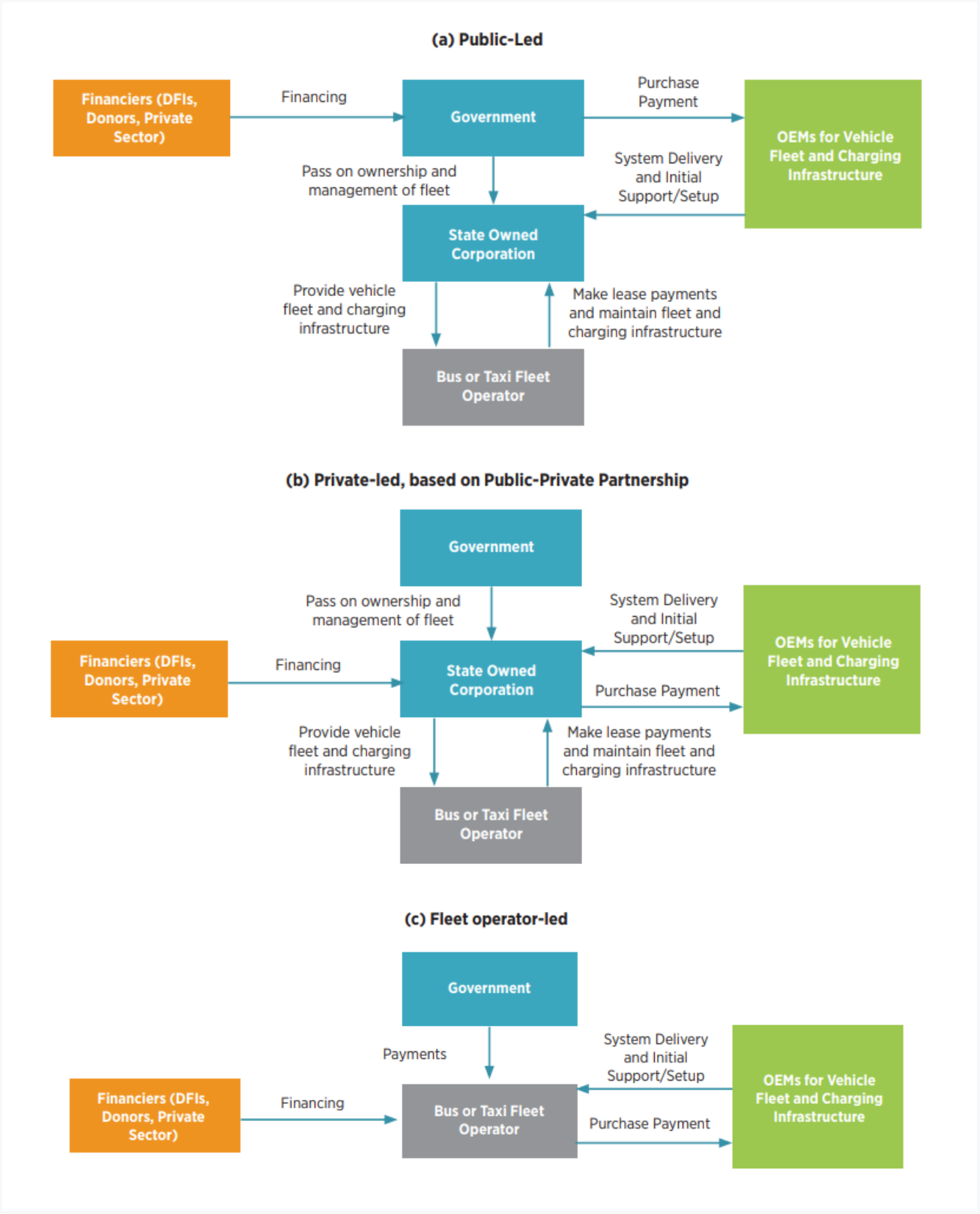
FUNDING SOURCES	EXAMPLE	FINANCIAL PRODUCTS	WHAT IS FINANCED
Multilateral Development Banks	World Bank, Inter-American-, African- and Asian Development Banks	Concessional loans, grants, guarantees, results-based financing	Bus and infrastructure acquisition and operations
Climate Finance (including for NDCs)	Clean Technology Fund, Green Climate Fund, Global Environmental Facility	Concessional loans, grant guarantee, equity	Incremental cost of low carbon investments
Natinal Development Bank	Choina Development Bank, Bancoldex (Colombia), Development Bank of the Philippines	Loans to buyers, credit line to manufacturers	Intermediary for co-financing, Blending of governmental and commercial sources
Export-Import Banks	OECD list of official export credit agencies, Berme Union association	Loans, Guarantees and insurance to exporters	Supports exporters
Commercial Banks	Large Banks (eg. IDCBY, JPMorgan, Chase, JPHLF, CICHY, BAC, ACGRY, CRARY, WFC	Loans, Lease Financing, Insurance	Supports exporters
Manufacturer leasing	Scania, Proterra	Lease financing of bus, infrastructure or batteries	Largest volume of financing
Specilized leasing companies	Connect through manufacturers		Partial or full coverage of purchase cost

Source: World Resources Institute, 2021

According to World Bank Group, three main financing models for the electrification of vehicle fleets, buses and taxis, can be overall identified (as shown in Figure 5):

- Public Led - The public sector takes ownership of vehicles and charging infrastructure, which will then be used by state-run companies or private companies who will lease the vehicles. In this scheme it is the state that cancels out the price difference between electric and conventional vehicles.
- Private-led, based on Public-Private Partnership - In this scenario the public sector creates a partnership with private actors and facilitates the electric transition through subsidies and other incentives.
- Fleet operator-led - Private actors purchase and manage the fleet and infrastructure. In this case, the state can stimulate the market and facilitate private entrepreneurs through subsidies aimed at bridging the price gap between electric and conventional vehicles and can offer state guarantees to protect the investment (Alam M. M. et al., 2021).

Figure 5. **Financing models World Bank Group**



Source: Alam M. M. et al., 2021.

In the international arena, several financial instruments have been launched in recent years to promote electric mobility, as hereinafter described.

- Green bonds - Debt instruments that are used by investors for investments in sustainability-oriented projects. In recent years, green bonds have been issued by the financial arm of electric vehicle manufacturers such as Toyota Financial Services, Hyundai Capital Services and the Chinese company Zhejiang Geely Holding Group. The latter's green bonds were issued to finance the construction of a zero-emission taxi factory and have been issued six times, demonstrating the high demand surrounding this financial instrument.
- Collaborative funds - They involve a partnership between the public and private sectors. For example, they have been used for co-financing the construction of charging facilities by Toyota, Nissan, MItsubishi and Honda. Private companies financed one third of the project in Japan, while two thirds were provided by the Development Bank of Japan.
- Microloans - Loans aimed at small businesses and characterised by very low interest rates. In America, one micro lender is LiftFund. This non-profit organisation provides loans for the purchase of electric vehicles and to facilitate the installation of charging stations. It operates in 13 US states and is supported by national and local banks, chambers of commerce, philanthropic associations and local governments (UNIDO, 2020).

2.3 Charging Infrastructure provision

Internationally, the lack of charging infrastructure is considered a key barrier to the transition to e-mobility, sometimes more relevant than the differential in purchase prices between electric and ICE vehicle models. Financial and non-financial incentives and regulatory measures set-up by governments have been accompanied by investment of private companies recognising in this sector huge market potential in the coming years.

For what concerns regulatory measures, specific attention is devoted to interoperability between charging points and vehicles. This refers to the possibility of charging vehicles independently of the supplier, charger and type of vehicle used. To this end it is essential to achieve standardisation that facilitates the use of the infrastructure with compatible chargers and established payment methods (Alam M. M. et al., 2021).

In Belgium, companies that operate in the corporate tax system and invest in charging points can obtain deductions of 13.5 % with potential savings of up to EUR 14,375.

The municipality of Brussels has also introduced parking tax exemptions of up to 75 EUR for those companies that install charging points.

In Denmark, companies that invest in charging points for commercial sales get rebates on electricity payments of about DKK 1 (EUR 0.13) per kilowatt-hour.

Over three years Helsinki has tripled the number of charging points with an investment of EUR 4.8 million. Furthermore, for 2020-2021 the Finnish government has allocated an additional budget of EUR 5.5 million to increase the number of charging points in the country. In 2016, the Ministry of Employment and the Economy expanded its subsidy programme for companies wishing to install charging points to cover up to 35% of the investment.

In France, the government has introduced several incentives for various actors investing in charging points. Subsidies of up to EUR 300 are available for individuals who buy charging stations for their

homes. For companies and public authorities, the purchase and installation costs are covered up to 40 %, and for apartment buildings up to 50 % of the investment.

In Germany, private individuals can benefit from subsidies that are provided by the KfW-Bank, the public sector and electricity suppliers. Charging stations can also benefit from important subsidies for the purchase of charging points based on kW power. These range from 3000 euros for charging stations up to 22 kW to 30000 euros for the purchase of chargers above 100 kW. Furthermore, there are tax incentives for employers who allow employees to recharge their electric vehicles at the workplace and for employees who recharge their company vehicles at home.

In Italy, from 1 March 2019 to 31 December 2021, individuals, condominiums and companies could enjoy tax reductions of up to 50% for a maximum amount of up to € 3,000 for the purchase and installation of charging points.

In Norway, the government did not focus much on tax reductions or subsidies but increased the public budget for investing in the purchase and installation of charging points. One of the key objectives of the Norwegian strategy is to have charging stations every 50 km on the country's main roads.

In Sweden, the Klimatklivet project targets companies and public associations and offers subsidies of up to 50%. The government has also launched the Charge at Home programme to encourage the installation of charging points in private homes. This provides funding of up to EUR 960 to cover installation costs.

In the Netherlands there are no incentives or subsidies for installing charging points, but citizens and companies can apply to public bodies. After installation, citizens can benefit from the charging points by paying only for the electricity used to charge the vehicle.

In the UK the Electric Vehicle Home Charge Scheme covers the installation of charging points in private homes up to 75% of the costs. The same benefit is available to companies through the Workplace ChargePoint Grant scheme.

In India the lack of charging points is one of the biggest obstacles to the transition. To remedy this, the central government has taken measures that have been codified in the FAME II scheme. In 2019, the government planned an investment of INR 10 billion (US $ 138 million) to support the construction of charging points. The central government and the various federal states are thus encouraging public and private sector companies, electricity suppliers and urban development authorities to make investments in the sector. Currently most of the chargers have been deployed within cities but the central government is making efforts to supply major roads and highways. Further measures were also taken in the regulatory field with definition of rules aimed at creating a competitive market and the destination of 20% of parking spaces in new buildings to charging points (WBCSD, 2021).

