



CCREEE

CARIBBEAN CENTRE FOR RENEWABLE
ENERGY & ENERGY EFFICIENCY

The Future of E-Mobility in the Caribbean



100%

Synopsis:

The Caribbean Centre for Renewable Energy and Energy Efficiency (CCREEE) envisions the transformation of the energy landscape into a climate resilient, sustainable and affordable sector; focused on improving the lives of Caribbean people. Sustainable transport is a major area of focus for the CCREEE, within this vision. The transport sector is a significant contributor to economic development, and its modern transformation therefore takes place within a socioeconomic context. A major part of this context is the cross-cutting interaction with the energy sector. This interaction in modern times has prompted an era of disruption ignited by emerging transport technologies and evolving stakeholder requirements. As Caribbean Community (CARICOM) Member States are supported to enhance their transport solutions, it is paramount that the main disruptors within the transportation sector are clearly stated and understood. This paper attempts to lay out the contextual frame of reference for adopting these disruptors, focusing primarily on road transportation.

Market Dynamics and Future Drivers of Transportation

Transportation is a significant contributor to economic development but also responsible for more fuel consumption than any other sector in the Caribbean, making it a leading source of greenhouse gas (GHG) emissions. On average, the value of fuel imports accounts for roughly 10% of Gross Domestic Product (GDP) across CARICOM Member States¹ and, 39% of total fuel consumed in CARICOM Member States is attributed to the transportation sector (see Figure 1)ⁱ; making it a prime area of intervention to reduce fuel import dependency, to promote the diversification of energy supply, to improve the efficiency of transportation, to mitigate GHG emissions and improve the quality of life of Caribbean people.

¹ Without considering Trinidad & Tobago, for which no figures were reported; CARICOM Energy Report Card 2018;

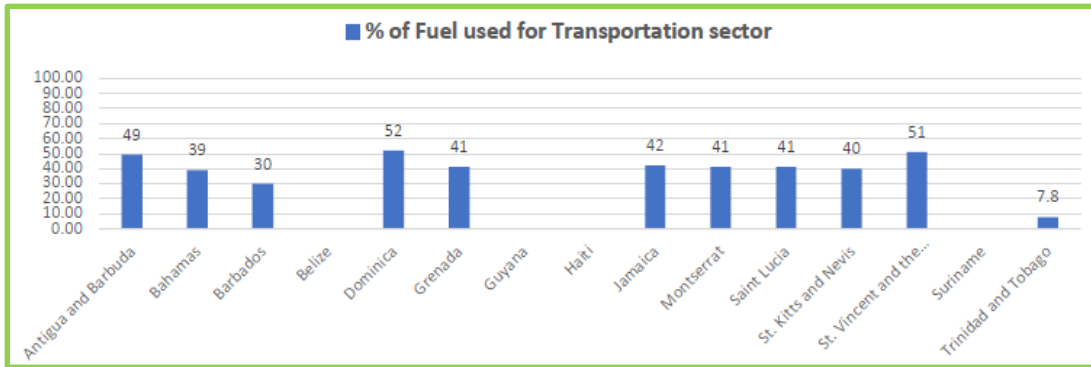


Figure 1: Share of fuel used for the transportation sector in CARICOM Member States (CARICOM ERC 2017)

Most CARICOM Member States recognize the impact of the transportation sector on the economy and the environment by defining it as a priority sector in their Nationally Determined Contributions (NDCs) - 11 out of 15 countries - as well as through the national adoption of sustainable transportation targets; 9 countries have existing targets and 1 country's is under development.

As Caribbean countries pursue the transformation of the transportation system toward a sustainable, efficient and effective sector, the accompanying successful delivery of future transport services will be driven by three main disruptors:



Electrification



Connectivity &
Digitization



Transport Demand
Management

1. ELECTRIFICATION



Electrification of the transportation system offers numerous benefits from both a macro and microeconomic perspective and can represent an enormous opportunity for the Caribbean. If the integration of mobility with the electricity sector and digital technologies is based on a renewable and efficient energy supply, as well as appropriate storage capacities and flexibility options to manage the grid, Small Island Developing States (SIDS) can benefit from reduced fuel import dependence, a diversification of their fuel mix, higher price stability and a healthier society and environment.

