The Potential of Electric-Mobility in CARICOM Member States

A GIZ STUDY

CHARLIN BODLEY

Table of Contents

List of figures

List of Tables

Abbreviations

RE	*Renewable Energy*
EV	*Electric Vehicles*
HEV	*Hybrid Electric Vehicles*
NEP	*National Energy Policy*
PHEV	*Plug-in Hybrid Vehicle*
EE	*Energy Efficiency*
RFID	*Radio Frequency Identification*
ICE	*Internal Combustion Engine*
SIDS	*Small Island Developing States*
GIZ	*German International Development Cooperation*
CARICOM	*Caribbean Community*
OLADE	*Latin American Energy Organization*

1 BACKGROUND

The transportation sector within the Caribbean region has a significant impact on all sectors of both domestic and regional economies. While the transport sector is responsible for 25% of the global primary energy consumption[1], in most CARICOM member states transportation accounts for a share of total energy consumption which far exceeds that of the global average. While more sustainable transport sector measures provide an opportunity to reduce greenhouse gas (GHG) emissions, air pollutants and even noise pollution, increased energy security and decreased imports of fuel can be anticipated in the Caribbean region, thus reducing its vulnerability to the vagaries of the international oil markets. Electric mobility is one option which provides opportunity to reduce these negative effects particularly if the electricity supply is generated from indigenous renewable energy sources.

While studies have been done on the potential of an electric mobility transition in many regions of the world, the potential of integrating large-scale electric transportation into both energy and transportation systems in Caribbean islands is unknown. Categorized as Small Island Developing States (SIDS) the Caribbean islands are vulnerable to the effects of climate change. While the last few decades have seen remarkable efforts in climate change mitigation actions such as the deployment of renewable energy and energy efficiency measures to reducing the carbon footprint in the region, extensive focus has not been given to the transport sector. Considering the anticipated favourable conditions such as comparatively short distances and proven high potential for renewable energy, the potential of electric mobility in the region will be investigated.

Activities and studies relating to electric mobility have been widely done in other regions of the world particularly in China, by the German International Development Cooperation (GIZ). Other regions will now be the target of investigation by the GIZ. One geographic grouping to be considered is SIDS. Therefore this report includes the results of a brief study of the potential of electric mobility in the Caribbean. The representative focus group considered through the study includes the fifteen (15) member states of the Caribbean Community (CARICOM).

2 INTRODUCTION

In many CARICOM member states transportation accounts for a share of end use energy consumption, of above 40% when considering all states for which this data is available. Saint Lucia records the highest known value of 63%. *(See Figure 1)* This provides proof of the opportunities

for significantly reducing GHG emissions through the deployment of more sustainable and energy efficient modes of transportation.

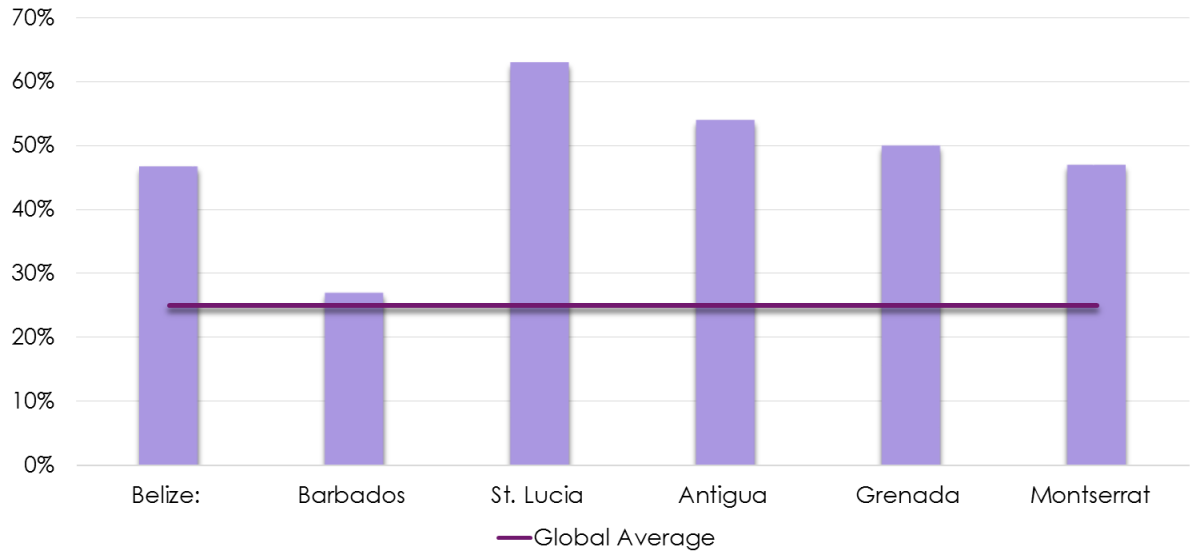

Figure 1: Share of end use energy consumption by transport sector in select CARICOM member states
Source: Elaborated with data from country National Energy Policies (NEP(s)), OLADE 2012

It is noteworthy that when compared to industrialized countries such as China, the Caribbean region does not contribute significantly to global GHG emissions. None the less, the islands remain dedicated to lowering their emissions as can be gleaned from various targets and policies implemented, discussed in this report. Moreover, as do most SIDS, the Caribbean islands are incentivized more and more to tackle energy consumption in the transport sector, in order to become less dependent on imported fossil fuels. This is even more attractive when considering that the Caribbean, due to its location and the formation of the islands, has a significant potential for renewable energy sources such as wind, solar, geothermal, biomass and waste to energy. This provides major opportunities for developing the electric vehicles (EVs) market in the region, thus reducing emissions and increasing energy independence and security. It is, however, essential to first determine the potential for integrating electric transportation into both transport and energy systems.

While some islands such as Barbados have already achieved a significant penetration of EVs many other islands have no recorded penetration of EVs into the transport markets. It is therefore essential to assess the current situation and analyse the drivers, opportunities and challenges for electric mobility in the region. It is further useful to determine application areas for the varying fleets available in varying modes of transportation. The potential of electric mobility integration is therefore considered for air, road, maritime and rail transportation.

The plans of member states to increase their share of renewable energy for power generation provide more incentive for the electrification of the transportation sector. Powering electric vehicles with electricity generated from renewable energy sources, means a higher level of reduction of GHG emissions, in tandem with an increased level of energy security and independence. CARICOM member states are estimated to have an aggregated potential for renewable energy of 21 GW from hydro, wind, solar, geothermal, biomass and waste to energy. [2]

Electric transportation, due to its immaturity and constant technological development, can be viewed as a transformative industry. This industry is however, faced with a suite of developmental challenges and opportunities. Despite the infancy of the market as a mainstream one, it is adequately poised to transform the Caribbean, contributing significantly to its sustainable development. It is consequently of ultimate importance to assess the potential evolution of the market in the Caribbean.

3 ELECTRIC MOBILITY IN CARIBBEAN ISLANDS

3.1 Current situation

While some member states have tapped into the developing EV markets, electric transportation remains inaugural in several member states. In few countries the EV market still remains untrodden as indicated by a lack of policy and absence of EVs and charging infrastructure in operation. *Table 1* summarizes the current status of EVs and its penetration in member states. Jamaica and Haiti have been omitted due to unresponsiveness of questionnaires, and telephone interviews and in part due to the unavailability of secondary data.