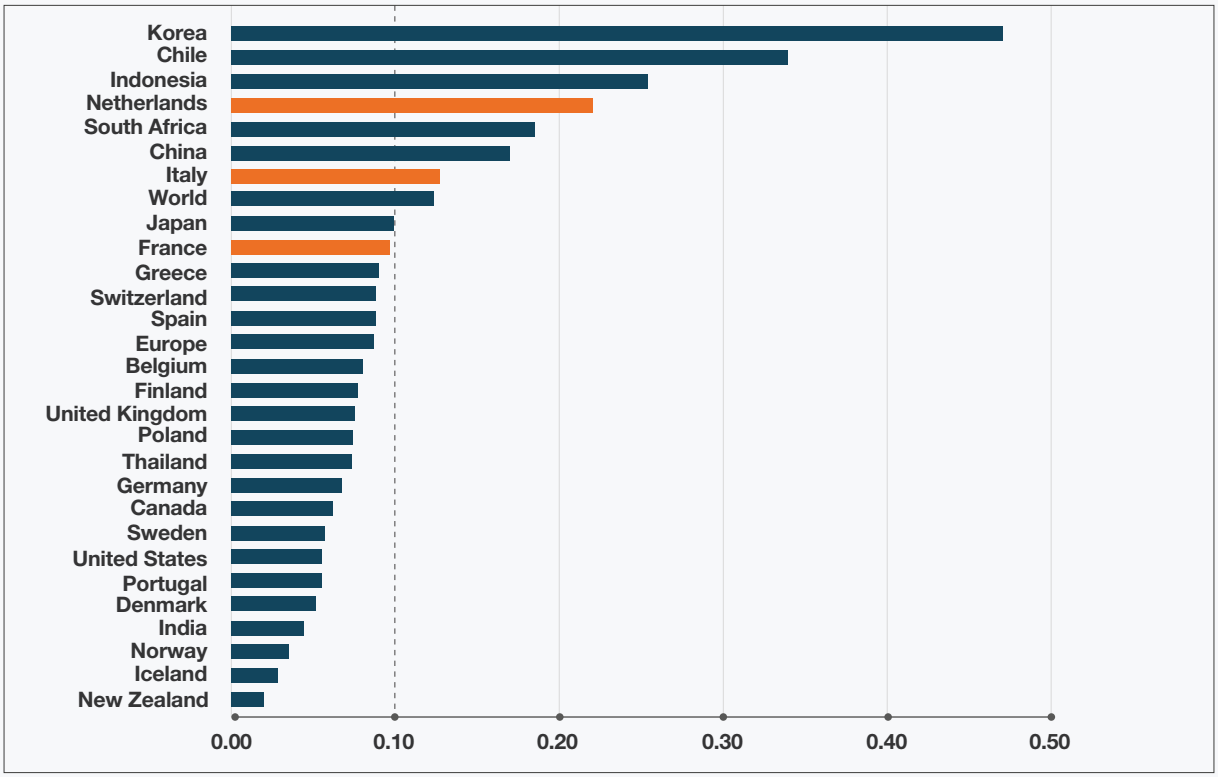
Still in India, the Haryana government encourages private investors to invest in the sector. To this end it provides land at a reduced rate and ensures continuity of the electricity supply. In addition, charging points will be installed in newly constructed public and private buildings and investments will be dedicated to the development of renewable energies, such as hydrogen and solar (Government of Haryana, 2021).

China has launched a $1.4 trillion investment in digital infrastructure development, which includes electric vehicle charging stations. About 10 cities have also announced the installation of 1.2 million charging points by 2025, which would confirm China as a global leader in the electric vehicle market.

In 2021, an Infrastructure Plan was launched in the United States with the objective to increase the number of charging points from the current 100,000 to 600,000. The States that offer the most tax incentives and subsidies for promoting EVs are California and New York State.

In Africa only a few countries have public charging infrastructure. Despite this, in recent years South Africa has made significant progress in this sector. In fact, South Africa is fifth on a global scale in terms of the ratio of public electric vehicle (EV) chargers to electric vehicles in 2020 (IEA2021). In the country about 1.8 chargers for every 10 electric vehicles are available, an endowment which places South Africa behind only Holland, Indonesia, Chile and Korea (Figure 6).

Figure 6. **Ratio of public chargers per EV stock by country, 2020**



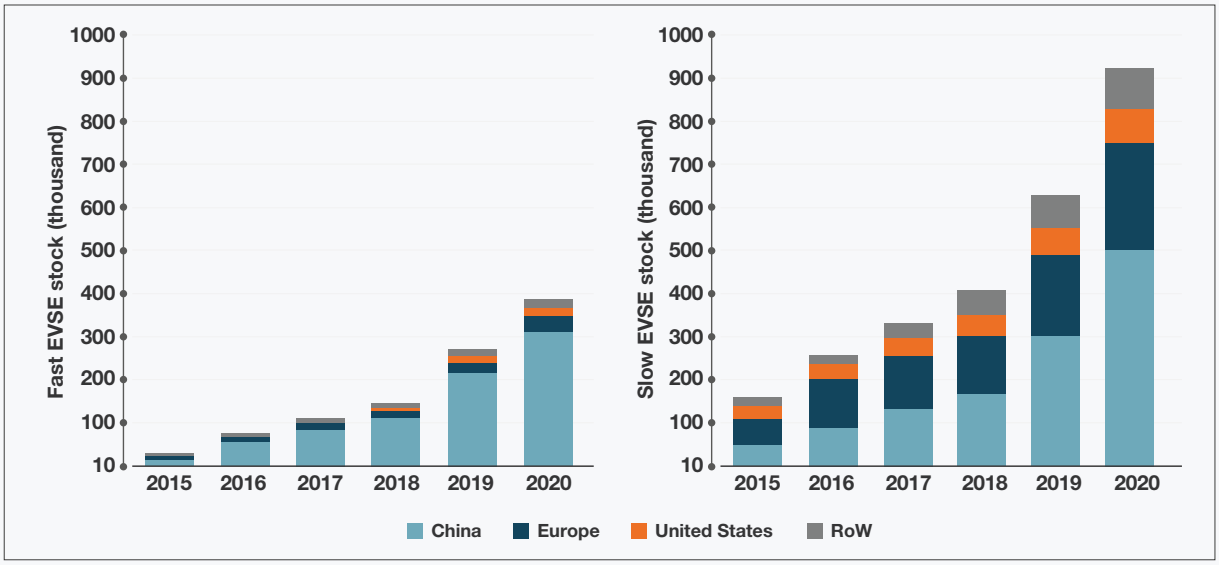
Source: IEA, 2021.

In Kenya, amendments to the building code to integrate charging points into public buildings and residential areas are being explored.

In Rwanda, the introduction of standards for the use of charging points and the application of special rates for electricity at charging stations are being considered. In addition, Kigali 2050 Transport Master Plan updated in 2020 envisions the installation of electric vehicle charging within fuel stations. (Galuszka et al., 2021).

Figure 7 shows the publicly available stocks of fast and slow chargers for light electric vehicles between 2015 and 2020 in an international comparison.

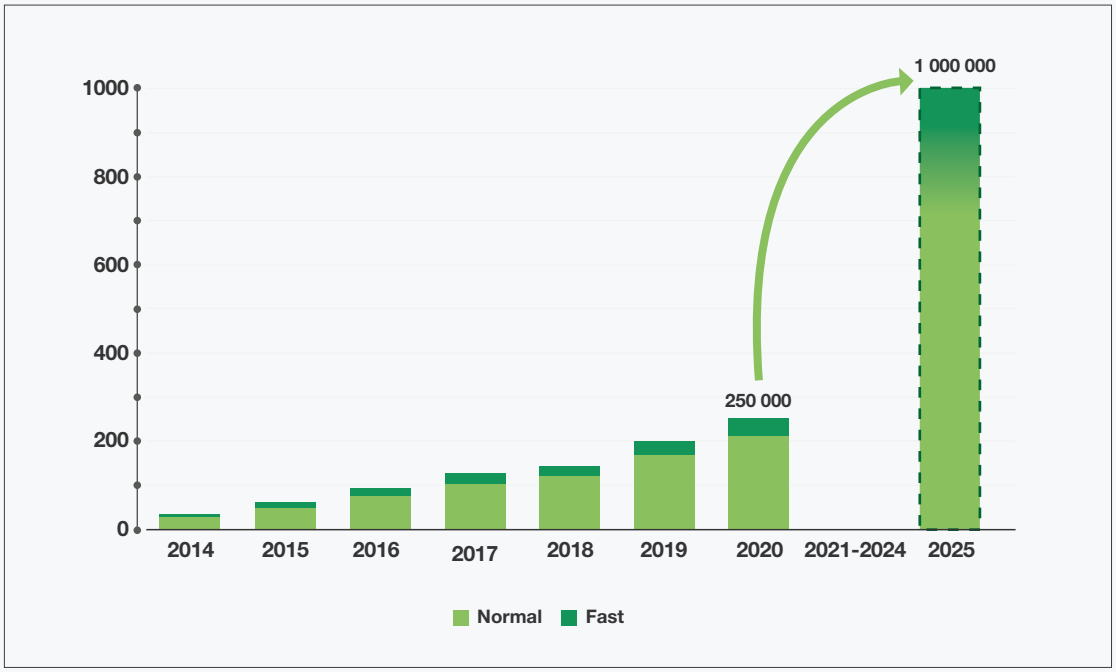
Figure 7. **Stock of fast and slow publicly accessible chargers for electric light-duty vehicles, 2015-2020**



Source: IEA, 2021

For the context of EU-27 and UK by 2020 the European Court of Auditors has highlighted a still insufficient development of the charging network compared to actual needs and initial plans. As shown in Figure 8, the total number of charging points in 2020 amounted to 250,000. This is a low number compared to the growth projected in the 2017 Action Plan, which called for 440,000 charging points in 2020. If the negative trend of the years between 2014 and 2020 is confirmed in the future, in order to reach the target of 1 million rechargers by 2025, 150,000 new points will need to be installed every year, corresponding to 3,000 points per week (European Court of Auditors, 2021).

Figure 8. **Charging points (EU-27 and the UK) and Green Deal target**



Source: European Court of Auditors, 2021

3. Country overview

3.1 Territory

Angola is a country in southwest Africa of 1 246 700 m³. The Angolan territory is characterised by a band of highlands running from north to south of the country and whose average height varies between 700m and 1000m, while the narrow coastal plain varies from 50km to 100km wide. To the east is where most of the population is concentrated as the highlands become softer and there is savannah, while to the southeast there is a desert area towards the Kalahari Desert except for the areas surrounding the Cuando, Cunene and Cubango rivers which are used for livestock and cultivation. Interestingly, the rivers in the highlands are used for hydroelectric power. The coastal strip extends for 1400 km, including the exclave of Cabinda, and is home to some of Angola's largest cities, including the capital Luanda.

Angola is the 20th largest country in the world.

Administrative organisation

Angola is a presidential republic. Presidential elections are held every 5 years and the elected president serves as head of government and commander of the armed forces. Legislative power is held by the unicameral parliament called the National Assembly and composed of 220 deputies elected through provincial and national constituencies. Angola is divided into 18 provinces, which in turn are divided into 173 municipalities and 618 communes. The provinces are: Bengo, Benguela, Bié, Cabinda, Cuando Cubango, Cuanza Norte, Cuanza Sul, Cunene, Huambo, Huíla, Luanda, Lunda Norte, Lunda Sul, Malanje, Moxico, Namibe, Uíge and Zaire. Figure 9 shows the provinces of Angola.

Figure 9. **- Provinces of Angola**

Source: mappr

3.2 Demography

In 2020, Angola's population amounted to 32.866.272, equally split between men and women. It is interesting to note the high rate of urbanisation, with 66.7% of Angola's population living in cities in 2020.The average age of the population is currently very low at around 16.7 years, while in 2050 the average is expected to be close to 20 years.

These numbers are set to increase significantly in the coming years. Indeed, Angola is expected to reach 77 million in 2050 with the urbanisation rate set to increase to 79%. The projected population growth makes it even more urgent to create a regulatory framework and strategy to implement the electricity transition.

3.3 Economy

The Angolan economy is essentially based on oil, gas and diamond mining. The hydrocarbon industry accounts for around 50% of GDP and is the sign of an undiversified economy that is subject to market fluctuations.

The sector also accounts for 70% of the government's revenue and 90% of the country's total exports. Despite its considerable size, the agricultural sector is not very well developed due to the consequences of the war, although in recent years the government has made several investments to encourage growth in the sector, which is currently worth only 10% of GDP.

