REGULATED INDUSTRIES COMMISSION

Energy Road Map Series: Advancing Electric Vehicle Adoption in Trinidad and Tobago

August 2019

RIC Staff Discussion Paper

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LIST OF ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
BEV	Battery Electric Vehicle
Bloomberg NEF	Bloomberg New Energy Finance
CO2	Carbon Dioxide
CNG	Compressed Natural Gas
DC	Direct Current
DCFC	Direct Current Fast Charging
DER	Distributed Energy Resource
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
GHG	Green House Gas
GORTT	Government of Trinidad & Tobago
GWh	Gigawatt-hour
HEV	Hybrid Electric Vehicle
HOV Lane	High-Occupancy Vehicle Lane
ICE	Internal Combustible Engine
IEA	International Energy Association
kw	Kilowatts
kWh	Kilowatt-hour
PHEV	Plug-In Hybrid Electric Vehicle
RE	Renewable Energy
RIC	Regulated Industries Commission
T&TEC	Trinidad & Tobago Electricity Commission
TWh	Terawatt-hour
UK	United Kingdom
USA	United States of America
USD	United States Dollar
V	Volts
V2G	Vehicle to Grid
ZEV	Zero Emission Vehicle

EXECUTIVE SUMMARY

Society today faces a dual challenge; how to reduce greenhouse gas (GHG) emissions while meeting escalating demand for energy. The scale of the challenge means that opportunities need to be considered to decarbonize transport (as one of the largest contributors to GHGs). Transitioning to a sustainable transport sector, that is, from internal combustible engines (ICEs) to electric mobility, demonstrates that a nation is committed to mitigating the impacts of climate change.

According to the *Global EV Outlook 2018* produced by the International Energy Agency, sales of new electric vehicles (EVs) worldwide surpassed 1 million units in 2017 – a record quantity. This represents a growth in new EV sales of 54% when compared to 2016. EVs accounted for 39% of new car sales in Norway in 2017, which is the world's most advanced market for EVs in terms of sales share. More than half of the global volume of EVs sold were in China, where EVs held a market share of 2.2% in 2017. In both cases, research has shown that EV deployment has mostly been driven by government policy and appropriate incentive mechanisms.

This paper explores conditions which collectively create a favorable environment for the adoption of EVs and presents evidence to justify enhanced EV adoption measures in Trinidad & Tobago. It is part of a series of papers released by the RIC on crucial energy issues in Trinidad and Tobago. For EVs to go mainstream in Trinidad & Tobago, a combination of EV charging infrastructure, consumer education, and awareness about cost savings on EVs, is imperative. The worst case scenario for EVs is that the appeal will not spread fast enough beyond environmental conservationists and early technology adopters to sustain the growth of the nascent EV market. In order to boost EV uptake in the country there needs to be a top-down approach to address barriers to adoption.

Consideration for a national policy that outlines the framework to achieve clear targets for electric mobility coupled with the establishment of an appropriate institutional structure, will facilitate the rollout of EVs on a significant scale. Collaborating with key stakeholders to provide easy access to a range of EV charging options will address consumer concerns over 'range anxiety' and provide solutions for public charging, thereby enabling EV adoption. Promoting incentives (fiscal or otherwise) for the purchase of EVs will be the key to shifting consumer preferences away from ICEs

and towards EVs. The transition to transportation electrification may be best managed with a three-pronged strategy to overcome barriers to adoption in Trinidad & Tobago as discussed below.

Priority One – Policy Mechanism: Develop Policy Framework and appropriate Institutional Structure

Recommendation- Develop Policy Framework and Establish a National EV Unit to spearhead and recommend appropriate policy actions and oversee the implementation of the National EV Roadmap. This entity:

- should ideally be located within a separate national renewable energy agency, in order to maximize the use of resources;
- should be autonomous in order to craft national policies including particular directives to propel the EV industry forward;
- will be responsible for facilitating EV uptake by fostering collaboration between public and private entities to support GORTT initiatives; and
- may assume responsibility for consumer education to make stakeholders aware of GORTT's EV Policy as well as spark greater interest and demand for EVs.