Table 1: Current status of EVs in CARICOM member states

Country	EVs in Operation	Year Introduced	No. of Charging Stations	Clean Transport Policy	Policy Related to EVs
Antigua & Barbuda	8	2016	3 residential	In develop-ment	×
Bahamas	~ 12*	2016*	2*	-	-
Barbados	180	2013	43 public, 175 private, 40 business, 4 public rapid chargers	Drafted	✓
Belize	1	2017	0	Suggested	×
Dominica	1	2016	0	Drafted	✓
Grenada	6	2012	2 public 2 residential	None	✓
Guyana	0	N/A	0	None	×
Jamaica	5	2016	1	In develop-ment	✓
Montserrat	0	N/A	0	None	✓
Saint Lucia	7	2013	0	Suggested	✓
St. Kitts & Nevis	0	N/A	0	In develop-ment	×
St. Vincent & the Grenadines	2	2015	1	None	×
Suriname	0	N/A	0	None	×
Trinidad & Tobago	4	-	1	suggested	×

*Information for Bahamas is only given for Nassau by a private sector source
✓ Indicates the existence of EV related policy
× Indicates the non-existence of EV related policy
- Indicates the unavailability of data

Barbados stands out as having achieved a higher penetration of the EV market than any other member state. It is worth noting that this is primarily driven by the private sector. Megapower is the company reported as being responsible for the development of the EV market in Barbados and has single-handedly managed the importation of electric vehicles, creating the entire island-wide charging network. *SIDE BAR 1* summarizes the success story of the integration of EVs in road transport systems in Barbados.

SIDE BAR 1: EVs IN BARBADOS; The Proof of Success

A successful introduction of electric vehicles to Barbados, evident from its population of 180 EVs and extensive charging network could prove to be a testimony of the viability of EV integration in similar islands in the region. The perceived technical limitations such as limited range have also been dismissed due to both new advances and a reliable charging network. The new 30kWh battery contained Nissan Leaf boasts of a range of 250 km/full charge; a range reported as being well above average daily driving distances in Barbados and similar islands.

The collaborative efforts in the development of the charging network in Barbados stands out as a key and essential element in the success of the EV integration. This required coordination with business owners to install public chargers in carparks such as supermarkets and shopping complexes, as well as persons in the residential sector to install personal home chargers. Further enhancing the charging network required the introduction of an RFID card for customers to charge their cars at any of the island wide chargers. This consists of a personal card that can be pre-loaded with money and used as and when needed. Recent advancements include the introduction of four (initially) rapid chargers capable of a 0%-80% charge in 25 minutes.

Renewable energy is incorporated in charging infrastructure, by means of harnessing solar energy to produce electricity at many charging stations.

Sources:

Interview with Simon Richards, CEO Megapower, Barbados

(Megapower , 2017) http://www.megapower365.com/ev-barbados

3.2 EV Related Targets and Interventions

Countries which signed the United Nations Framework Convention on Climate Change, aimed at reduction in greenhouse gases, have published their *Intended National Determined Contributions* (INDCs). Under the Paris agreement and on the occasion of ratification by member countries, the INDCs will become the first nationally determined commitments (NDCs), serving as GHG emission targets applied to both developed and developing countries. The NDCs therefore serve as the most recent communicated intentions of CARICOM member states which may include commitments to reductions of emissions in the transport sector. Moreover specifically, interventions related to electric transportation have been highlighted in *Table 2.*

Table 2: INDC GHG reduction targets and EV related targets

Country	GHG reduction commitments & targets	Transport sector specific targets	E-Mobility interventions
Antigua & Barbuda	Conditional and unconditional policies, measures and actions (Non-target)		• Support for HEVs, flex-fuel for EVs as national targets. • Efficiency standards for the importation of all vehicles.
Bahamas	30% by 2030		Interventions to discourage importation of inefficient motor vehicles by *inter alia* lowering import duties on EVs
Barbados	37% by 2025 44% by 2030 (Baseline:2008)	29% reduction in non-electric energy consumption (including transport) by 2029	GOB investments in alternative vehicles and fuels including HEVs & EVs and encouraging their adoption through tax incentives.
Belize		20% reduction in conventional transportation fuel use by 2033	Lower energy intensities across key economic sectors including transport.
Dominica	44.7% by 2030	16.9% reduction in GHG transport sector	Introduction of (i) policy to facilitate all scheduled government vehicle replacements by HEVs; (ii) market based mechanisms to motivate the private sector to buy HEVs & promote import of hybrids.
Grenada	30% by 2025 40% by 2030	20% reduction emissions in transport sector by 2025	Disincentives (taxes) for diesel and gasoline, incentives for fuel efficiency standards.
Haiti	Unconditional:5% by 2030 Conditional: 26% by 2030		Develop and implement transport NAMAs (Conditional)
Jamaica	10% below BAU by 2030 Baseline: 2005 (Conditional)		Expansion of energy efficiency initiatives in the transportation sectors, in line with sector action plans
Saint Lucia	16% by 2025 23% by 2030 Economy-wide Baseline 2010		• Improved/expanded public transit • Reduction of excise tax and duties on fuel efficient vehicles. • Proposed development of transport policy and strategy
St. Kitts & Nevis	22% by 2025 35% by 2030	Reduce at least 5% of national fuel consumption	More efficient transportation
St. Vincent & the Grenadines	22% by 2025		• New policies to reduce the import duty paid on low emission vehicles. • International support for a transport sector NAMA will be sought
Suriname	Forests and RE are only sectors covered	N/A	N/A
Trinidad & Tobago	15% by 2030 across 3 sectors (power generation, transport, industrial)	30% by 2030 in public transport sector (unconditional)	

All percentages refer to a percentage reduction; NAMA refers to National Appropriate Mitigation Actions; Guyana and Monserrat have been omitted due to unavailability of NDC documents

Source: Published INDC document reports for each member state

In addition to the NDCs communicated by member states, other national plans, strategies and policy relating to EVs have been investigated. The novelty of the EV market in the Caribbean is apparent when considering the first year of introduction of EVs and the low numbers of EVs in the majority of member states for which data is presented. A number of member states have incentives put in place to encourage the up-take of EVs. The majority of member states have alluded to the support for EVs in the NEPs some of which remain in the draft stage. Further details are provided in *Table 3*.