A report by the World Economic Forum predicts a mobility revolution driven by electric vehicles, where more than half of new cars sold worldwide by 2040 will be Electric Vehicles (EVs). In its EV30@30 Scenario, the International Energy Agency (IEA) foresees EV sales reaching 44 million vehicles per year by 2030, with a vehicle stock of more than 250 million vehicles (see Figure 2)².

This global phenomenon will inevitably impact the transport market in the Caribbean. How the region responds will be critical to the future of transportation and its supporting infrastructure. Attention must therefore be paid to all the regional market influences including the region's increased access to both electric vehicles from international dealers and previously owned/pre-owned Internal Combustion Engine (ICE) vehicles resulting from rapid EV uptake in other parts of the world.

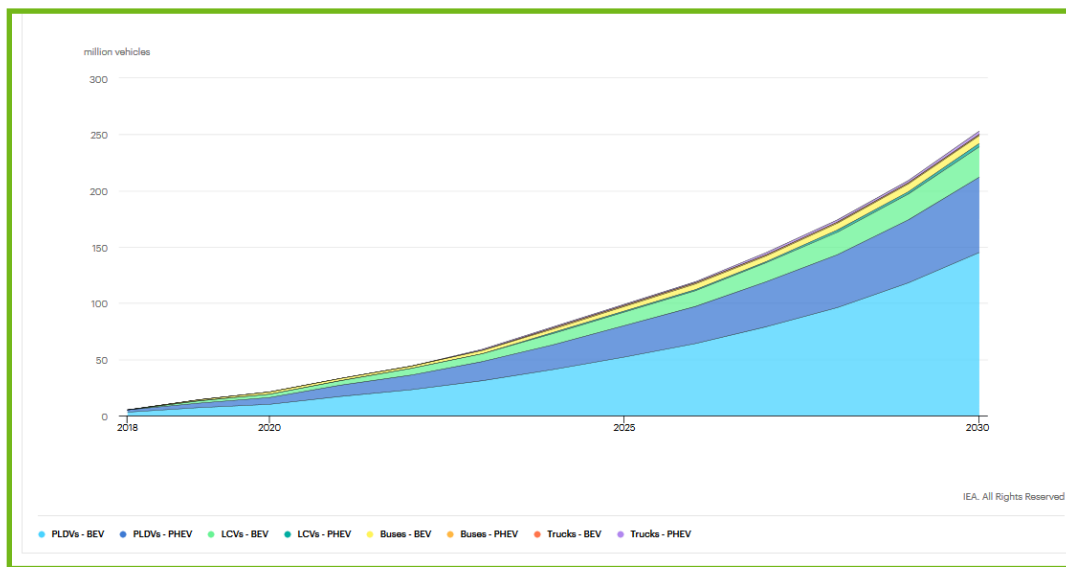


Figure 2: Electric Vehicle Stock 2018-2030 in the EV30@30 scenario (IEA Global EV Outlook 2019)

² The EV30@30 Scenario accounts for the pledges of the EVI EV30@30 Campaign to reach 30% market share for electric vehicles (EVs) by 2030 (excluding two/three-wheelers); IEA Global EV Outlook 2019;

Nonetheless, simply replacing ICE vehicles with EVs in the short-term, without adequate planning and infrastructure and, without a renewable energy source could limit their environmental benefits and create challenges for the grid. To properly design the transportation system of the future, (i) a market-specific approach that considers all relevant stakeholders should be applied, (ii) high-use vehicles in public and commercial fleets should be prioritised as they represent a higher volume of miles travelled, and (iii) charging infrastructure has to be deployed and integrated with renewable electricity generation sources and grid edge technology today while anticipating future mobility and vehicle ownership patterns³.

Policymakers in the Caribbean will have to manage several enablers on both the supply and demand side to drive this transition and prevent undue market distortions. These comprise a favourable import regime for electric vehicles, appropriate charging infrastructure, a conducive market environment and market uptake of EVs. Some specific thematic electrification interventions are discussed below.