Priority Two – Commercial Mechanism: Creating an enabling environment for Market Development

Recommendation – Create a National EV Roadmap Implementation Strategy to chart a course that shifts from policy to action. This implementation strategy should:

- provide a framework for decision making with regard to EV development including goals, overall objectives and specified timelines where possible;
- outline operationalization activities for charging infrastructure and EV market development;
- specify the path to legislative change, financing, regulatory and institutional mechanisms to operationalize the EV Roadmap;
- address safety considerations for EVs and types of charging infrastructure; and
- prescribe market assessments and feasibility studies for specific initiatives.

Priority Three – Economic Mechanism: Funding the Development of the EV Industry

Recommendation – Facilitate Resources for Funding and Development of the EV Industry. National EV Unit can spur action to EV uptake with the help of a financing vehicle. This resource vehicle is meant to:

- focus on securing financing resources, oversee fiscal incentives and provide financing for the development of human capacity to service the EV industry;
- provide a link between procurement and funding activities so as to bridge the gap between what GORTT wants to achieve and how the private sector can help finance that process; and
- stimulate innovation in the EV industry with objectives to fund critical infrastructure projects, reduce viability gaps and promote entrepreneurship in the EV market place.

SECTION 1.0 INTRODUCTION

1.1 Context

The transport and electricity sectors are becoming increasingly connected as Electric Vehicles (EVs) currently represent a small but rapidly growing part of the global transport market. Sales of new EVs worldwide surpassed 1 million units in 2017, where the most advanced market for EVs was Norway with 39% of new car sales. By the end of 2018, other major players included China and the USA, where total vehicle sales coming from EVs were around 4.4% and 2.1%, respectively[1].

Recently, governments in several countries have proposed policies that would discourage or prohibit the use or sale of non-electric vehicles in the not too distant future. The Norwegian government hopes to end the sale of vehicles with Internal Combustible Engines (ICEs) by 2025. India's government announced that by 2030 only electric vehicles will be sold in India. The governments of France and the United Kingdom have stated that they will ban the sale of ICEs by 2040[2]. It is clear that reliance on ICE vehicles will diminish and that EVs are what many governments are expecting to meet their future national transportation needs.

As signatories to the Paris Agreement on Climate Change,[3] the Government of Trinidad & Tobago (GORTT) has committed to reducing cumulative greenhouse gas (GHG) emissions by 15% from industry, power generation and the transport sector by 2030. Decarbonisation commitments arising out of this Agreement would impact the local transport sector and meeting these targets may require a specific roadmap that addresses EVs. This roadmap may include grid modernization from early-stage adoption (experimenting and exploring EV options to educate the utility, customers and special interest groups) to the integration of Distributed Energy Resources (DER)[4] in the progression to the intermediate stage (proactive and strategic implementation of EV activities and programs already in place).

[1] Global EV Outlook 2018
[2] International Energy Outlook 2017
[3] The Paris Declaration on Electro-Mobility and Climate Change & Call to Action brings together individual and collective commitments to keep the increase in global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels.
[4] According to the Federal Energy Regulatory Commission, traditionally, DERs referred to small, geographically dispersed generation resources, such as solar or CHP, located on the distribution system. However, the definition of DERs has evolved to include not only generation resources, but also energy storage, energy efficiency and demand response resources.

Although EVs provide the same transport utility to end users, they offer significant benefits in terms of lower maintenance costs and reduced environmental and noise pollution when compared to ICEs. The cost of the batteries that power EVs were once prohibitive, resulting in higher prices for consumer vehicles, however, this cost has decreased significantly as the EV battery industry has evolved. Market projections suggest that EVs could reach price equivalency with ICEs by the mid-2020s, which implies that in the near future, EVs may retail to consumers at prices which are comparable to those being charged for conventional ICE vehicles[5].

In Trinidad & Tobago, the transition to complete adoption of EVs may provide substantial benefits to energy consumers. However, there will be challenges for the electricity utility, the business sector and various industry regulators since facilitating the adoption of EVs could have considerable implications in balancing the interests of the energy and transportation sectors. Currently, uptake of EVs is negligible and plug-in hybrids is minimal; if this is to change the lessons of the more successful approaches of regional leaders in EV adoption like Barbados and other jurisdictions which have already experienced early deployment, should shorten the learning curve. On a national level there needs to be proactive discussions on making the EV ownership experience as convenient as it is today for ICEs. Achieving successful EV adoption would therefore, require a great deal of collaboration across all stakeholders in the electric mobility supply chain.