Table 3: Other national plans, strategies and incentives for EVs

Country	Incentives For EVs	National Plans/ Strategies/Initiatives	Policy Related To EVs
Antigua & Barbuda	Waiver of duty and environmental levy for EVs and Hybrids	×	Support of HEVs, flex-fuel or EVs. Government shall explore the feasibility of introducing EVs into its fleet.
Bahamas	Reduction of import duties to 25% compared to ICE vehicles (≥ 65%)	×	Discourage the importation of inefficient motor vehicles through tax regime & lowering import duties on HEVs & EVs.
Barbados	17% reduction in import duties compared to ICE vehicles	×	Customs and fiscal policies for providing incentives to private vehicle buyers to purchase fuel efficient vehicles including EVs. Development of alternative fuelling infrastructure-to include stations for EVs (provided that solutions are cost-benefit justified)
Belize	×	×	Instigate change-over to more energy efficient and environmentally friendly vehicles and modes of transport
Dominica	×	Conduct cost benefit analyses to estimate economic impact of alternative vehicles (Including EVs) and supporting infrastructure	Studying the feasibility of integrating EVs into the transport sector. (Draft)
Grenada	Concessions on domestic duties relative to RE & EE technology	×	Create appropriate tax regime to encourage importation of fuel efficient vehicles and development of supporting infrastructure. Consider introduction of mandatory annual quotas for dealers regarding HEVs, EVs and other efficient vehicles
Guyana	Reduction of excise tax on HEV & EVs.	Climate (TNA) includes Introduction of EVs & HEVs as recommended technology options	Foster the development of EV industry to substitute fossil fuels with electricity while enhancing

	Granting of tax exemptions to set up EV charging stations		the ability of the electric grid to integrate high levels of intermittent RE. (Draft)
Jamaica	Import duty reductions for both individuals and dealers *(See Annex for details)*	Utility company initiative pilot study and plans for charging station expansion.	Discourage importation of inefficient motor vehicles
Montserrat	×	EV Trial Programme	1. Promote the development of EVs, HEVs, and advanced vehicle technologies. 2. Facilitate public awareness campaigns to promote efficient transportation 3. Investigate potential for using RE in the ferry system in Montserrat
Saint Lucia	25% reduction in import duties	Fleet Transition roadmap developed for transition of the government fleet to EVs, HEVs or PHEVs	Introduce tax systems to promote the purchase of more energy-economical vehicles, including new generation of HEVs and EVs.
St. Kitts & Nevis	×	×	×
St. Vincent & the Grenadines	×	EV demonstration project	Study the potential for introducing EVs & HEVs. Government can introduce EVs into its own fleet.
Suriname	×	×	×
Trinidad & Tobago	Zero rated Import Duty, Motor Vehicle Tax and Vat for EVs ≤179 kilowatts, < 4 yrs	University training programme on the installation of EV charging stations	×

TNA refers to 'Technology needs assessment'
Data sources include NEPs for member states, and information gathered from Energy Units

The lack of public awareness related to electric mobility, as discussed further, has been cited as a major barrier to EV integration in the region. The current status of public awareness was determined by investigating the existence of related and active campaigns in the region, identifying by which entity the campaigns are driven. The summary provided in *Table 4* bears witness to the inadequacy of existing EV public awareness campaigns in the Caribbean.

Table 4: Active EV awareness programmes

Country	Active Awareness Programmes	Implementing Agency
Antigua & Barbuda	✓	Private sector
Barbados	✓	Private sector
Belize	×	
Dominica	✓	Utility
Grenada	✓	Utility/ Private Sector
Guyana	✓	GIZ
Jamaica	✓	Private sector
Montserrat	×	
Saint Lucia	×	

St. Kitts and Nevis	×	
St. Vincent and the Grenadines	✓	Government
Suriname	×	
Trinidad and Tobago	×	

Source: Energy units in member states

4 INTEGRATION OF ELECTRIC MOBILITY INTO TRANSPORT & ENERGY SYSTEMS

4.1 Drivers for E-mobility Integration

In the context of the classification of SIDS, the drivers which dominate a transition from current mobility models under different application areas are high cost of import fuel, commitments to combatting global warming through the implementation of mitigation actions as well as increases in demand for mobility needs. However it is clear that in a region which records a comparatively low penetration of electric transportation, technological changes and political influences are key enablers for the aforementioned ecological and economical drivers depicted in *Figure 2.*

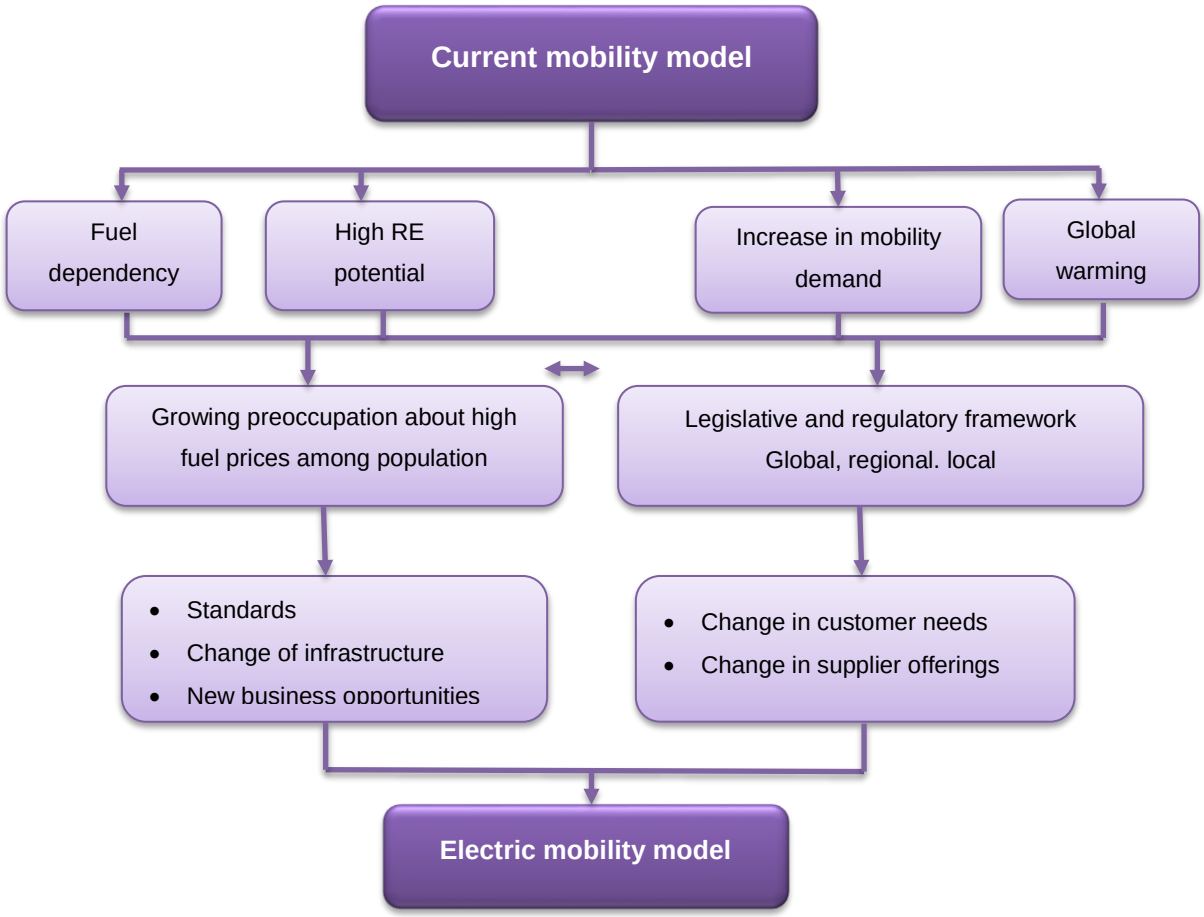

Figure 2: Drivers for transforming the current mobility model to an electric mobility model

Source: (Own research)

4.2 Application areas and market segments

Economic activity in member states are highly dependent on the transport sector. Eleven (11) out of fifteen (15) member states are characterized by an active tourism industry[3]. Other industries include but are not limited to light manufacturing, food processing, agriculture clothing and textiles. These main activities determine the application areas for mobility and market segments for a transition to electric mobility. The tourism sector for example depends highly on air and sea travel; both international and inter-island travel. Road transportation also records significant relevance in the areas of economic and social development. Functional rail systems only exist at present in three (3) member states, St. Kitts and Nevis, Jamaica and Suriname, and the development of rail systems is not anticipated for the remaining member states.