Import Regime

Caribbean SIDS, much like other SIDS, have characteristic features and vulnerabilities such as insularity, geographical remoteness and small economies, populations and land space. These bring about a heavy import reliance, openness to international trade with varying effects on economic growth, significant exposure to external shocks and vulnerability to environmental threats and degradation. Moreover, they create specific logistical challenges in transport and trade.

Owing to the limited market size of individual SIDS, the import of EVs is often monopolised or oligopolised with a limited number of dealerships. This can lead to a situation where consumers make decisions based on limited access to information in the local market. At present, the only official EV dealership within the CARICOM region is based in Trinidad and Tobago. Other companies provide EVs to the market in the region but are operating as retailers. Where these retailers are not official dealerships, the warranty granted by car manufacturers is voided once the EV leaves the country of manufacture or purchase. The warranty conditions offered for these vehicles are therefore determined at the discretion of the local or regional retailer. In small economies like those of Caribbean territories, the electric vehicle market is currently not strong enough to create better pricing and import conditions and so, the mainstreaming of electric vehicle imports on a regional level could facilitate the creation of attractive markets with better conditions for both consumers and car dealers.

³ World Economic Forum, Electric Vehicles for Smarter Cities: The Future of Energy and Mobility, 2018

Charging Infrastructure

To ensure better market penetration of EVs and, to address consumer concerns like range anxiety, the availability and accessibility of appropriate charging infrastructure is an important precondition for EV market uptake and can influence consumers' decisions to purchase an EV over an ICE.

With approximately 430 EVs, Barbados is a forerunner in EV penetration in the CARICOM region, which goes hand in hand with an extensive charging network of about 400 private EV chargers and 45 public chargers compared to approximately 40 gas stations on island⁴. Gas stations, however, can accommodate more cars to refuel and fuelling times are shorter compared to charging times. Other islands reporting EVs in operation include Antigua & Barbuda, the Bahamas, Belize, Dominica, Grenada, Jamaica, Saint Lucia, Saint Vincent and the Grenadines, and Trinidad & Tobago, although in much lower numbers.

When planning for and setting up a network of charging stations, the most suitable locations and their accessibility must be considered while anticipating future mobility changes. A multi-stakeholder approach should be applied to capture all relevant actors ranging from energy, mobility and infrastructure enterprises, to policymakers, regulators and urban planners; possibly transforming their roles and the appearance of the changing market.

Infrastructure planning needs to be closely linked with electric network planning in order to assess the preparedness of the existing electricity grid for the additional load, the integration of renewable energy sources and electricity storage options at the point of installation associated with electric mobility charging.

Further, policy, legislation and regulation need to be appropriate to govern the setting-up and operation of a charging infrastructure, standards to facilitate the inter-operability of various types of charging infrastructure, the tariffs charged to consumers, as well as the collection, management and protection of data that is produced every time a vehicle is charged.

Attractive Market Conditions

World leaders in electric mobility use a variety of policy measures to support the uptake of EVs; typically starting from the establishment of e-mobility targets, followed by the adoption of vehicle and charging standards and an EV deployment plan. Support measures range from fuel economy standards and incentives for zero and low-emission vehicles, to fiscal and economic instruments bridging the cost gap between electric and conventional vehicles; and policies to facilitate the deployment of charging infrastructure. Existing good practice examples would require adaptation to the Caribbean context and market specificities. Policies and market

⁴ Megapower, Caribbean Renewable Energy Forum 2019

frameworks must ensure that e-mobility can play an active role in enhancing the flexibility of power systems.

Progressive rate structures like time-of-use tariffs could encourage drivers to charge vehicles during daytime hours, utilising renewable energy generation resources with energy storage, and with the introduction of enhanced grid management. Strategically located solar charging stations can help to ensure that EVs draw primarily from renewable sources rather than conventional power plants.ⁱⁱ