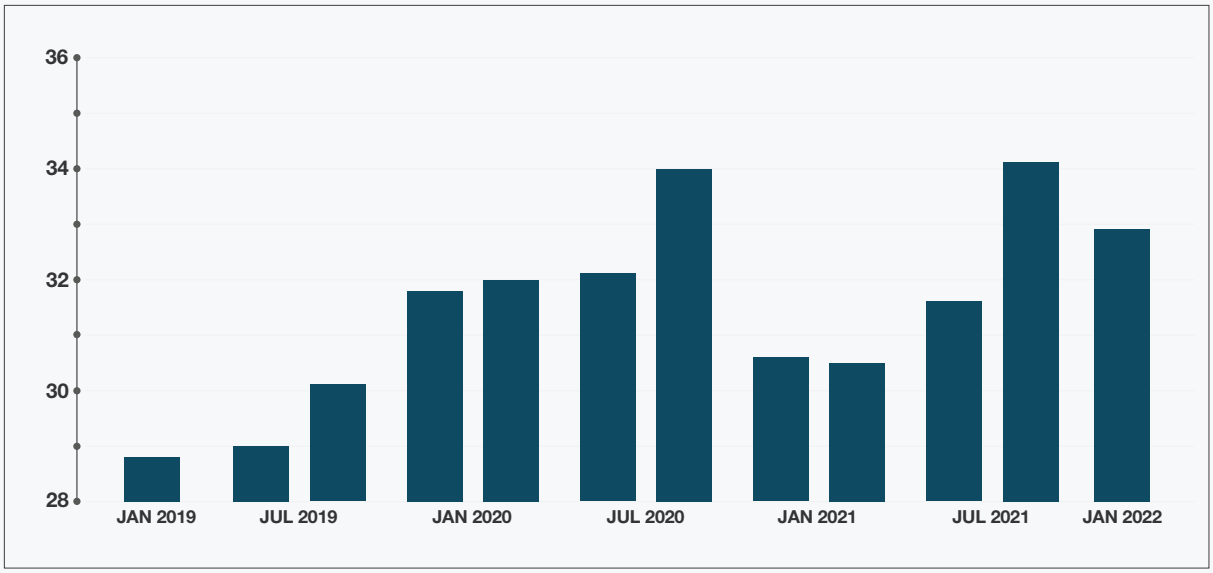
These investments are mainly aimed at boosting the production of coffee and cotton in order to increase the export basket. The industrial sector is currently not very important, while the tertiary sector has experienced considerable expansion and now accounts for 43% of GDP. The business of banks and financial institutions is particularly important, although tourism is also slowly expanding despite the lack of infrastructure. After the end of the civil war, Angola experienced a rapid development favoured by the high price of oil, with annual growth rates of over 11% (Cross Border, 2021).

After 2010, falling oil prices and declining demand put an end to the oil boom and slowed Angola's growth rates, which in recent years have been in recession.

The high dependence on the oil sector and the global trajectory towards net zero require the Angolan government to adopt long-term strategies aimed at economic diversification, development of renewable energy sources and environmental sustainability.

As regard to the workforce, 50% of Angolans are employed in the primary sector, although it only accounts for 10% of GDP. In fact, Angola mainly practises subsistence agriculture to meet the basic needs of its citizens. In the secondary sector, the employment rate is around 8%, with most workers employed in the oil and gas industry and related activities. The remaining 42% of Angolans are employed in the tertiary sector. In 2022 the unemployment rate will be around 32.9% as shown in the Figure 10.

Figure 10. **Unemployment rate**



Source: tradingeconomics.

The Angolan market is characterised by free trade, with few barriers and taxes imposed by the government. As mentioned above, Angola exports mainly oil and gas, with a small percentage of diamonds, of which it is the second largest producer in Africa. Exports are mainly to the Chinese market, followed by India, the USA, Spain and South Africa. Imports are much more varied: Angola imports refined oil products and drilling equipment, as well as rice, palm oil and poultry.

In the transport market, car sales experienced a downturn following the sharp drop in oil prices in 2015, before slowly recovering. In 2020, the COVID-19 pandemic, increased taxation and an increase in the purchase of second-hand vehicles put a brake on car imports, which picked up again in the second quarter of 2021, with an increase of 24% and 2,276 sales. In terms of car brands, Toyota is in first place, followed by Suzuki and Hyundai.

Despite the predominance of these brands, in 2021 the Angolan market saw a sharp increase in the sale of Chinese-made cars, according to ACETRO (Associação angolana dos Concessionários de Equipamentos de Transporte Rodoviário e Outros). It is estimated that around 2,000 Chinese cars have been sold, capturing a market share of around 50%. The brands in question would be Jetour, Borgward, Changan and Geely. In addition, the Angolan police have reportedly started using Chinese-made vehicles, namely the Jetway x70 model produced by Chery.

In order to tackle the import of cars that are too old, the Angolan government has introduced restrictions that prohibit the import of vehicles that were produced more than six years ago.

3.4 Energy

The energy mix in Angola is mainly focused on three areas: hydropower, thermal power plants and gas. At the end of 2018, generation capacity was estimated at 6.3 GW of which 64% was from hydro, 12% from natural gas and 24% from other fossil sources. Given the population growth and the consequent increase in energy demand, the Angolan government has launched a plan called Angola Energy 2025, which aims to provide electricity to 60% of the population, compared to 42% in 2020. Demand is expected to increase to 7.2 GW.

Electrification of rural areas through line extensions or the creation of 500 off-grid 'solar villages' and the provision of individual photovoltaic systems is also a strategic objective (República de Angola. Ministério de Energia e Águas, 2016).

The 2025 plan focuses mainly on the exploitation of renewable energies and especially on the upgrading of hydroelectric infrastructure. In fact, 159 sites have been selected in Angola that would seem to be suitable for hosting this type of installations, increasing the hydroelectric generation capacity from 1 200 MW to 9 000 by 2025. In addition to these sites, there are many opportunities for the construction of micro-hydro plants to meet the needs of small communities (Global Legal Group, 2020).

Given the difficulties of Angola's public economy due to the volatility of oil prices and the international situation, the aim is to create an environment conducive to the development of private sector initiative. To this end, the Angolan government is introducing various measures to facilitate the bureaucratic process and reduce corruption to attract private investment from abroad.

Another objective of the plan is to homogenise power lines so as to fully connect the infrastructure of all Angolan provinces in order to exploit the electricity surplus produced and to supply electricity to as many people as possible. To this end, and to improve energy security, Angola has estimated a budget of USD 1,800 million to remedy the shortcomings of the electricity network and to connect it with neighbouring countries. Funding is also open to investments from the private sector. To facilitate the achievement of its objectives, Angola also participates in multilateral organisations, with Angolan companies being members of the Southern African Power Pool and the Central Africa Power Pool. Angola plans to create electricity infrastructure links with both the Republic of Congo in the north and Namibia in the south to bring electricity to southern cities and rural areas of Angola (Global Legal Group, 2020).

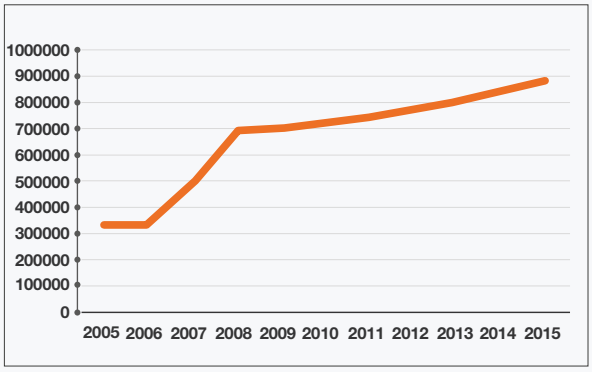
In June 2021, the price of electricity in Angola was one of the lowest in Africa and in the world. In fact, the price per kWh for households was 11.830 Angolan Kwanza corresponding to 0.025 dollars. For business, the price was 9.640 Angolan Kwanza, or 0.021 dollars.

3.5 Transport and mobility

The vehicle fleet in Angola has grown steadily in recent years. In 2015 it had a fleet of 880 000 vehicles and has grown 2.6 times since 2005 like shown in the Figure 11. By 2020, the total number of vehicles is estimated at 1.4 million, 36% of which are located in the capital Luanda alone. The increase in urbanisation and vehicle use has led to inevitable problems of traffic congestion and potential pollution levels (Benmaamar M. et al., 2020).

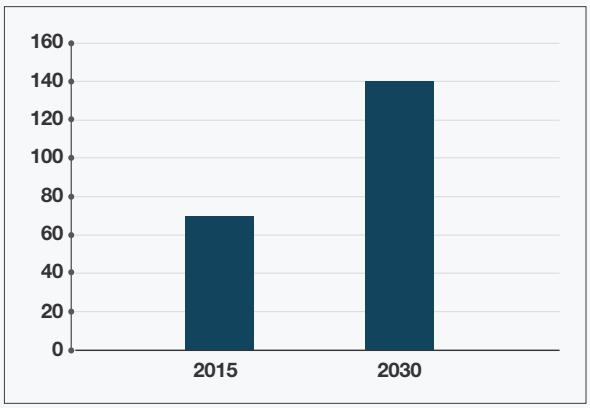
The number of vehicles per capita in Luanda in 2015 amounted to about 70 cars/1,000 inhabitants, while such figures is forecasted to double by 2030 (Figure 12) However, such figures are low compared to what registered at international level; for example, in Lisbon the number of vehicle per capita amounted to 850 cars/1000 inhabitants (PDGML, 2015).
The structure of Public Transport system in Luanda is described in Figure 13.

Figure 11. **Luanda vehicle fleet**



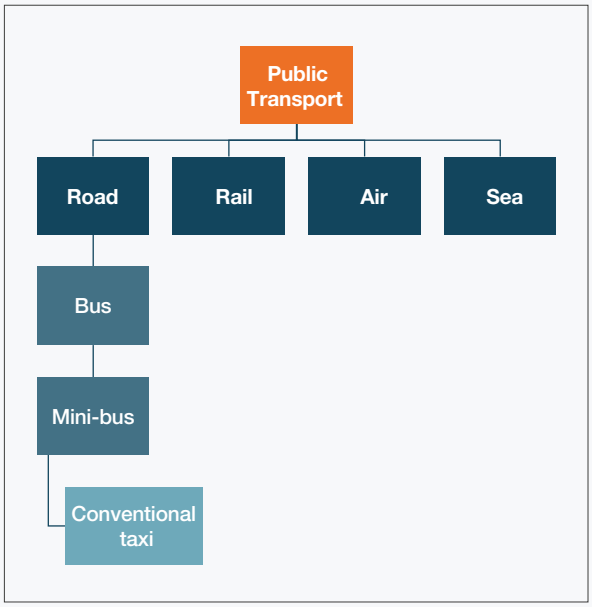
Source: Benmaamar M., et al., 2020

Figure 12. **Car ownership in Luanda (cars/1,000 inhabitants) in 2015 and 2030**



Source: elaboration on General Metropolitan Master Plan of Luanda (PDGML) data

Figure 13. **Public transport in Luanda**



For what concerns road transport, in 2020 in the Province of Luanda, according to the Office for Transport, Traffic and Urban Mobility, about 200 public buses were estimated in circulation; such number is recognised to be insufficient to satisfy the actual mobility demand. However, by 2022 436 new buses will be integrated in public fleet and deployed in public transport to facilitate urban and peri-urban mobility.

Figure 14. **Public buses in Luanda**

The inefficiency supply by public buses implies a significant relevance of minibuses (used for public transport mainly from the suburbs to the centre), both from a transport point of view and in terms of employment for a large number of persons. Such lack is further compensated by services by moto-taxi and 'kupapatas'.

The price for minibuses rides are established by an agreement between the Ministry of Finance and the taxi drivers' association. The price is variable and is adjusted according to the distance travelled, the time of year, existing demand and changes in fuel prices. According to money changes in 2015 the price varied between 100 and 400 Akz equivalent to 0.60€ and 2.40€. The low price and the possibility of avoiding road traffic more easily have greatly increased the use of this form of transport. Minibuses usually carry 15 people per trip, but if demand increases, they can carry up to 18 passengers (Fiston, 2015).

For what concerns minibuses represented by ANATA (National Taxi Association), which represents about 41,000 associates, most of vehicles are Toyota Vans with 15 seats, whixh are bought in Angola with technical assistance included. Each operator possesses between 5-30 vehicles, with a maximum of 300 passengers daily carried by each vehicle. On average, the daily mileage travelled by each mean is about 400-450 km.