4.2.1 Road transport

Recent years have seen increases in the number of vehicles in member states. Due to a lack of data availability, it was impossible to determine the fleet composition for most countries. Alternative information is presented to paint a basic picture of the road transport fleets in the region. The World Health Organization (WHO) reported an increase in the number of vehicles on the small island of Grenada of at least 30, 000 vehicles between the 2006 and 2010. This is a significant increase for an estimated population of roughly 111, 764 in 2010[4]. There were approximately 23,500 registered vehicles in Dominica in 2011. An estimated 25% of registered vehicles were cars, 30% SUVs, 35% pickups, and the remainder were buses and heavy trucks. On average 300-350 new vehicles are sold per annum, while about 600 second-hand cars are imported annually, the average age being between 5-12 years old. In the tourism sector, approximately 70% of public taxis are 13-seater mini buses.[5] In 2009 it was estimated that the number of vehicles in St. Vincent and the Grenadines would increase at a rate of 2% per annum[6].

Road transportation fleets in the Caribbean include private vehicles, business vehicle fleets, government owned fleets and public transportation fleets comprising primarily of buses, all of which can collectively be classified as cars and four wheeled light vehicles, motorized two wheelers, lorries and trucks, buses and heavy equipment. Complete and reliable data sets for fleet compositions were made available for only two (2) member states including St. Kitts and Nevis and Guyana, the former being a smaller Caribbean island while the latter is a larger Caribbean territory. *Figure 3* and *Figure 4* show the respective fleet compositions in the two aforementioned territories.

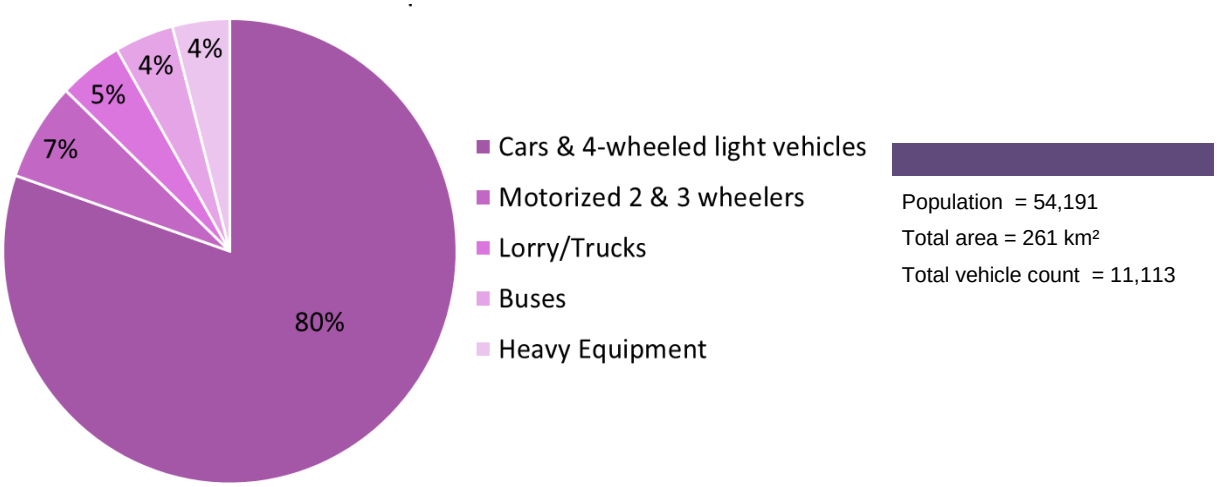

Figure 3: Vehicle Fleet Composition, St. Kitts & Nevis
Source: Government of St. Kitts & Nevis (2017)

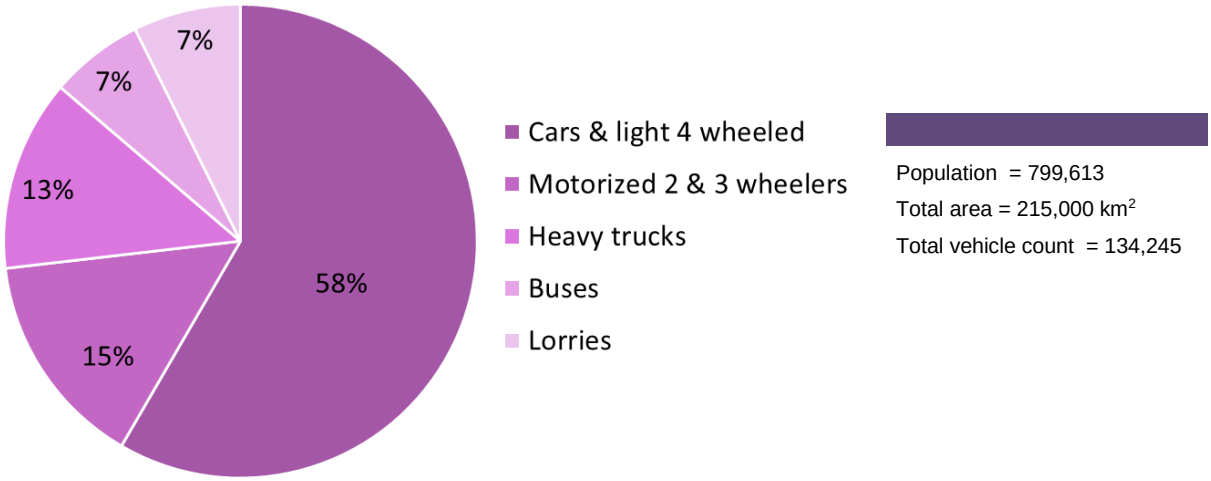

Figure 4: Vehicle Fleet Composition, Guyana
Source: Guyana Energy Agency (2017)

It is assumed that the shorter driving distances in smaller islands may influence the use of private vehicles, many of which fall into the category of cars and 4-wheeled light vehicles, causing its share to be higher and resulting in a lower percentage of public buses. It is also important to note that the travelling distances even for Guyana as a comparatively larger land mass in the Caribbean make for a feasible transition to EVs at first glance. Even in the case of the highest typical travelling distance being from buses with 150 km, is a transition to EV technically feasible. The latest electric bus technology provides an impressive range of 560 km on a single charge and could easily replace the current ICE buses used in Guyana and other Caribbean countries.