Government Tax Revenue and E-mobility

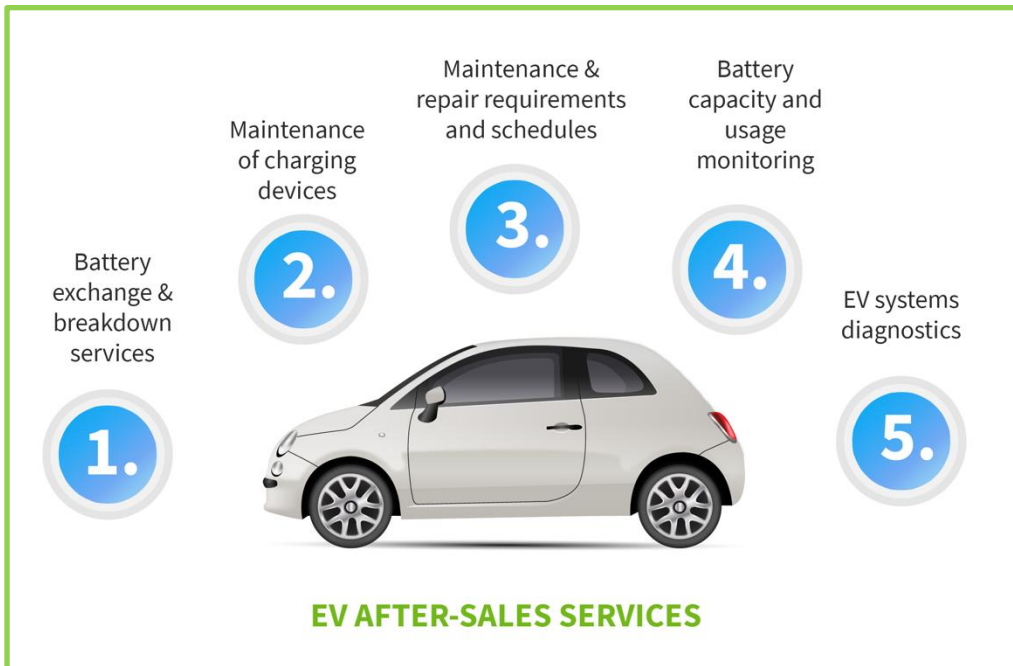
Losses or reduction in the tax revenue derived from vehicle and fuel taxes are a major concern for governments when transitioning to an electrified transportation sector. The balance, however, is often only considered between foreign exchange spending on fossil fuel imports and government revenues from vehicle related duties and taxes - without factoring in the substantial health and environmental costs of conventional vehicles to society. Gradually increasing taxes on carbon-intensive fuels, combined with distance-based charges⁵ are among possible measures to support the long-term transition to zero-emission mobility and congestion reduction, while maintaining revenue from transportation related taxes⁶. The fiscal impact of a higher EV penetration requires more in-depth analysis to develop appropriate solutions for the Caribbean context that maintain government revenues from the transport sector to recover infrastructure costs, reflect the costs of pollution and congestions, while taking social implications into account.

Adaptation of Services

The e-mobility transition will also require new and adapted services along the whole vehicle value chain. Car dealerships need to adapt warranty conditions to appropriately capture electrical and non-electrical parts of a vehicle. After-sales services will therefore need to consider the following: 1) accommodate for battery exchange and breakdown services; 2) establish different maintenance and repair requirements, and schedules for the electric powertrain; 3) maintenance of charging devices; 4) monitoring of battery capacity and usage; 5) monitor and report on EV systems diagnostics.

⁵ A distance-based charging system would charge per kilometre driven, instead of providing unlimited access to the road network (via a vignette or other verification system); distance-based charging is introduced to charge for costs imposed by vehicles, including road use, insurance, pollution emissions, and other environmental impacts.

⁶ IEA Global EV Outlook 2019



Mechanics and first responders should also be trained in the specifics of EVs, and service stations and vehicle maintenance workshops may have to be retrofitted to repair or service EVs. Insurance companies in many cases lack the necessary knowledge about electric vehicles, or are hesitant to offer appropriate insurance products, which requires active efforts in awareness raising, information provision and training.

Ensuring Market Uptake

Apart from economic incentives and other policy measures that increase the value proposition of EVs (such as lower toll or parking fees, waivers to access restrictions, use of priority lanes etc.), consumer and industry awareness about the benefits, challenges and opportunities of electric vehicles have to be improved to enable a stronger uptake of EVs.

Prevailing market structures can cause information deficits and market transparency issues that make it difficult for consumers to make informed purchase decisions. Consumers may not be informed enough to consider the total cost of ownership instead of higher upfront investment costs of EVs or mitigate concerns and preconceptions like range anxiety⁷.