In relation to electric mobility, the taxi association highlights the following potential challenges:

- Road conditions and vehicle characteristics. E-vehicles are mainly manufactured in China but, according to ANATA, such vehicles did not prove to be reliable in terms of durability in the presence of bad road conditions

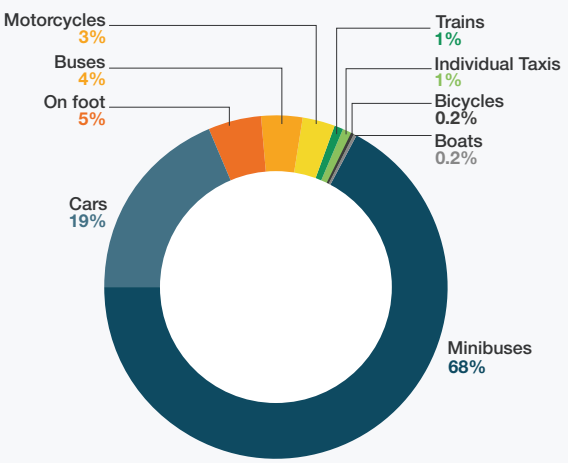
- Distances and battery duration, as collective taxis operate on long distances linking peripheral areas and the city centre.

Mototaxis and Kupapatas services are used both in the suburbs and in the city centre (Kupapatas are also used for freight transport). Fares vary according to the length of the journey and demand. In 2015 in the suburbs, the average fare was around 100 Akz, while in the city it varied between 300 and 500 Akz.

Taxi fares vary according to the parts of the day. In the morning and evening, the starting fare was 600 Akz (€4.80), while during the day it was 300 Akz (€2.40) in 2015 (Fiston, 2015).

According to the 2015 estimated modal share shown in Figure 15, in Luanda 68% of daily displacements to the city centre for work, leisure and study purposes are made by minibuses (candongueiros). Cars (individual) follows with 19%, while only about 5% of commuting is made by public transport (autocarro, barco, comboio), as for travelling on foot. Motorcycles account for about 3%, while the remaining is shared between bicycles and taxi (Fiston, 2015).

Figure 15. **Current and future modal share in Luanda**



On average, the inhabitants of Luanda travel between 2.5 and 39.6 km. These distances are expected to be covered by car in between 3 and 53 minutes. However, according to data collected in 2015, travel times in Luanda are between 30 minutes and 3 hours. This is due to a variety of factors such as heavy traffic jams, traffic violations, poor road conditions, high number of breakdowns and lack of ascending and descending points for mini-buses.

Within the Angolan emerging market of electric mobility, it is worth highlighting the experience of T'Leva start-up, which has attracted investors for the deployment of electric cars, that transported 40 000 people in Luanda in 2020 This was also possible thanks to the partnership established with the Chinese electric vehicle manufacturer Ledo Holding.

The overall fleet of T'Leva (whose core is linking drivers and passengers through app) is of about 500 EVs with leasing of vehicles to the drivers. Vehicle manufacturer (chinese) is a T'Leva partners. On average TLeva vehicles travel 25-30,000 km per week, with an average trip of 10.5 km per car. Drivers can decide if charging vehicles at home or at 9 fast-charging stations deployed in Luanda (charging takes about 15-20 minutes).

T'Leva is a growing company and plans to expand in Congo Brazaville in the near future. According to the T'Leva General Manager, barriers to the development of electric mobility are constituted by the following:

- Charging infrastructures. A wide deployment of electric mobility could imply an instable electricity supply with eventual shortage for people in specific neighbourhood of the city
- People education. Change in people's attitudes and behaviour requires awareness raising and is not an automatic and swift process
- Road conditions. Technical problems in the presence of heavy rains, with batteries getting wet, have been experienced
- Oil companies. Companies are not supportive and try to slow-down electric transition.

Figure 16. **T'Leva start-up**

For what concerns the sale of electric cars in Luanda by Chinangol/Leo Holding, customers are provided with a charger and a two-year warranty for maintenance. In addition, customers can use the three charging points of Pumangol in Rocha Pinto, Patriota and Nova Vida by purchasing an electronic card costing between 1000 and 5000 Kwanzas. Figure 17 shows the station in Patriota (Luanda).

Figure 17. **Pumangol in Patriota (Luanda)**

Source: mapsus

3.5.1 Road transport infrastructures

Angola has a road network of 76 000 km. The most important roads are those that run along the coast from north to south and connect the main port cities of Luanda, Lobito and Namibe. However, of the 76 000 km of roads registered, only 24% are paved.

According to the PDGML (Plano Director Geral Metropolitano de Luanda - General Metropolitan Master Plan of Luanda) the provincial road network of Luanda in 2015 had an extension of 1.544 km, with 68% belonging to secondary network (1.048 km) and 32% to primary network (496), as detailed in Table 1.

The Metropolitan road network, on the other hand, had an extension of 1,197 km, with 67% of roads constituting the secondary network (Table 2).

At provincial level, the Public transport network has an extension of 933 km, with 83% constituted by metropolitan network (775 km) and the remaining by railway network (158 km), as shown in Table 3. At metropolitan level the public transport network had an extension of 856 km, with 38% constituted by railway (322 km) and the remaining by road corridors (534 km), as detailed in Table 4.

Table 1. **Luanda provincial road network**

PROVINCIAL LEVEL ROAD NETWORK	CHARACTERISTICS	LENGTH (KM)
Primary network	National roads	98
	Expressways	398
Primary network total		496
Secondary network	Provincial roads	249
	Metropolitan roads	799
Secondary network total		1.048
Total		**1.544**

Table 2. **Luanda metropolitan road network**

METROPOLITAN ROAD NETWORK	LENGTH (KM)
Primary road network	398
Secondary network	799
Total	**1.197**

Table 3. **Luanda province public transport network**

PUBLIC TRANSPORT NETWORK AT PROVINCIAL LEVEL	CHARACTERISTICS	LENGTH (KM)
Railway		158
Railway network total		158
Metropolitan transport network	Commuter rail	207
	Express rail	44
	Fully segregated corridor	207
	Partially segregated corridor	317
Metropolitan network total		775
Total		**933**

Table 4. **Metropolitan public transport network**

PUBLIC TRANSPORT NETWORK AT METROPOLITAN LEVEL	LENGTH (KM)
Railway network	322
Fully segregated corridors	207
Partially segregated corridors	317
Total	**856**

3.5.2 General Metropolitan Master Plan of Luanda (PDGML)

The PDGML of 2015, which has a time-horizon of 15 years, pursues an improvement of the Luanda transport system capable of fostering economic development, while providing equitable access to opportunities, amenities and services for the population.

The key pillars of the future transport systems are constituted by efficiency and sustainability and around them efforts are made in order to combine the full range of transport modes into a single integrated system, with the objective of reducing operational costs while increasing the overall benefits for local community.

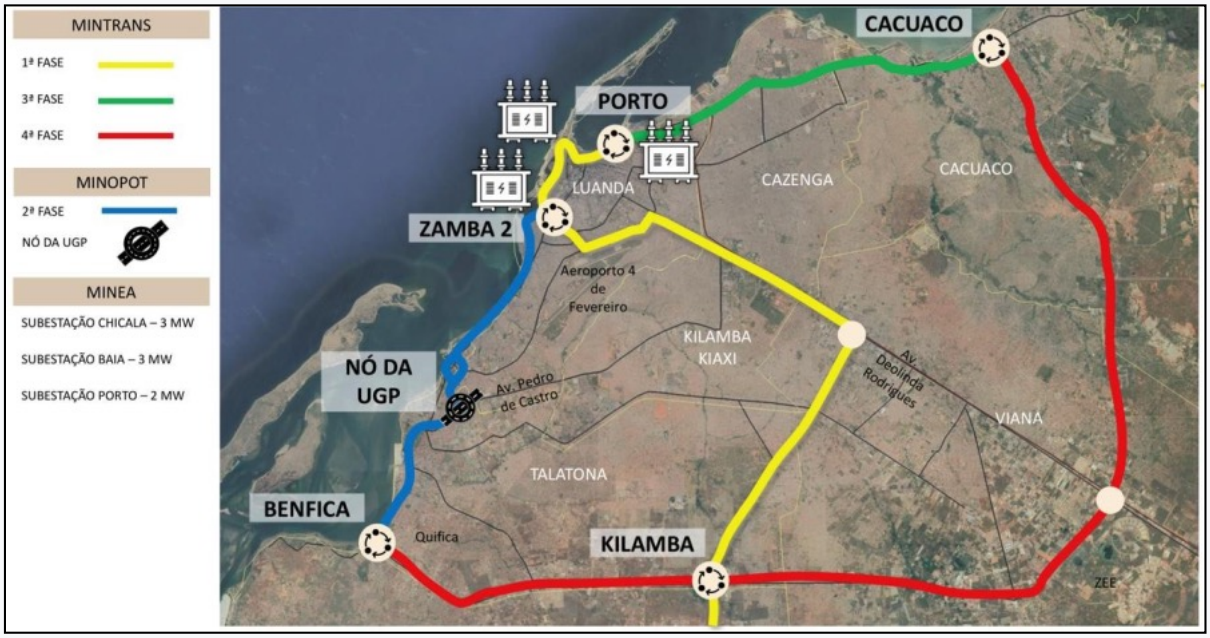
The PDGML establishes the following phased transport strategies for the mobility of people and goods within the Province and in Metropolitan Luanda:

- Increase the capacity of the existing under-provided highway network; establishing a formal network of new roads with a clear hierarchy that would accommodate for the future traffic and, at the same time, favour a regulated and more balanced expansion of the city
- Introduce measures to contain private cars traffic growth implementing a parallel set of policies that aim at containing the excessive use of roads and limit the economic costs of delays and the other negative externalities linked to congestion
- An integrated and efficient transport system where different hierarchical levels integrate to offer the greatest accessibility levels, in the most cost-effective way for all
- Protect/promote active travelling and enforce regulations on access, circulation and parking in inner urban areas, increasing the amount of urban spaces where slow mobility has priority
- Support economic growth through improving freight mobility in order to become safe and efficient, to support the city's economy and be in balance with the needs of the environment and quality of life.

PDGML suggests an integrated public transport (TP) system with high-capacity corridors, secondary urban corridors and tertiary streets connecting to the main lines.

A major public transport project identified by the PDGML is the Luanda Surface Metro (MSL), as depicted in Figure 18 with the different implementation phases, which includes the construction of electricity substations and the increase of parking lots.

Figure 18. **Luanda Surface Metro**



Other potential projects include:

- Electrification of the section of the railway between Bundo and NAIL (New Luanda International Airport), which connects the International Airport to the charging station near the Port of Luanda
- Electric bus services on Avenida Marginal and Nova Marginal
- The UniBUS service in the Camama University Campus
- Buses and electric vehicles within the 4 de Fevereiro Airport area.

PDGML pays particular attention to road safety and active mobility.
As around 30% of trips in Luanda Province are forecast to be on foot in the PDGML time horizon, the Plan highlights the importance of identifying protected areas with restricted access to vehicles and facilities for a safe and efficient circulation of pedestrians. At the same time the plan stresses the importance of road safety criticalities or what concerns cycling.

In this respect, the following strategies are set-out to address not only the infrastructural design but also enforcement and education of road users, in order to significantly reduce road fatalities:

- City 30 - Adoption of 30 km/h maximum speed on all urban local roads away from public transport routes. Reduction of through traffic in designated areas with local character and functions and design policies favouring pedestrians.
- Street design and regulation – Action to redesign, operate and maintain streets guaranteeing safe road access and circulation to all users.
- Public campaigns – Campaigns to increase awareness of road users about road safety issues and induce responsible behaviour.
- Traffic management – Set-up of an agency to collect and analyse road safety data.

It is important to highlight that PDHML public consultations revealed the existence of a wide “support for public transport if the walking experience between Public Transport stations and homes could be improved”. In particular, attention should be paid to initial and final parts of journeys.

PDGML recognises that cycling could become an important mode of transport in Luanda if cycle lanes are incorporated in the building of new streets, according to new design standards based on the ‘complete streets’ approach.