Table 5: Typical travelling distances in Guyana	
Vehicle classification	**Typical travelling distance / route**
Cars & light 4 wheeled	75 km
Motorized 2 & 3 wheelers	35 km
Heavy trucks	50 km
Buses	150 km
Lorries	75 km

Source: Guyana Energy Agency (2017)

Road transport is thought to have the most potential out of the various modes of transportation in member states when considering the integration of electric mobility. Electric road vehicle technologies are mature and are available commercially. Moreover, advancements in battery technology continue to evolve rapidly to improve range and performance, making road EVs more competitive. Rail transportation is not popular among SIDS and electric mobility technologies for air and sea transport remain in infancy stages. Application areas for road electric mobility can therefore be listed as follows:

1. **GOVERNMENT AND MUNICIPAL FLEETS:**

   Electrifying all or part of the existing government and municipal fleets, or opting for EVs for future replacement vehicles, executed in tandem with the necessary policy change may offer a higher level of opportunity and preparation for other application areas. Should this transition be driven by CARICOM governments it presents opportunity for the governments to lead by example and have first-hand experience to inform the effective development of related EV policy. Motorized two and three wheelers could be of particular interest as they are normally used for short distance travel, and have lower charging requirements. Government and municipal fleets may fall into the following categories, which may be prioritized for fleet transition:

   I. Law enforcement vehicles
   II. Postal service vehicles
   III. Fire and emergency vehicles
   IV. Public works vehicles
   V. Vehicles for administrative purposes

2. **PRIVATE VEHICLE FLEETS:**

   The continuous import of inefficient fuel dependant and privately-owned vehicles to the member states coupled with unstable fuel prices, provides an opportunity to promote the EV market to private vehicle owners.

3. **BUSINESS FLEETS:**

Many international studies and a study on the economic impact of electric mobility transition in St. Vincent and the Grenadines[7] suggest fossil fuel savings are guaranteed and therefore could provide businesses with more disposable cash. One such example is the taxi industry which highly supports the tourist destinations among member states. Application areas include the following listed:

I. Taxi service vehicles
II. Car rentals
III. Commercial delivery vehicles
IV. Tour operator vehicles

Taxi, car rental and tour operator vehicles are compelling application areas particularly for small island member states with high dependency on the tourism sector. An added value anticipated is the opportunity to also market the islands as 'green' destinations.

4. **PUBLIC TRANSPORT FLEETS:**

A transition to electrified public bus system can benefit member states in a number of ways. Public transportation is widely used by the citizenry of member states. Territories, for example St. Lucia, have communicated their commitments to the development of more efficient and expanded public transport systems. This provides opportunity for intended expansions to be implemented using EVs. A more efficient and cost-effective public transport system could result in less private vehicles in operation which will reduce fuel consumption. An electric public transport fleet, once early implementation is achieved, may also provide visibility and encourage private and business fleets to transition. Buses in CARICOM member states complete routes much more often than private or commercial vehicles. This results in comparatively higher reduction in fuel consumption.

4.2.2 Maritime transport

Despite the existence of a number of international air and sea carriers which enable the transfer of tourists and goods into the Caribbean region, the movement of goods and people among Caribbean islands remains unreliable and costly, both in terms of money and time. These limited intra-regional transportation services consequently persist as a major constraint to achieving regional integration according to a study completed by (ECLAC, 2016) The study further highlighted the immense potential for maritime passenger transportation given the region's large maritime

space and high ratio of sea to land mass, providing an additional option for addressing the challenge of limited intra-regional transport, while at the same time promoting a sustainable economy. The principal marine transport users consist of shipping lines, fisher folk and persons engaged in recreational water sports. While the volume of fossil fuels consumed by marine users is considerably less than that consumed by ground transportation users, there are significant environmental concerns associated with emissions and the disposal of used fuel, which directly affects the marine environment. On the contrary, full electric-drive maritime vessels would eliminate the need for the disposal of fuel or potential spills into water bodies.

Electric ships and ferries are still not being deployed as mainstream technology. The world's first all-electric battery-powered ferry completed and put into operation in Norway in 2015, however, provides some insight into the possibilities for the application of electric power-train ferries in the region. *Side bar 2*, outlines the main operation information related to the ferry, named *'Ampere'.*

Side bar 2: Electric Ferry in Norway: "*Ampere*"

***DIMENSIONS OF FERRY**: 80m by 20m*
***CARRYING CAPACITY:** 360 passengers; 120 vehicles*
***POWERTRAIN:** All electric with two electric motors, 450 kilowatts output each*
***MATERIAL:** Aluminium instead of steel*
***RECHARGING:** 10 mins at turnaround times at the pier*
***ELECTRICITY CONSUMPTION:** 150 kilowatt-hours (kWh) per route (1 hour)*
***SAVINGS:** 30% reduction compared to ICE ferries*
Source: (Clean technica , 2015)

Assuming the continuous technological development of electric powertrain ferries into technically and economically viable mainstream technology, electrifying the maritime transport sector could be beneficial to member states. As a case in point maritime passenger transportation in member states have been considered and is summarized in *Table 6*. It must be however noted that potential exist with additional possible routes for example between Barbados and neighbouring islands such as St. Lucia and Trinidad and Tobago. More ferry services particularly fuelled by electricity could reduce on air travel requirements in the region. The high potential for solar energy in the region additionally creates opportunities for solar powered electric yachts, and other applicable sea vessels. Opportunity also exists with harnessing power from the wind to reduce fuel consumption in maritime vessels. Already existing in Barbados, this mature technology can be used to electrify sea transport in many if not all Caribbean territories.

Table 6: Regional and domestic passenger ferries in member states

Origin	Regional destination routes	Frequency of regional routes	No. of domestic routes
Antigua & Barbuda	Monserrat	1-2 times/day	2
Bahamas	Miami		>20
Barbados	N/A	N/A	0
Belize	Mexico Guatemala	Undetermined	6
Dominica	Martinique St. Lucia Guadeloupe	2-4 days per week	0
Grenada	St. Vincent	2 times/week	2
Guyana	Suriname	1/ day	N/A
Haiti	N/A	N/A	N/A
Jamaica	N/A	N/A	2
Montserrat	Antigua	1-2 times/day	0
Saint Lucia	*Dominica* *Martinique* *Guadeloupe*	2-4 days per week	0
St. Kitts and Nevis	N/A	N/A	7
St. Vincent & the Grenadines	Grenada (Carriacou)	2 times/week	3
Suriname	Guyana	1/day	
Trinidad and Tobago	N/A	N/A	1

Further studies which will permit data collection for both cargo and passenger maritime transportation are recommended. Despite the absence of this data, it can be recommended that ports and piers be equipped with a network of charging stations to facilitate a transition to electrified sea transport.

4.2.3 Air transport

Similarly to maritime transportation, the air transport market in the Caribbean is strongly shaped and influenced by the small and isolated nature and dependence on tourism of many countries in the region. An IDB report on air transport in the Caribbean region concluded that while the insularity and isolation of Caribbean islands forces a high seasonal volume mostly of inbound international air travel, inbound traffic is generally thought to be weak for most territories in the region. Until 2013, domestic and intra-Caribbean markets had experienced continuous capacity reductions, with an average annual combined decrease of 2.9% in passenger traffic. The same study notes a high level of liberalization with North American and European markets but the intra-Caribbean markets contrarily remain fairly regulated characterised by restrictive bilateral air service agreements. Air travel is also reported to suffer from low cost competitiveness. One major contribution to this is high jet fuel prices which are established as being 14% higher than world average.[8] Consequently high fuel prices contribute to making Caribbean territories a costly destination

to operate. However this provides opportunity for exploring options for decreased operation costs, which, provided the technology availability, could include electric air transport. At present commercial technology for air transport is unavailable and therefore electric mobility would not be recommended for immediate exploration as part of electrifying the Caribbean transport sector.