Besides targeted information campaigns, the deployment of an extensive charging network and technological innovations like accurate navigation and range prediction systems, the continued

⁷ Range anxiety refers to the fear that a vehicle has insufficient range to reach its destination and would thus strand its occupants; it is considered one of the most significant barriers for large-scale adoption of electric vehicles.

development of higher battery capacity at cost-effective prices or the introduction of battery swapping services will gradually alleviate range anxiety.

Among the known factors which dissuade Caribbean consumers from choosing EVs over ICE vehicles, are range anxiety and high upfront costs. However, consumers are very seldomly privy to all the necessary information to equip them to make informed decisions about purchasing EVs. Several global studies⁸ suggest a lower total cost of ownership⁹ (TCO) for EVs compared to conventional models in different markets, which also includes cost considerations for the investment in a replacement battery before its expected end of life.



Nonetheless, this information is not readily available to potential EV buyers and is thus not considered in the purchase decision. Without these important considerations, purchasing and owning an EV is often perceived as a 'rich man's hobby'. Targeted consumer information campaigns and efforts from the automotive industry and local markets, are essential to influence the availability of competitively accessible and aesthetically desirable EVs. Increased availability of affordable and attractively designed EVs maybe helpful in encouraging a higher penetration into the EV market, for consumers who are motivated not by environmental awareness but rather by the comfort of owning a personal vehicle.

⁸ e.g. Palmer, K., Tateb, J. E., Wadudc, Z. et al. (2018). Total cost of ownership and market share for hybrid and electric vehicles in the UK, US and Japan. *Applied Energy*, 209: 108-119;

⁹ TCO including motor vehicle depreciation, registration, fuel, insurance, maintenance and financing costs (with interest)

2. ENHANCED CONNECTIVITY & DIGITALISATION



At the beginning of Industry 4.0¹⁰ and the emergence of the ‘Internet of Things’, vehicles, infrastructure and users are becoming increasingly digitalised and connected. Enhanced connectivity and digitalisation enable interactions within vehicles, between vehicles and infrastructure as well as across transportation networks, allowing users to manage their smart vehicles, homes and appliances remotely, and enabling EVs to provide flexibility services to the power system.

Vehicle to Grid (V2G) technology allows EVs to serve as distributed storage assets and flexible capacity, which facilitate the integration of higher shares of renewable energy into the grid by managing and stabilizing power output during periods of power output intermittency created by variable renewable energy sources like solar or wind power. When aggregated and connected to the grid, EVs can collectively mimic a fast-responding backup generator¹¹. These ancillary services could help utilities (or grid operators) maintain grid stability by optimising charging for demand response, and better manage the integration of EV charging loads and distributed generation onto the grid, while generating revenue for vehicle owners. Nonetheless, the provision of these services might negatively affect vehicle battery performance and lifespan, which requires further assessment. Utility business models and planning processes will have to be adapted to appropriately capture the ancillary services provided by EVs, to account for and manage additional loads; and to appropriately mine and utilize data for measurement and verification.

Enhanced interconnectivity and digitalisation create a wealth of data. This requires secure data collection, processing and management. Ensuring data protection and cyber security is very important for EV industry development; however, in order to appropriately capturing the value of this data, legal and regulatory frameworks will have to govern the following: 1) who has access to the data and when 2) who can process which data and develop intelligence based on big datasets; and 3) who will benefit from the respective datasets and intelligence products.

¹⁰ Industry 4.0 or the “Fourth Industrial Revolution” refers to an era where technological advancements are revolutionizing industrial production, where automation of manufacturing processes is upgraded with smart autonomous systems that are capable of self-cognition, self-optimization and self-customisation. Industry 4.0 is expected to affect all sectors and disciplines, with particularly strong impact on developing countries, where substantial changes in education systems are required to award the necessary skills in literacy, numeracy and digitalisation (UNIDO, Industry 4.0, the opportunities behind the challenge, 2018).