4. The National Strategy for Electric Mobility

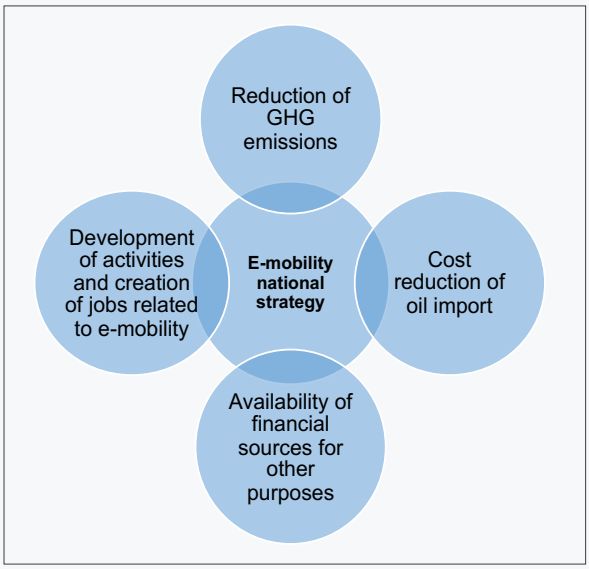
Angolan government developed a National Strategy for electric mobility (currently in the process of approval) to align the country with the best international practices regarding sustainable mobility and the preservation of the environment, within the framework of the following international agreements and related commitments:

- Paris Agreement on climate change
- Kyoto Protocol
- United Nations 2030 Agenda.

With the implementation of the electric mobility system, Angola will pursue the objectives of reducing its dependence on fossil fuels and combating climate change by reducing greenhouse gas emissions (GHG) by 35% by 2030, with an eventual additional 15% through the access to international funds.

According to the strategy, from the introduction of electric vehicles (e-vehicles) is expected a reduction of public spending, with a direct impact on the quality of life of citizens. In fact, while implying an increase in the production and distribution of energy, the progressive diffusion of e-vehicles in the mobility system would reduce the cost of importing oil products, while allowing the allocation of saved financial resources to other purposes of public interest. Furthermore, the market uptake of electric mobility would also foster the development of activities related to electromobility generating new jobs.

Figure 19. **Benefits expected from the implementation of the e-mobility strategy**



In particular, from the implementation of electromobility in Angola is expected the generation of wide business opportunities related to:

- assembly of electric vehicles
- battery manufacturing
- maintenance services
- manufacturing of parts and other accessories for electric vehicles

Furthermore, the economy could benefit from the export of hydrocarbons for the manufacture of batteries.

The introduction of electric vehicles would imply a change of paradigm in the energy sector, where particular attention should be paid to the production of renewable energy.

The National Strategy addresses the various fringes of society, including the public sector and public and private collective passenger transport. It also addresses technical requirements and characteristics of the electric mobility system (both from vehicle and charging infrastructure sides).

In order to ensure a timely and efficient introduction of electric vehicles the national strategy, as per the draft analysed, is based on the following steps:

- Review of the key international agreements that form the basis of global environmental improvement and action to prevent climate change;
- Analysis of what has been done worldwide, including in African countries, and what lessons have been learned;
- Inventory of the existing legislation in Angola regarding electric vehicles and the measures that should be taken to correct the current legislation;
- Diagnosis of the infrastructural situation in Angola related to electric mobility, namely the production and distribution of electricity and the import of electric vehicles and the road network;
- Identification of potential pilot projects that could be implemented in order to establish the first early lessons before launching at national level.

Strategic axes and lines of intervention, as defined by the National Strategy are described in the following table.

Table 5. **Strategic axes and lines of interventions**

STRATEGIC AXES	LINES OF INTERVENTIONS
1. Energy Capacity Building	• Increasing the energy capacity to support the demand of EVs; • Installation of PTs in strategic public areas to support charging points; • Revision of the electricity network to ensure the supply of public transport modes and other EV fleets.
2. Structuring of EV charging infrastructure	• Establishing a charging network for EVs in the pilot phase in several municipalities in the country starting with the Luanda metropolitan area; • Structuring charging networks on inter-provincial roads to be selected; • Encourage private companies and investors to establish charging networks through economic and financial incentives; • Ensuring that all residential and office developments provide sufficient charging infrastructure, requiring developers to include charging facilities for EVs; • Promote incentives for the installation of home and office chargers (especially for solar charging), in existing urbanisations aimed at EV users.
3. Tax benefits and other incentives for EV adoption by citizens and businesses	• Concession of extended tax benefits; • Exemption from taxes and fees; • Facilitating the opening of recharging stations to legal and natural persons, provided they comply with the legal regulations and technical guidelines; • Granting of non-fiscal benefits, such as a reduction in the electricity tariff, the possibility of payment in instalments for private individuals and other benefits; • Free parking and «reserved/dedicated» lanes for EVs; • Promote cheaper registration permits for EVs; • Identify and implement measures to reduce the purchase price of EVs and accessories.
4. Promotion of the EV industry, batteries and accessories	• Encourage, through private initiative, the creation of electric vehicle and battery manufacturing units in the country • Promote the creation of workshops specialized in the maintenance of EVs; • Extraction and export of minerals to support the battery industry for EVs. • Compulsory installation of charging points at petrol stations, large shopping centres, public and private car parks (buildings, condominiums, urban social facilities).

5. Defining the legal and regulatory framework for electromobility	• Legal regime for electric mobility; • Regulation of the activity of operating recharging points; • Technical guide; • Other regulations.
6. Environmental sustainability and technological evolution	• Promotion of infrastructure for supplying/charging EVs with renewable energies; • Deployment of charging stations with solar and wind energy; • Introduction in the medium term of electric vehicles fuelled by hydrogen; • Introduction of bicycles.
7. Public transport and state institutions	• Introduction of EVs in public administration institutions and sovereign bodies; • Gradual replacement of vehicles; • Introduce electrification in various forms of public transport; • Introduction of electric (or hybrid) buses to replace vehicles already providing service in the pilot phase; • In the longer term the aim is for all diesel rail services to be replaced by electric rail services.

4.1 General Enabling Strategies

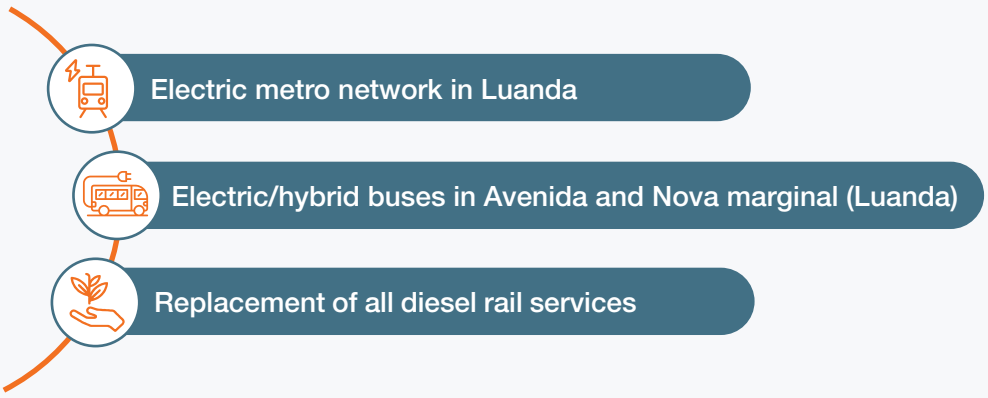
Besides the outline of strategic axes, general enabling strategies focusing on key aspects are defined as well and reported below.

4.1.1 Enabling Strategy 1

In order to implement electrically powered mass transit service a phased implementation scheme, initially focusing on Luanda capital city and later expanding to the entire country is suggested. It particular this should be constituted by:

- Deployment of the electric metro network within Luanda (through a phased implementation)
- Introduction of electric (or hybrid) buses as a replacement for vehicles already servicing Avenida Marginal and Nova Marginal;
- Replacement (in the longer term) of all diesel rail services by electric ones.

Figure 20. **Enabling strategy 1**



4.1.2 Enabling Strategy 2

The strategy suggests to employ small e-vehicles such as taxis and minibuses, starting with pilot projects in selected municipalities, by focusing on contexts where there is already a significant use of this kind of vehicles. The pilot projects should include the development of suitable charging infrastructures and their results will provide useful indication to deploy small e-vehicle in the rest of the country.

The selection of pilot cities should be based on the following criteria:

- Willingness and understanding of the municipality to carry out the pilot plan.
- Low levels of private vehicle ownership
- Distribution of population and land uses in the municipality
- A sufficient energy supply surplus to allow the operation of the EVs involved in the pilot study
- Number of taxis and registered vehicles per 1,000 inhabitants

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Furthermore, the following accompanying measures should be considered to incentivise the use of e-taxi and e-minibuses:

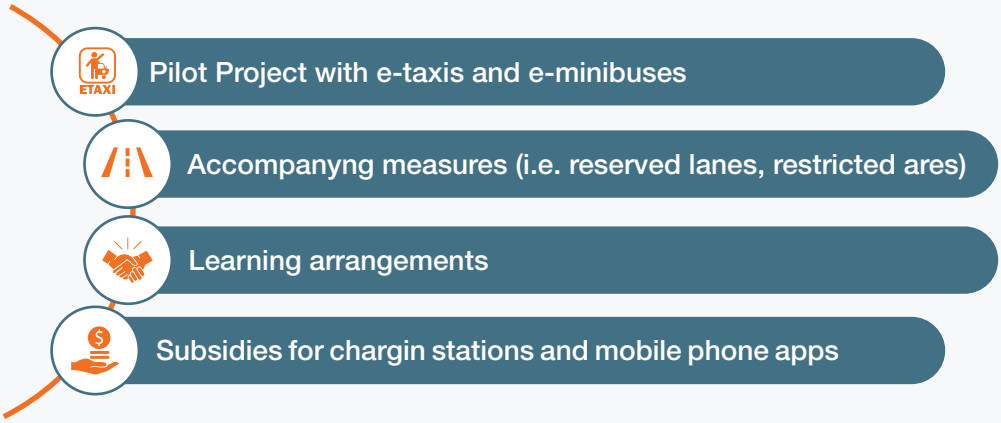
- City central areas with access allowed only to e-taxi and e-minibuses
- 'EV reserved' lanes with priority at traffic light controlled junctions.
- EV-only' lanes for passenger entry and exit.

Private sector should be involved in pilot projects, although the commercial interest could be limited. Therefore, government should be involved by setting-up leasing arrangement for individuals and small businesses to get new or used e-taxis and e-minibuses.

At the same time, government should provide subsidies to the private sector/municipality for a percentage of the investment in charging stations. Moreover, grants should also be allowed for mobile phone applications to provide real-time information on vehicle charging locations and occupancy status.

The preparation and implementation period for this strategy is estimated to be around 3 years. Such short period is needed to accelerate the whole process of mobility electrification in the country.

Figure 21. **Enabling strategy 2**



4.1.3 Enabling Strategy 3

Creation of fiscal incentives and regulation to encourage the shift from ICE to EVs in the purchase/lease and operation of private vehicles as well as to encourage investments by private companies in infrastructure facilities. In particular, the following measures are suggested:

- Identify measures to reduce the purchase price of electric vehicles
- Reduce vehicle registration permits

- Ensure that all new residential and office developments provide sufficient charging facilities

- Encourage private companies and investors to establish charging networks through financial incentives, e.g. reduction in electricity bill.

The price of EVs is currently higher that ICE vehicles and this constitute a disincentive to the adoption of electric mobility despite lower operating costs. Among the main incentive measures it should be considered the reduction of import duties and the reduction of vehicle registration permits.

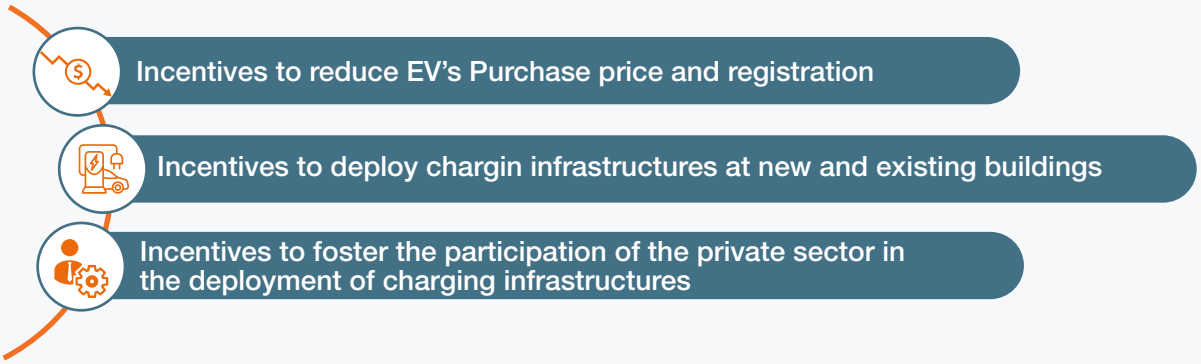
In Annex 1 is reports a comparison between the existing fiscal incentives and those proposed within the new legal framework of the national strategy.