There is however opportunity resulting from the challenges associated with intra-Caribbean air transport. The development of sustainable maritime transport system among member states, including electric maritime transportation can assist in overcoming the barriers outlined with the air transport sector.

4.2.4 Rail

Little to no potential is anticipated for smaller island states, which are already hamstrung by competing and conflicting land use. However, electric rail transport systems could be a viable solution for addressing long-range travel in the region's larger islands or land-based countries. This also permits the reduction of GHG emissions associated with inefficient fossil fuel-run vehicles. In St. Kitts, a small island state is equipped with a 30 mile route consisting in 12 miles by sightseeing bus and 18 mile by double deck narrow gauge train[9]. Suriname records a total railway distance of 166 km. The total railway distance in Jamaica was undetermined.

4.3 Electric mobility integration supported by renewable energy systems

Each member state has set targets for renewable energy generation. Dominica, Nevis, Grenada and Monserrat have set targets as high as 100% renewable energy for electricity generation. Solar energy has been identified as a crucial sustainable energy solution for many application areas in the Caribbean region. All CARICOM member states possess strong solar energy potential making it a viable option for distributed electricity generation for charging of electric vehicles inclusive of charging of maritime transport at piers. *Table 7* shows the solar potential recorded for each member state.

Table 7: Potential of solar energy	
Country	**MW**
Antigua & Barbuda	27
Bahamas	60
Barbados	39.7
Belize	42
Dominica	45
Grenada	50
Guyana	575.8 million MWh/year
Haiti	1.7
Jamaica	650-1876
Montserrat	1.5
Saint Lucia	*36*
St. Kitts and Nevis	16
St. Vincent and the Grenadines	23
Suriname	N/A
Trinidad and Tobago	308

Source: (CARICOM, 2015)

4.4 Electric transport value chain

In order to determine the key stakeholders in the CARICOM region for large-scale dissemination of electric mobility, in particular for road transport, a broad glance at the expected value chain is necessary. From the marketing of imported EVs to the dissemination to the EV final user, determined by the application areas previously discussed, the main enablers include policy framework, proper financing options, maintenance services and sustainable electricity supply.

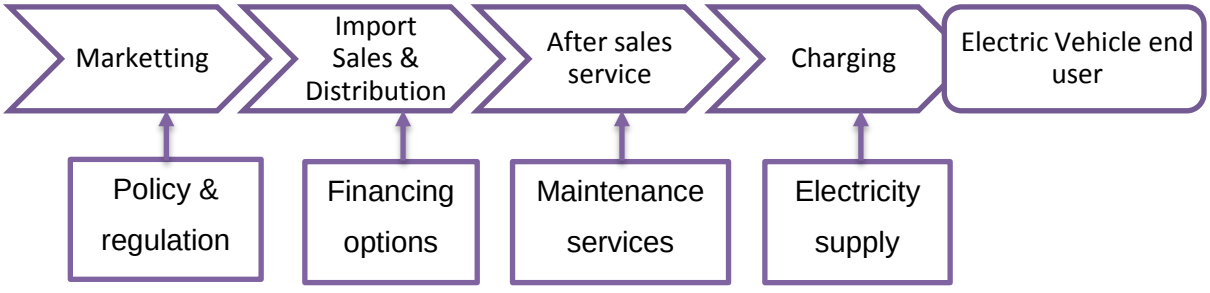

Figure 5: Value chain electric vehicles in CARICOM member states

Source: Author

4.5 Electric mobility integration: Business opportunities

It is important to determine possible revenue streams associated with the large-scale dissemination of electric mobility to determine the potential of its integration in both transport and energy systems. *Figure 6* shows a graphical summary of the products and services portfolio for the main service areas including the distribution of EVs, battery services, charging services, electricity provision, and other value added services. The main revenue stream for each classification of service is listed.

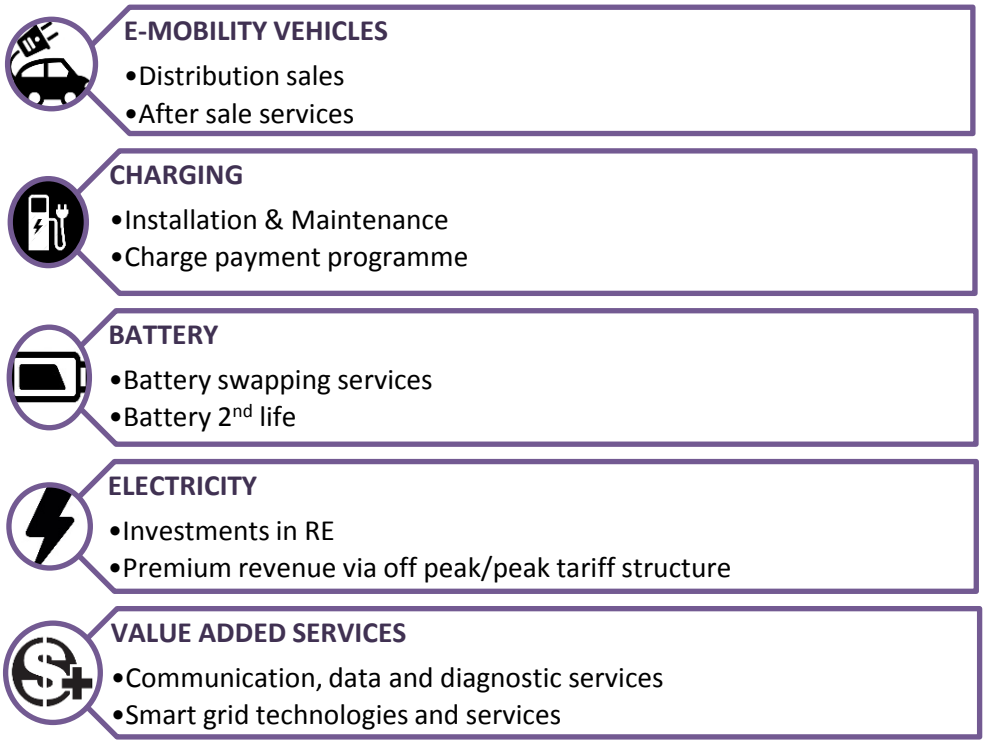

Figure 6: Products and services portfolio for E-mobility in CARICOM member states

Source: Own research

4.6 Key stakeholders

Emanating from the assessment of the value chain of EV dissemination and the resulting business opportunities, the key relevant stakeholders in the region are summarized in *Figure 7*.