¹¹ World Economic Forum, Electric Vehicles for Smarter Cities: The Future of Energy and Mobility, 2018 (WEF, 2018)



3. TRANSPORT DEMAND MANAGEMENT



The switch from conventional to electric vehicles will not singlehandedly achieve the desired mobility revolution and reap the full benefits of EVs. Transport demand management aims to reduce and redistribute transport demand in space and time, through the application of policies and strategies. Some related interventions include improving urban planning, enhancing the public transportation system, expanding the pedestrian and bicycle infrastructure and introducing parking management. These measures hold the potential to substantially mitigate existing mobility challenges in the Caribbean, including high rates of congestion, traffic accidents and pollution, and should be considered in parallel to the deployment of EVs. Intelligent transportation systems can provide innovative services for different modes of transport and traffic management that will enable users to be better informed, and make the transportation system smarter, safer and more coordinated across the networks. Technology examples include

automatic road (speed) enforcement, dynamic traffic light sequencing, collision avoidance systems or emergency vehicle notification systems.

Car manufacturers and tech companies are exploring disrupting current transportation systems and modes from a different angle: Replacing ICEs, human control and private car ownership with shared, electric and autonomous vehicles. Autonomously driven vehicles hold the promise of higher fuel efficiency by optimising the drive cycle¹², improving traffic flow and reducing road accidents and fatalities. They could also provide better access to mobility for elderly or disabled people. However, while their convenience could alleviate critical transportation problems for some, it might simultaneously contribute to an increase in car travels.

Autonomous driving, whether considered the future prediction of big data enthusiasts, or the optimistic aspirations of the automotive industry, is presently experiencing pivotal advances at scale in many parts of the world, with the evolution of adaptive cruise control and assisted driving, among other technologies.

Policy, legal and regulatory frameworks will eventually have to address when and where autonomous vehicles can be integrated into urban road networks through transport planning and management. Also, consideration should be given to how they will co-exist with pedestrians, cyclists and other road users, whether their operation requires special licenses or permits; and how they are interconnected with smart city networks. Besides the technical challenges of improving the perception system¹³ and decision-making capabilities to allow for a widespread use of these vehicles, the legal framework has to govern liability in case of accidents, but also data management and security issues related to vehicle communication systems. Similarly, as with electric vehicles, adaptations in the delivery of services will be required, ranging from warranties, to maintenance and insurance regimes.

About CCREEE

The [Caribbean Centre for Renewable Energy and Energy Efficiency](#) (CCREEE) is an institution of CARICOM, established in the framework of the Global Network of Regional Sustainable Energy Centres (i.e. the GN-SEC) and its sub-network for small island developing states (SIDS) in Africa, the Caribbean, the Indian Ocean and the Pacific. The CCREEE is the implementation hub for

¹² A **driving cycle** is a series of data points representing the speed of a vehicle versus time. **Driving cycles** are produced by different countries and organizations to assess the performance of vehicles in various ways, as for example fuel consumption and polluting emissions.

¹³ Perception systems using cameras, radar, lidar, electronic maps etc. to identify objects and understand how to circumvent them or how to react to a certain situation;

sustainable energy activities and projects within the CARICOM region, having been operationalised with the signing and ratification of the CCREEE legal agreement in May 2018.

The CCREEE has a clear vision, mission and mandate which are fully aligned with the CARICOM's vision, mission and core values:

“A Caribbean Community that is integrated, inclusive and resilient; driven by knowledge, excellence, innovation and productivity; a Community where every citizen is secure and has the opportunity to realise his or her potential with guaranteed human rights and social justice; and contributes to, and shares in, its economic, social and cultural prosperity; a Community which is a unified and competitive force in the global arena”.

The CCREEE aims at improving access to modern, affordable and reliable energy services, energy security and mitigation of negative externalities of the energy system (e.g. local pollution and GHG emissions) by promoting renewable energy and energy efficiency investments, markets and industries in the Caribbean. Sustainable Transportation is one of the core Strategic Programmes of the CCREEE Strategic Plan 2019-2023. The programme will contribute to the implementation of the Regional Electric Vehicle Strategy and aims at improving the efficiency of transport while reducing CO2 emissions and adverse environmental impacts of transportation.

ⁱ 2017 Energy Report Card CARICOM <https://energy.caricom.org/reports-2/>

ⁱⁱ <https://blogs.iadb.org/energia/en/mobilizing-the-future-of-transportation-in-the-caribbean/>