All new residential and office developments should provide sufficient charging facilities by embedding them in the building process. For existing developments, incentives should be provided to the owners of private parkings for the installation of chargers at homes and offices (with specific attention to solar-powered charging points). If it is not feasible to install private chargers, investor/municipality funded community chargers accessible to all EV users should be placed.

The overall involvement of private companies and investors in the development of charging networks should be supported through financial incentives, such as a reduction in the electricity bill.

The timeframe for drafting legislation and implementing the above recommendations is estimated to be approximately 2 years.

Figure 22. **Enabling strategy 3**



4.1.4 Enabling Strategy 4

The electricity supply network should be adequate to the demand from collective transport modes and other EV fleets (minibuses, taxis and private cars). It is suggested to:

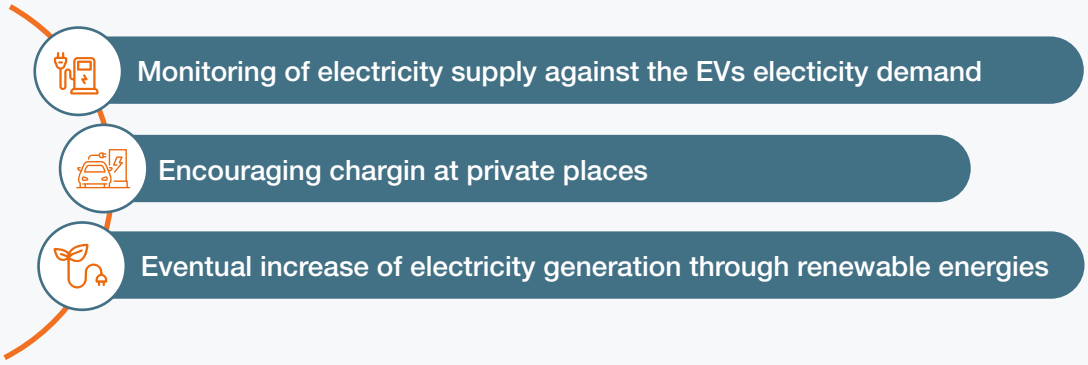
- Monitor the electricity generation and supply network;

- Assess the electricity consumption required by the electric vehicles to be implemented;

- Encourage the charging of electric vehicles in residences, condominiums and businesses;

- Consider increasing power generation through alternative energy sources, such as solar and wind power, to cover any shortfall resulting from the introduction of electric vehicles.

Figure 23. **Enabling strategy 4**



4.2 National strategy implementation

The implementation of the national strategy is structured according to three phases:

- Pilot phase (until 2027);
- Growth phase (until 2030);
- Consolidation phase (from 2031 onwards).

The pilot phase should include the construction of minimum infrastructure, procurement of vehicles, adoption of the necessary incentives for electromobility in the municipalities selected for the pilot phase and implementation of the initial phases of the Luanda surface metro project.

The pilot phase seeks to validate technological, service and business solutions, in order to attract investors in the field of electric vehicles as well as in the installation of charging stations and batteries. The planning of the charging points and the electromobility network in general, should take into consideration the socio-economic conditions of potential users and its phased implementation, with adjustments according to the degree of difficulty and progress that is achieved over time.

The pilot phase will cover the following municipalities of the metropolitan area of Luanda (identified according to a set of criteria including potential demand for e-vehicles, socio-economic characteristics, road conditions, electricity supply etc.):

- Belas;
- Cacuaco;
- Cazenga;
- Kilamba-Kiaxi;
- Luanda;
- Talatona;
- Viana.

During the pilot phase 30 normal charging points and 11 fast charging stations should be deployed by the end of 2023. Further 50 normal charging stations and 25 fast charging points should be deployed from 2023 to 2027.

The normal charging stations will be initially installed in the urban municipalities that integrate the metropolitan area of Luanda and may be extended to the capitals of provinces whose urban and economic structure allows it.

The fast charging points will be available along the main road axes, with particular emphasis on expressways, avenues with heavy road traffic and other locations to be defined through appropriate assessments.

The growth phase should envisage the extension of basic infrastructures and the adoption of solutions successfully tested in the pilot phase. Charging infrastructure should integrate smart grid technologies, such as V2G (Vehicle to Grid technology) which would enable e-vehicles to

operate as 'accumulators' of electricity that could be send back to the grid when not used. In this phase public sector should make efforts for the acquisition of electric vehicles for public services. The consolidation phase should represent a market maturity stage, when e-vehicles, infrastructures and operators are integrated, with well defined mobility and business models throughout the national territory.

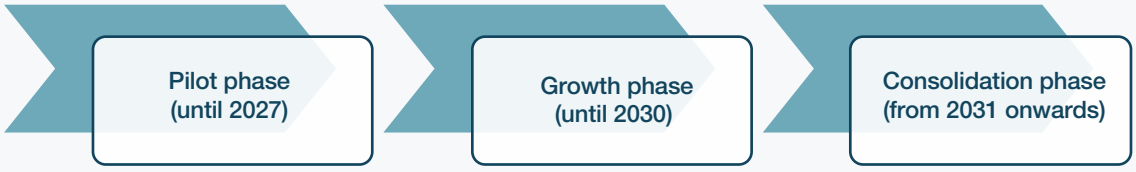
The national strategy implementation is inspired by the following principles:

- Equity and universality in the access to the acquisition, use, charging and maintenance of electric vehicles. Regardless of the supplier chosen, it should be ensured the technical conditions of interoperability between the various brands and models, batteries and charging systems, with the State being responsible for promoting the large-scale use of electric vehicles, both individual and for collective passenger transport; f fmkkkgotio
- Promotion of free competition. Electromobility market shall guarantee attractive conditions for several companies to enter the Angolan market, promoting free competition under the terms of the legislation in force;
- Increase use of energy from renewable and clean sources. The electricity production from renewable energies should be strengthened through the harnessing of wind, solar and hydrogen, with the integration of intelligent energy networks, in the logic of bidirectionality
- Promotion of e-vehicle charging at homes, condominiums and companies' premises;
- Planning the implementation of charging points along primary roads or strategic points in the municipalities selected for the pilot phase, at a distance that ensures autonomous travel of electric vehicles.
- Gradual technological evolution and subsequent updating of the charging points of the electromobility network.

The following specific measures to be adopted by public and collective passenger transport bodies to promote electromobility are further suggested:

- Replacement, by the institutions of the direct, indirect and autonomous administration of the State, in the territorial constituencies chosen for the pilot phase, of 10% of their fleet of combustion vehicles by electric vehicles;
- Encouraging the other sovereign bodies with headquarters or representation in the territorial districts chosen for the pilot phase to replace 10% of their fleet of combustion vehicles with electric vehicles
- Encouraging the installation of charging stations in the vehicle parking areas of the aforementioned institutions
- Creating attractive and subsidised conditions for charging and scrapping electric vehicles in public institutions
- Creating conditions and incentives for the replacement, by the providers of the collective transport of passengers service operating in the municipalities selected for the pilot project, of 10% of their fleet of combustion vehicles by electric vehicles.

Figure 24. **National strategy implementation**



4.3 Legal and regulatory framework

Government is developing a regulatory and normative framework to support the development of electric mobility in the country and therefore incentivise private sector investment in the sector. The new framework is a fundamental element to ensure an effective deployment of the National strategy for Electric Mobility presented later on.

The main measures focus both on developing the infrastructure needed to ensure a smooth electric transition and on stimulating and informing individual users. With regard to infrastructure, the Angolan government aims to liberalise the electricity distribution market as well as the installation of charging points.

Particular attention is also being paid to the standardisation of technical equipment in order to standardise and create intermodality between infrastructure and vehicles. On the individual user side, the Angolan government envisages the introduction of fiscal incentives to support the spread of electric vehicles, as well as incentives to support the business of individual market players.

In particular, the following documents constitute the main references:

- Projecto de Decreto Legislativo presidencial que define o regime jurídico da electromobilidade (Draft Presidential Legislative Decree defining the legal framework for electromobility;
- Anteprojecto de Regulamento sobre a distribuição de energia eléctrica para a electromobilidade (Preliminary draft Regulation on the distribution of electricity for electro-mobility);
- Projecto do Decreto Presidencial que aprova o guia técnico sobre a electromobilidade (Draft Presidential Decree approving the technical guide on electromobility);
- Projecto de regulamento sobre a operação dos pontos de carregamentos para a electromobilidade (Draft regulation on the operation of recharging points for electromobility);
- Projecto de decreto presidencial que estabelece as regras de exercício da actividade de comercialização de energia eléctrica para a electromobilidade (Draft presidential decree establishing the rules for the exercise of the activity of commercialisation of electrical energy for electromobility).

4.4 Communication strategy

A communication strategy should be defined to inform civil society and national and international business about the advantages of using electric vehicles both from an economic and environmental point of view.

Furthermore citizens ‘awareness should be raised towards towards environmentally friendly attitudes and transport, by including a large set of social actors.

To this end, a massive campaign of dissemination and public discussion should be developed in the conventional media and social networks under the coordination of a team experienced in the matter.

5. SWOT analysis of the National strategy for electric mobility

In this section is provided a general SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis of the national strategy for electric mobility in Angola, on the basis of the specific version of the draft document that was possible to access. Such analysis provides a general overview of the potential of the strategy, highlighting the main promising elements besides aspects that deserve particular attention for a successful transition to electromobility.

This will constitute the basis for the analysis presented in the next section where further direction of strategy development are suggested and specific advices for the implementation phase presented.

Strengths

The national strategy for electric mobility addresses the main domains influencing the potential of diffusion of electric mobility, as recognised at international level, as well as to further aspects strictly related to the electric transition that could generate social and economic benefits.

In fact, the strategy duly takes into consideration the key factor of the presence of a wide network of charging stations in the country as enabling element of the market uptake of electric mobility; this includes the deployment of charging point in residential and business premises. The lack of a widespread charging network, indeed, constitutes a relevant barrier for road users in switching to e-vehicles, sometimes even stronger than the other key factor constituted by the purchase price differential between electric and ICE (Internal Combustion Engine) vehicles; in fact, current market prices of e-vehicles are generally higher than ICE vehicles, especially for car segment, while two-wheelers are closer to price parity.

Fiscal incentives are therefore set as fundamental measures to mitigate such issues and promote investment in charging infrastructure as well as the shifts towards EVs by road users; this in line with several international experiences. At the same time incentives are intended as temporary measures to support the kick-start of electric mobility during the first years of the transition.

The strengthening of electricity supply and the monitoring of the actual capacity of the network in the presence of specific demand level from EVs is duly recognised as a pre-condition to enable the development of a new mobility system. Importance is also given to the generation of electricity from renewable sources (such as solar energy) in order to boost the environmental benefits linked to the transition. Furthermore, in the development of the electricity capacity due attention is paid to technological innovation as mean to increase the efficiency of the system.

The emerging of electric mobility is perceived also as an opportunity of economic development and job creation, through the possible development of national manufacturing (both for vehicles and batteries) and new maintenance services. This would contribute to overcome the structural weakness of a non-diversified economy, while reducing the dependence from foreign markets. A further opportunity is identified in the export of hydrocarbon products for the production of EV's batteries in foreign countries.

The strategy presents an effective phased-structured, with specific actions and objectives. This allows to create suitable conditions for a mass development of electromobility in a sequential manner, by testing technical solutions and operational models, assessing the responsiveness of the market as well as the capacity of the electricity grid and therefore identify the needed next measures. At the same time, it allows a more efficient management of financial resources available, Within this structure a valuable role is played by pilot projects in Municipalities. At the same time, it is valuable the role attributed to the public sector in initiating the electromobility (and therefore stimulating the market) through the deployment of EVs in the vehicle fleets of public institutions and the progressive substitution of ICE vehicles in public transport services.