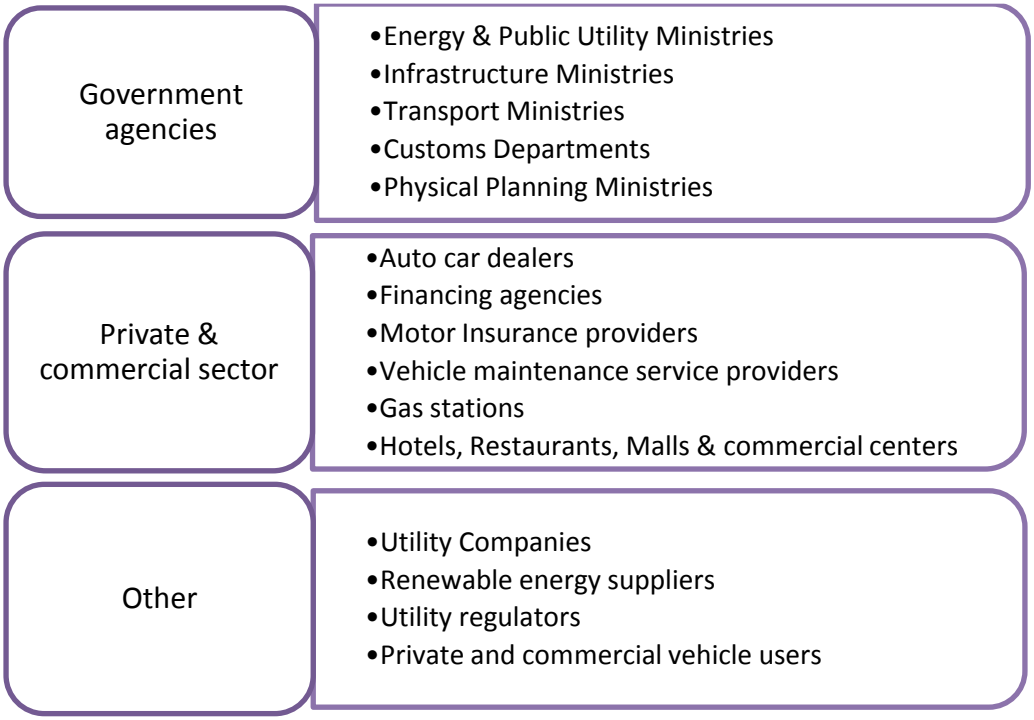

Figure 7: Key stakeholders
Source: Own research

The success of integrating large-scale electric mobility is very dependent on engaging relevant players at various stages in the process. Individual CARICOM governments are key stakeholders primarily because any related policy, mandates, targets, and market instruments such as tax incentives are led by government agencies. The private and commercial sector players, although relevant at different stages in the process, are very important for a robust transition. In the Caribbean context particular importance should be placed on financing agencies to facilitate attractive financing models for potential customers. Auto car dealers who will have a great influence on the market along with business opportunities for their benefit, have been identified as major stakeholders. Vehicle service and maintenance providers, gas station owners and operators, and commercial businesses with high volumes of clients are also key in the stage of after sales service. An adequate charging network requires that existing, but especially new buildings be equipped with charging infrastructure.

Utility companies remain at the forefront of the electricity supply for E-mobility. Utilities are also important stakeholders when considering the services of charging. Moreover, they are key players when renewable energy is explored for electricity supply. Closely linked are utility regulators who will be important in establishing or regulating charging tariffs and models for public charging services.

4.7 Factors which influence electric mobility integration in the region

4.7.1 Barriers

This study identified a number of barriers to the successful integration of E-mobility into existing transport and energy systems in member states. Barriers fall into four main categories; Policy, technology, financing and acceptance and include:

- Lack charging infrastructure
- High up-front purchase prices
- Relative low purchase price of ICE vehicles
- Absence of policy frameworks to support local EV market including appropriate incentives
- Lack of interest from local vehicle providers and/or the unwillingness of manufacturers to supply EVs to the region
- Lack of appropriate financing options (e.g. Leasing) particularly for business markets
- Unwillingness of some insurance companies to provide insurance packages for EVs
- Lack of fiscal incentives for EVs and disincentives for ICE vehicles
- Lack of capacity for maintenance and repair
- Lack of public awareness and education

4.7.2 Opportunities

Tipping the scale on the opposite end of the myriad of challenges are opportunities for EV market in the Caribbean region. Identifying the opportunities which exist provide a basis for bridging the gaps and overcoming the barriers. The opportunities identified by this study include:

- Unstable fuel prices
- Commitments to combating climate change both locally and internationally
- Advances in technology
- Relatively short travel distances within member countries
- Dire need for cost competitiveness in the tourism sector
- Renewable energy targets committed to by member states

5 BRIDGING THE GAPS: PRIORITY AREAS

5.1 Policy actions

With the majority of INDC targets set by member states to include more efficient transportation, policy actions toward the development of clean transport policy which encompasses electric mobility as a fuel alternative mode of transportation is undoubtedly a priority area. Transport policies and strategies in member states must recognize air, road, maritime and rail modes of transportation and should acknowledge realistic targets. Existing policies must be examined to assess other interventions geared towards achieving energy efficiency which may be conflicting with an EV transition, for example policy actions to encourage the deployment of alternative fuels including biofuel blends. Transition strategy for particular fleets such as government fleets and public transport fleets should be included.

5.2 Data Collection

Comprehensive transport strategies which would encompass electric mobility in the four modes of transport must rely on a robust data collection system which will facilitate feasibility and market studies in each member state. This should reflect accurate fleet composition, corresponding typical travelling distances and fuel consumption data. Research and data collection will also assist in informing policy decisions and establish legislation. Data-gathering efforts should strive to obtain exhaustive data on engine type, emissions quality, fleet age, and current levels of fuel efficiency. Moreover data collection will consider specific characteristics of individual member states. Larger islands and mainland countries such as Jamaica, Guyana and Suriname have more vehicles than smaller islands like Dominica, in addition to varying fleet compositions and average driving distances. These factors will affect the feasibility of large-scale integration of e-mobility in each member states.

5.3 Mandates and market instruments

Upfront costs of EVs remain a major limitation to its wide-spread adoption in member states. Adequate incentives which provide fiscal neutrality between incentives and revenue generated would therefore create an enabling environment for the integration of electric vehicles. A suite of options may be employed including import duty concessions, review of road tax conditions, tax and fiscal disincentives for conventional ICE vehicles. In Barbados for example, the road tax is dependent on the mass of vehicles resulting in higher road tax for electric vehicles[10].

5.4 Public charging infrastructure

One of the more commonly identified barriers among member states is the lack of timely development of public charging networks to support EV integration. Megapower, in Barbados attributes the success of the EV market in Barbados to the major investment (2.5 -3 Million USD)[11] made by the company for charging infrastructure island-wide. It is opined that the attempted introduction of EVs on other CARICOM islands saw an untimely death of the market because of a lack of parallel development of charging infrastructure. Stakeholder consultations will be especially important as the development of charging infrastructure can be driven by either the public sector, private sector or a collaboration between the two.

5.5 Integration of renewable energy

Already established is the increased life cycle reduction in GHG emissions when the electricity supply for electric mobility is generated from renewable energy. While most member countries have national targets for renewable energy, special attention should be paid to distributed RE generation for the charging of EVs.

5.6 Awareness and Education

Public awareness and education campaigns must be developed to tap into the potential of large-scale dissemination of EVs. Awareness strategies should seek to address, *inter alia*, matters of lifetime costs versus upfront costs of EVs and the perception of technical limitations and environmental benefits in the Caribbean context. All key stakeholders should be targeted for these campaigns.

5.7 Capacity building

Capacity building for many different groups of stakeholders should be considered, including maintenance and repair services personnel, car dealers, and ministry personnel involved in transportation and energy data collection among others.

6 CONCLUSIONS AND FINAL RECOMMENDATIONS

The potential of electric mobility especially for road transportation, though unquantifiable in this study, is substantial in CARICOM member states. Potential also lies with electrifying rail transportation in larger member states such as Jamaica, Suriname, and possibly developing electric railway system in Guyana as an alternative to conventional vehicles, therefore offsetting high fuel consumption of ICE vehicles. Given the infancy of technology for electrifying maritime transport and the non-commercialization of electric air transport technology, electric mobility related to the two aforementioned modes of transportation (particularly the latter) show less promise for the region. Once electric ferries, yachts, ships and other marine vessels become commercially available, given the insularity and proximity from one island to another, which characterize the islands in the region, an electrified maritime transport system offers attractive opportunities.

In a region characterized by a high potential for renewable energy and in particular the potential for distributed solar power, electric mobility becomes even more attractive. Integrating electric mobility into planned energy systems are anticipated to be supported by the existing plans of Caribbean territories to transition to RE, as proven by the renewable electricity targets (See Appendices) and NDC targets for the reduction of GHG emissions.

An assessment of the value chain of electric vehicles resulted in the identification of key services for business potentials, along with key stakeholders for a large-scale integration of electric mobility. Stakeholders vary from public sector representatives to private sector representatives and civil societies. Major opportunities for EVs include commitments by member states to implement climate change mitigation action and high cost and instability resulting from import of fossil fuels. On the other hand the main barriers identified included the lack of charging infrastructure, lack of policy and high upfront costs of purchasing EVs. However a suite of interventions have been identified to close the gaps including data collection, the development of an incentives framework, policy, education campaigns and capacity building.

Engagement of stakeholders is key to overcoming some major barriers identified by this study I particular utility companies, policy makers, financial institutions, insurance companies, large business owners, among others. Appropriate business models, incentives frameworks, insurance packages, and a clear way forward for the development of charging infrastructure should result from stakeholder consultations. Additionally robust public awareness campaigns are recommended to compliment stakeholder engagement and therefore facilitate an electric transport transition.

Further suggested studies include cost-benefit analyses which take into account the development of charging infrastructure in member states and the effect of a transition on the economy. Readiness assessments should be done for each member state, ensuring to include renewable energy penetration in connection with electric mobility. Technical studies should be carried out to determine the effect of EV business models on electricity distribution, including grid stability and effect of demand and supply.

7 APPENDIX

Table 8. Renewable Energy and Electricity Targets in CARICOM Member States, as of 2015

Country	Renewable Energy Target	Renewable Electricity Target
Antigua and Barbuda	15% by 2030	20% by 2020
The Bahamas	30% by 2030	15% by 2020; 30% by 2030 10% residential self-generation by 2014
Barbados	10% by 2012 20% by 2026 (from 3.2% today)	29% by 2029
Belize	50% reduction in fossil fuel dependence by 2020	89% by 2033
Dominica	100% by 2020	25% by 2010 100% through addition of geothermal by 2020
Grenada	20% by 2020	10% by 2013 and 20% by 2017 (Grenada) 40% by 2011 (Carriacou and Petite Martinique) 100% by 2030
Guyana	None	90% through hydro development; 15,000 solar home systems installed (no date given)
Haiti	None	20% by 2017 28% by 2022 46% by 2027
Jamaica	20% by 2030	12.5% by 2015 20% by 2030
Montserrat	None	100% (geothermal and solar) by 2020
Saint Lucia	35% by 2020	5% by 2013 15% by 2015 35% by 2020
St. Kitts and Nevis	None	20% by 2015 100% by 2010 (Nevis)
St. Vincent and the Grenadines	None	30% by 2015 60% by 2020
Suriname	None	None
Trinidad and Tobago	None	5% of peak demand (or 60 MW) by 2020

Note: "None" indicates that no target had been set or announced by the date of research for this report.
Source: See Endnote 4 for this section. © *Worldwatch Institute*

Source: (CARICOM, 2015)

Incentives for encouraging EVs in Jamaica

For individuals, the aggregated import duty is 40% for hybrids and 52% for fully electric vehicles compared to percentages ranging from 54% (≤1000 CC) to 82% (≥8000 CC) For dealers, the aggregated import duty is 48% for hybrids and 58% for fully electric vehicles compared to a range of 46% to 75% for non-commercial vehicles.

REFERENCES

[1] (Energy Information Administration (EIA), 2016)
[2] (CARICOM, 2015)
[3] (CARICOM, 2015)
[4] (WHO , 2012)
[5] (OAS/EU, 2014)
[6] (GoSVG, 2009)
[7] (GEF/UNDP, 2016)
[8] (IATA , 2013)
[9] (St. Kitts and Nevis, 2017)
[10] (Richards, 2017)

Barbados, M. (n.d.). Retrieved from http://www.megapower365.com/recharging

CARICOM. (2015). *Caribbean Sustainable Energy Roadmap and Strategy: Baseline report and assessment.* IDB, Worldwatch Institue, GIZ.

Clean technica . (2015, June). *World's first all electric battery powered ferry* . Retrieved from https://cleantechnica.com/2015/06/13/worlds-first-electric-battery-powered-ferry/

ECLAC. (2016). *Towards a demand model for maritime passenger transportation.* Santiago, Chile: United Nations .

Energy Information Administration (EIA). (2016). *International Energy Outlook 2016 .* Washington DC.

GEF/UNDP. (2016). *Economic Impact of E-mobility Transition in St. Vincent and the Grenadines.* Corresponding author: Suzanne Shaw, Sustainable Strategies Ltd., Contributing author: Damien King University of the West Indies (UWI).

GIZ/CARICOM. (2016). *The Power to Change; The Monterrat Energy Policy 2016-2030.* Monterrat.

GoSVG. (2009). *Sustainable Energy for St. Vincent & the Grenadines; The National Energy Policy.* SVG: The Government of St. Vincent & the Grenadines .

Government of the Bahamas . (2013). *The Bahamas National Energy Policy 2013-2033.* Bahamas: http://www.thebahamasweekly.com/uploads/16/energypolicy.pdf.

IATA . (2013).

Megapower . (2017). *The Barbados Project*. Retrieved from MAgapower 365 EV Barbados : http://www.megapower365.com/ev-barbados

Ministers and other Heads of Delegation of the Alliance of Small Island States. (2012). *Barbados Declaration on Achieving Sustainable Energy for All in Small Island Developing States (SIDS).* Barbados.

OAS/EU. (2014). *Draft National Energy Policy of Commonwealth of Dominica.* Dominica: http://www.cipore.org/wp-content/uploads/downloads/2014/04/FINAL-NEP-Final-Draft-Commonwealth-of-Dominica-140415.pdf.

OLADE. (2013). *Saint Lucia Energy Balance 2010-2012.* Latin American Energy Organization.

Richards, S. (2017, January). CEO Megapower, Barbados.

St. Kitts and Nevis, M. w. (2017, March). St. Kitts and Nevis. (B. B. Secretary), Interviewer)

Sustainable Energy for All . (n.d.). *Rapid Assessment and Gap Analysis.* Barbados.

WHO . (2012). *Grenada; Health in the Americas.*