The overall legal framework outlined by the Angolan draft legislation effectively addresses the 'new regime' created by electric mobility, which needs to be reconciled with the efficient operation of the electric system as a whole. In this respect the legal framework regulates the distribution and commercialisation of electricity, the operation of charging points while paying attention to the standardisation of technical equipment and interoperability between charging services. The draft framework is aligned with provisions adopted at international level.

Finally, the notational strategy is inspired by principles of equity and universality in acquisition, use, charging and maintenance of electric vehicles. Furthermore, it promotes free competition among all companies in the electromobility market. The application of such principles should ensure the maximisation of the social wellbeing.

Weaknesses

The strategy is overall structured in an effective manner, addressing the most relevant critical factors for the transition to electric mobility. However, hereinafter are described some weak elements deserving consideration.

The strategy lacks the definition of specific targets to be achieved during the different phases, according to the overall set objectives. Such a definition in fact, from one side would allow a better monitoring of the performance of the strategy and, on the other, would constitute a clear indication about the trajectory taken by the government and therefore about the investments to which operators should direct themselves.

The strategy does not consider the potential of micro-mobility as driver of the electric transition and effective component of the mobility system, especially in urban areas. Despite their growing success at international level and their potential relevant role in the future mobility system of the country and, in particular, of the Luanda metropolitan, vehicles such as e-bikes, e-mopeds and e-kick-scooters, are not mentioned in no one of the strategy steps.

One of the main future issues that will arise with the development of electromobility is represented by the battery disposal at the end of their useful life. It is widely recognised that efforts should be made in the direction of battery recycling. The national strategy lacks a specific focus on this issue.
For what concerns the involvement of private subjects in the future eventual development of local vehicles and battery manufacturing no specific strategies are outlined, with the path towards such objective remaining quite undefined.

Opportunities

A favourable factor for the implementation of the national strategy is constituted by the commitment of Angolan government in complying with the international agreements related to environment and climate change as well as by its intention to support electric transition as opportunity to strengthen national economy. The development of electro mobility, in fact, is considered capable of generating economic opportunities in vehicles and batteries manufacturing as well as in new services (e.g. vehicle maintenance, charging services etc.). Furthermore, the development of electromobility and the consequent reduction of import of oil products would make available resources other priorities of the country.

A further favourable factor for the implementation of the strategy is constituted by the existence of suitable technical capacities in the Angolan national administration, necessary to steer the process and monitor its performance.

The low average age in the country is also an element that could foster the transition. In fact, one of the main barriers to the adoption of innovation is the tendency to stick to established habits, while it is widely recognised that young people are generally less conservative and therefore more open to changes.

Furthermore, the partial diffusion of e-vehicles in urban areas of the country, in particular in the metropolitan area of Luanda, could pave the way to a smoother progress of the transition, due to the 'readiness' of operators and users to deal with the new type of mobility.

Finally, during the recent years a growing number of initiatives in electric mobility have been registered in the continent, especially in Est Africa (i.e., Kenya, Uganda and Rwanda). These are constituted by both pilot projects financed by international institutions and private investments in start-ups. Such experiences and the possibility to access the related knowledge could represent a valuable guide for a successful implementation of the different actions of the national strategy.

Threats

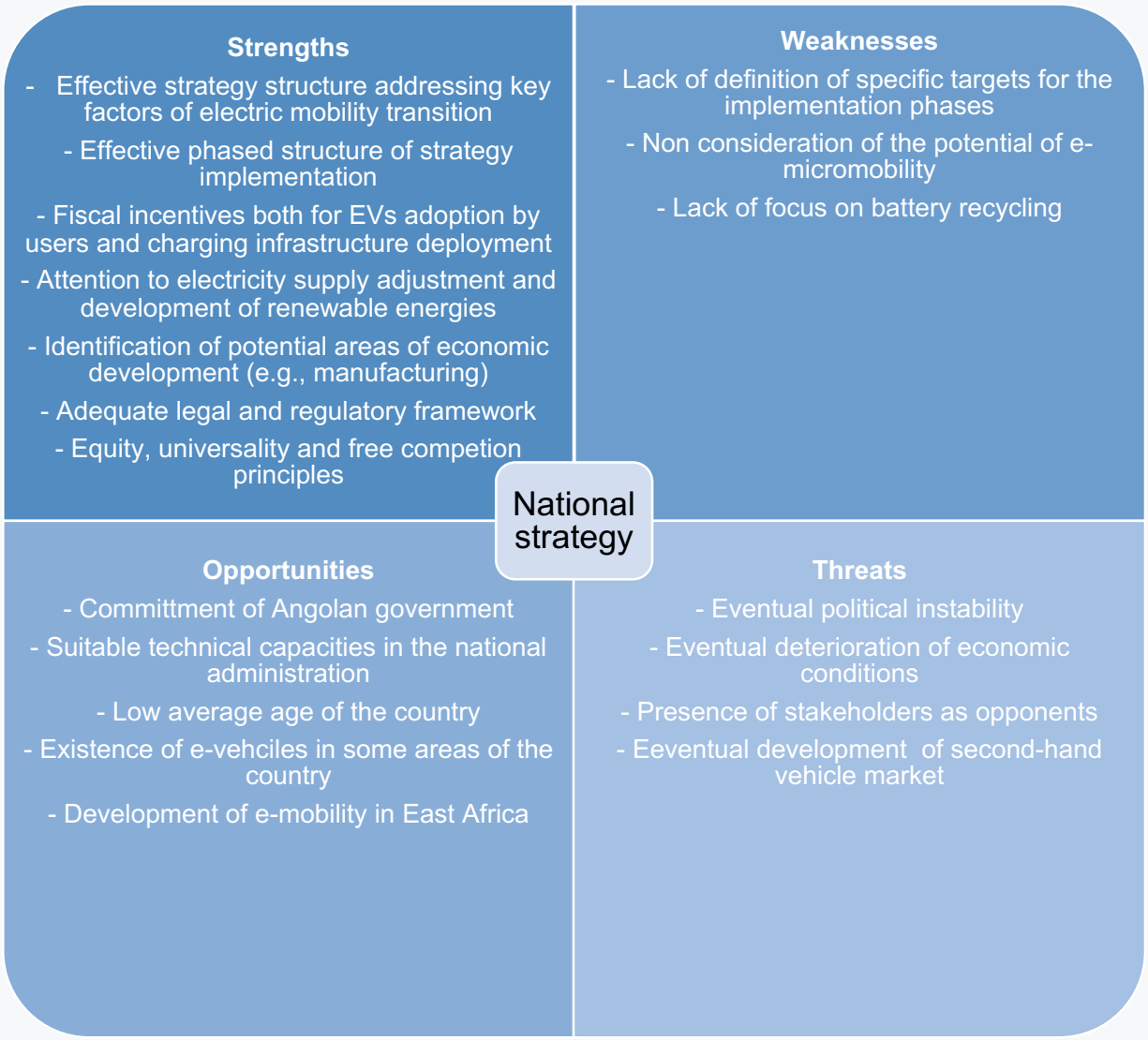
Political instability traditionally constitutes one of the main barriers to the effective implementation of policies and programs. At the moment, Angola benefits from an overall political stability, however the change in political situation should be considered as a possible event (even if unlikely) with huge impact in the deployment of electric mobility strategies and interventions.

Analogously the international economic conditions constitute a relevant external factor with huge influence on the capacity by government to deploy the strategy. In particular, economic troubles in the international and internal market could further reduce government revenues and its capacity of financing the strategy.

A further threat would be the presence of stakeholders opposing the implementation of the electromobility strategy to defend their own interests. As shown by international experiences, examples could be constituted by business operators in the oil sector, as well as transport professional categories scared about the new challenges created by the transition (e.g., repairers of ICE vehicles). This would require a careful definition of a stakeholder engagement process, with mechanisms of 'consensus building' through which identify solutions to mitigate eventual social tensions and resistance. At the same time, a threat could be constituted by the eventual scarce willingness to change mobility habits by people; in this case, besides fiscal and non fiscal incentives awareness raising actions should be widely used in the strategy deployment at national level.

Finally, it should be also considered the threat linked to the potential grow of second-hand vehicle market in the near future. In fact, as highlighted by some observers, the development of electromobility in high-income countries, the so-called 'global north', with the progressive 'ban' of ICE vehicles, could make available a large number of second-hand vehicles (in particular cars) which could be sold in the African market. This would contribute to maintaining a purchase price differential between ICE and electric vehicles, therefore keeping 'traditional' vehicle more attractive for road users. This issue would deserve specific attention from the point of view of the enforcement of the dedicated legislation.
In Figure 25 are synthesised the main elements of the SWOT analysis.

Figure 25. **SWOT analysis of the national strategy for electromobility**



6. Advice for strategy implementation

Based on the analysis of the overall strategy for electromobility and the related SWOT analysis presented in the previous section, hereinafter some general advice to improve weak aspects of the strategy and boost its effectiveness are provided.

6.1 Targets of the strategy implementation phases

The national strategy defines some targets in relation to the development of charging points (both normal and fast charging stations) as well as in relation to the progressive substitution of ICE vehicles in the fleet of public institutions and private companies. However, further specific targets (short-term, medium-term and long-term) could be defined. In fact, while the strategy, for its nature, is demanded to outline high-level pathways towards the set scopes and objectives, the definition of intermediate targets would be beneficial in better addressing strategic actions and measures, getting a better pilot design, monitoring the effectiveness of the implementation and taking eventual corrective measures. Furthermore they would constitute a clear demand signal for e-vehicle manufacturers and private investors in the different fields of electric mobility, which is fundamental to orientate and stimulate the allocation of financial resources within the country.

Examples of quantitative targets that could be defined throughout all phases of strategy implementation (pilot, growth and consolidation) are constituted by the following:

- Minimum target of phase-out of fossil fuel vehicles;
- Minimum market penetration rate of EV's at national and urban level;
- Minimum amount of modal share for EVs in public and private transport;
- Intermediate reduction of GHG emissions towards the 2030 objective;
- Minimum reduction of pollutant emissions in urban areas;
- Minimum share of electricity production from renewable sources;
- Minimum number of existing buildings equipped with charging points.

6.2 Pilot implementation

Among the criteria of the selection of cities hosting pilot projects, it should be considered also the expected duration of permitting processes, eventually needed for the deployment of the different project components (e.g., installation of charging pints). According to international experiences, permitting can constitute one of the main causes of project delays compared to the workplan, with consequent risk of undermining the capacity of the project actions to achieve the project scope and objectives.

Furthermore, municipality should not necessarily be identified on the basis of low rates of vehicle possession. In fact, some pilot could be structured with the specific objective of assessing the capacity of electric vehicles in replacing 'traditional' ones, while analysing in detail users' preferences between the 'usual' mobility solutions and the new one proposed. Discarding contexts where vehicle ownership is significant would miss the opportunity to assess local key factor for a wide market uptake of electromobility. Once identified the pilot sites, pilot projects should be structured with clear objectives, targets and Key Performance Indicators (KPIs), with suitable monitoring plan to track the progress of the activities and achievement of the objectives. The monitoring plan requires the identification of responsibilities, a clear description of the activities to undertake (e.g., data collection and analysis) and ad adequate allocation of financial resources. Furthermore, for each pilot project a risk plan should be developed by identifying all relevant risk categories, their likelihood and the related mitigation and recovery measures.

In setting-up pilot projects it could be also beneficial to carry out a local stakeholder mapping to identify specific needs and expectations of the different social categories and prevent/mitigate eventual resistance. This should be accompanied by a wide stakeholder engagement with the two-fold objective of getting suggestions for a successful pilot design and contribute to increase the general awareness of citizens about electromobility.

It is believed that one of the most promising pilot projects would be constituted by the implementation of services by minibuses operating in the metropolitan areas of Luanda (Figure 26), linking peripheral and central areas of the city. Such a pilot project, in fact, would give the opportunity to test technical and organisational solutions within the most relevant segment of local collective transport, while the high demand volume could constitute guarantee for the deployment of a profitable service (especially if specific measures for vehicles provision are taken into account).

Figure 26. **Collective taxi in Luanda**

Both for this and other pilot projects, 'battery swapping' should be tested as operational solution besides the use of charging points. In fact, this approach could constitute the best solutions for services and uses not compatible with charging times at charging points (especially if the only available are not fast charging).

Battery swapping should be considered also for the development of electric mobility in Angola during the growth and consolidation phases. In section 6.2.1 some experiences of battery swapping are described.

Pilot projects should also include forms of mobility other than those indicated by the strategy, in particular electric e-motorbikes and micro-mobility, as described in section Erreur ! Source du renvoi introuvable.. In this respect, it is worth highlighting that for some types of electric two-wheelers the total cost of ownership (which includes purchase and operational costs) is already lower than the ICE counterparts.

6.2.1 Battery swapping

Battery swapping is a technology that aims at overcoming vehicles' battery-related issues by accounting for a physical separation between the battery and the vehicle: the user can leave the discharged battery at a charging station, while picking up a fully charged battery to be placed onboard the vehicle. This solution increases the travel range of the vehicle, while the problems of recharge time, wear, and eventual substitution of batteries weighs on the service provider rather than on the user.

Figure 27. **Example of battery swapping station for e-mopeds**

In Rwanda, Ampersand company offers both electric motorbikes and a network of battery swapping stations. The benefits are considerable as they can save on the high purchase price of batteries, risk and there is no waiting time for recharging the battery.

According to Ampersand's data, renting a charged battery can save 500 USD by year. The rental process is managed through the platform 'Amper-Ops'.

It is estimated that from its launch in May 2019 to November 2021 Ampersand has carried out more than 50,000 battery swaps on a fleet of 56 vehicle users covering a distance of more than two million kilometres. In addition, in 2021 Ampersand secured a 3.5million USD investment from the Ecosystem Integrity Fund (EIF), which could allow the start-up to expand its market into the growing electric vehicle market in East Africa. In Kenya, many start-ups are investing resources in battery swapping. For example, in Nairobi Stima Mobility offers local drivers a swapping service with a PAYGo payment system. Stima's service allows drivers to swap electric motorbike batteries in less than a minute anywhere in the city, saving 500 USDby year on petrol and ICE vehicle maintenance.

In rural Kenya, Powerhive provides a swapping service in combination with electric vehicle rental as part of their mini-grid services.

Instead, the Charge up! project has installed 45 charging and battery swapping points in Nairobi that can be used by boda-bodas users. It is a partnership involving companies and universities such as Energy 4 Impact, Arc Ride, Fika Mobility, Imperial College London and Strathmore University. The project was funded with 300,000 USD from Partnering for Green and Global Goals 2030 (P4G) to collect data to test the commercialisation of the battery-as-a-service model. The start-up company Kira also offers a battery swapping service, which is managed through the Kirigo App. Customers can find the nearest swap station and can reserve a battery that can be changed in less than a minute.

In Uganda, Zembo offers electric motorbikes and battery swapping service. InfraCo Africa, together with a consortium including DOB Equity and Mobility 54, funded Zembo with three million USD to deploy 2,000 electric motorbikes and more than 60 charging stations and battery swapping

Figure 28. **Ampersand (left) and Zembo (right) e-motorbikes**

In Germany Swobbee company provides a broad range of vehicles to be employed in battery swapping schemes. This includes cargo bikes in several forms, as well as electric kick scooters, electric scooters, pedal-assisted bikes/trikes whose battery can be swapped at specific charging stations. The system relies on manual operations by the users to connect/disconnect the charging cables once the battery packs are put in/extracted from the charging stations. Battery packs are standardized (manufactured by GreenPack) and can be mounted in the diverse declinations of Swobbee vehicles.

In Taiwan Gogoro company deploys electric scooters that can be employed in a battery swapping scheme. Gogoro battery pack is especially designed to be easily put in/extracted from the charging station so that the user is not required to connect or disconnect any charging cable.

Examples of battery swapping for e-buses can be found in Seogwipo City on Jeju Island (South Korea), where such technology is in place since since March 2016, and in Qingdao in China (Figure 30).

Figure 29. **Gogoro moped and battery swapping station**

Figure 30. **E-bus with swappable batteries in China (left) and South Korea (right)**

6.3 Micro mobility

With micro mobility is intended the use of light e-vehicles such as bikes, mopeds, kick-scooters, monowheels. In recent years e-micro mobility has experienced significant growth worldwide becoming a relevant component of urban mobility systems.

Station-based bicycle sharing[2] systems have rapidly spread worldwide, pushed by the growing availability of electric bikes and pedelecs, passing from 17 services in 2005 to over 2,900 in 2019. An analogous growth has been registered worldwide for bike sharing in free-flow[3] from 2010 onwards.

Also the deployment of e-kick-scooters in sharing schemes (free flow scheme) have had huge success; for example services provided by Lime and Bird companies, which were launched in California in 2017, expanded to over 100 cities worldwide just in two years (Oeschger et al., 2020).

Figure 31. **Example of 'station-based' (left) and 'free-flow' bike sharing (right)**

Figure 32. **Example e-kick scooters (left) and e-mopeds (right) sharing**

The main potential of micro mobility in urban contexts is linked to the possibility to solve the so-called 'first and last mile' issue, arising when stations/stops mass public transport are located far from origin and destinations of people's journeys. The opportunity to cover such miles by micro vehicles improve the access to public transport, fostering the adoption of more sustainable mobility patterns and contributing to reduce the dependence on private and pollutant means of transport (mostly cars).

In this respect it is worth mentioning as example the MOBY project in Munich (Germany), which showed that the overall accessibility to public transport for inhabitants increases from 21% by foot to 68% with micro mobility vehicles (EIT Urban Mobility, 2021).

Further evidence of the valuable contribution of micro mobility is provided by the EU-funded project Leonardo, aiming at developing and commercialise and innovative model of kick-scooter; a survey on German e-kick scooter users, conducted within the project, has indeed demonstrated that that almost 23% of riders use the micro mobility vehicle to cover routes otherwise travelled by car.

Micro mobility would perfectly align with the specific need highlighted by the PDGML of strengthening public transport by improving its accessibility, through an improvement of initial and final parts of people's journeys. In this context, the PDGML recognises a strategic role to walking and cycling and e-bikes and e-scooters (both as sharing services and private means) would therefore qualify as effective mobility options, provided that road safety conditions are duly guaranteed. In this respect, safe infrastructures (cycle lanes, reserved lanes) as well as a general education of motorised road users to a safer interaction with more 'vulnerable' road users should be provided.

Figure 33. **Segregated cycle lane in Luanda**

6.4 Education and training

Transition to electric mobility can both create new economic opportunities (e.g. e-vehicles and batteries manufacturing, charging services) and threats to traditional business if not able to adapt to change (e.g. mechanics of ICE vehicles). In both cases education and training aimed at strengthening knowledge and skills of current and future workers are key elements to maximise the net benefits of electric transition.

Angolan government should therefore consider, within the strategy, the launch of training programmes for workers in order to adequately prepare them to the diffusion of electromobility. At the same time, attention should be paid to the quality of technical education delivered at schools and universities and eventually integrate the educational offer to strengthen technical competences.

In India, the Government of the National Capital of New Delhi had planned to launch training courses in 2020 to create new jobs in the e-mobility sector. These courses were offered to interested parties at reduced rates and covered drivers, charging point operators and mechanics of electric vehicles.

In California, the Clean Tech Institute offers a 16-week course to train new specialists in repairing and maintaining electric vehicles.

6.5 Private sector involvement

Private sector investments in the deployment of e-vehicles and charging infrastructure services are of paramount importance to ensure a strong and financially sustainable electric transition.

Angolan government should try to mobilise private-sector initiatives both through international financing and partnerships with international vehicle manufacturers, as suggested for governments of Emerging Markets and Developing Economies (EMDE) governments (Khan et. al, 2022).

Cooperation with private subjects should be fostered within Public Private Partnership (PPP) schemes, especially for medium-large scale activities. This would require the setting-up of a preliminary PPP framework in the first phases of the national strategy, which should be later consolidated. The PPP framework should define:

- Procedures
- Rules of implementation
- Responsible institutions for the implementation.

7. Recommen-dations

In this section are reported the main recommendations aiming at contributing to a smooth and effective deployment of the Angolan national strategy, on the basis of the analysis and considerations presented in the previous sections.

- The national strategy should define short-term, medium-term and long-term specific targets to: better address strategic actions and measures; get a better pilot design; monitor the effectiveness of the implementation; send a clear demand signal to the market.
- In the operationalisation of pilot projects attention should be paid to the definition of: clear objectives, targets, KPIs, monitoring plan, wide stakeholder engagement.
- Among pilot projects it should be considered the possibility to deploy a service by e-mini buses in Luanda.
- Battery swapping should be considered as charging technology alternative to charging points.
- Electrification should also include forms of mobility other than those indicated by the strategy, in particular electric e-motorbikes and micro-mobility.
- In order to maximise the net benefits of electric transition attention should be paid to technical education and training of students and workers.
- Private sector initiatives should be encouraged both through international financing and partnership. A suitable PPP framework should be defined.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Annex

Annex 1. Fiscal incentives

Table 5 describes the fiscal benefits currently existing in Angola, related to the possession of road vehicles while Table 6 describes the different fiscal incentives discussed within the national strategy for electric mobility.

Table 6. **Existing fiscal benefits**

BENEFIT	%	TIME	LOCATION	DECREE
VAT on the purchase of public passenger vehicles	Exemption	Indeterminate	National territory	VAT Code
VAT on the purchase of wheelchairs and similar vehicles	Exemption	Indeterminate	National territory	VAT Code
All imports of goods under international agreements	Exemption	Indeterminate	National territory	VAT Code
VAT on the transfer of wheelchairs and similar vehicles	Exemption	Indeterminate	National territory	VAT Code
Reduction of customs duties on importation	50%	Indeterminate	National territory	Proposal of the Code of Fiscal Benefits
Reduction in the rate of Excise Duty	50%	Indeterminate	National territory	Proposal of the Code of Fiscal Benefits
Reduction in the rate of Motor Vehicle Tax	50%	Indeterminate	National territory	Proposal of the Code of Fiscal Benefits

Table 7. **- Proposed fiscal benefits for electromobility**

BENEFIT	%	TIME	PHASE	LOCATION	DECREE
Reduction in the rate of Motor Vehicle Tax	50%	Indeterminate	Pilot	National territory	General State Budget of 2023
Reduction in the rate of Excise Duty	50%	5-7 years	Pilot	National territory	General State Budget of 2023
Reduction of Customs Duties on the import of electric vehicles and component parts	50%	5-7 years	Pilot	National territory	General State Budget of 2023
Value Added Tax Reduction	50%	5-7 years	Pilot	National territory	General State Budget of 2023
Reduction of the General Customs Emoluments the fee for services provided by AGT	2%	5-7 years	Pilot	National territory	General State Budget of 2023
Pure electric vehicles, motorbikes and other Electric motorbikes and accessories and components	Exemption	5-7 years	Pilot	National territory	General State Budget of 2023
Partial reduction of vehicles on Hybrid vehicles, accessories and components	50%	5-7 years	Pilot	National territory	General State Budget of 2023
Taxation on importation of parts, materials and tools for assembly	Exemption	5-7 years	Pilot	National territory	General State Budget of 2023
Partial reduction of Customs Duties on the importation of used vehicles, parts, accessories and components	20-50%	5-7 years	Pilot	National territory	General State Budget of 2023
Partial reduction of the Excise Tax on used vehicles, parts, accessory parts and components	20-50%	5-7 years	Pilot	National territory	General State Budget of 2023
Partial reduction of Value Added Tax on used vehicles, parts, accessory parts and components	20-50%	5-7 years	Pilot	National territory	General State Budget of 2023
Partial reduction of the tax on the transfer of vehicles, accessory parts and components	20-50%	5-7 years	Pilot	National territory	General State Budget of 2023

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