1.2 Objectives of Document

This paper explores the conditions which collectively create a favorable environment for the adoption of EVs and presents evidence to justify the need for enhanced EV adoption measures in Trinidad & Tobago. Policy considerations for the development of a national Energy Roadmap to drive EV adoption in the country are also outlined.

1.3 Structure of Document

The rest of this document is structured as follows:

Section 2 – Technical Review of the Electric Vehicle Industry.

[5] Bloomberg New Energy Finance, Electric Vehicle Outlook: 2018 (May 2018)

Section 3 –Advancing Electric Vehicle Rollout.

Section 4 – Key Factors in Developing a Policy for Electric Vehicle Adoption.

Section 5 – Recommendations for a National Electric Vehicle Adoption Policy.

Responding to this Document

All persons wishing to comment on this document are invited to submit their comments. Responses should be sent by post, fax or e-mail to:

Executive Director
Regulated Industries Commission
#37 Wrightson Road
Port-of-Spain, Trinidad

Tel. : 1(868) 625-5384; 627-7820; 627-0821; 627-0503
Fax : 1(868) 624-2027
Email : ricoffice@ric.org.tt

A copy of this document is available from the RIC's website at **www.ric.org.tt**.

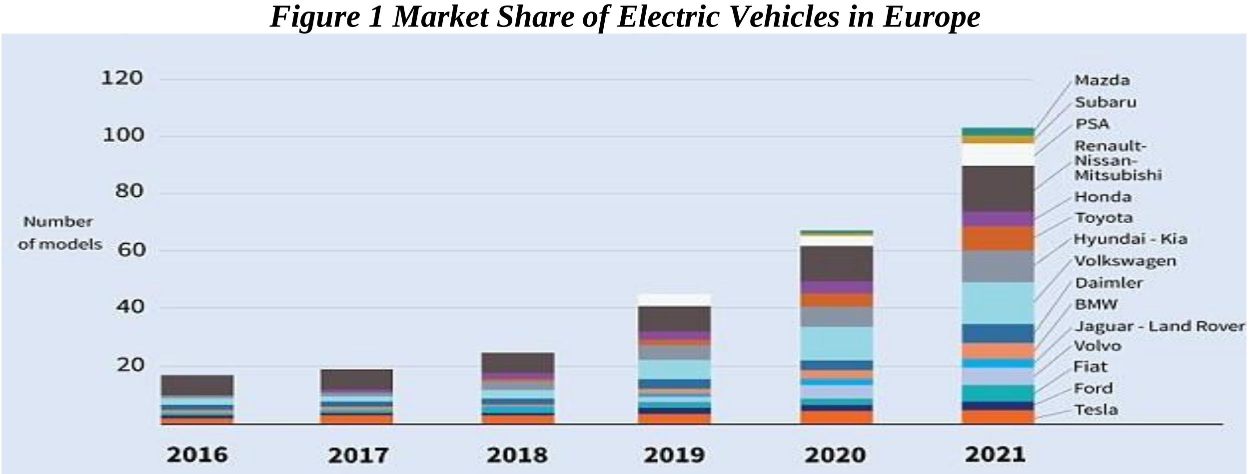
SECTION 2.0 TECHNICAL REVIEW OF THE ELECTRIC VEHICLE INDUSTRY

2.1 Introduction to Electric Vehicles

Generally speaking, an EV is any vehicle that is powered by a battery that has been charged from an electricity source. EVs have been in existence as long as ICEs. Circa 1900s, EVs were the more popular choice owing to the fact that they were quiet, easy to drive, did not emit pollutants and increasing access to electricity at that time, meant more convenient charging. By the 1920s a number of factors had led to a decline in EV sales in the United States (US) such as mass production of cheaper ICEs, the discovery of Texas oil and the rise of fuel stations outside of urban areas[6]. Between the 1970s – 1990s increasing oil prices, gasoline shortages and environmental concerns sparked a renewed interest in EV development. It was not until the beginning of the 21st century that a true revival of the EV industry took place.

Today, there is uncertainty about global oil and gas reserves and its impact on the cost of fuel for transportation. In addition, concerns about increased GHG emissions and access to government funding for EV research programs have led more manufacturers to accelerate their work on the performance of and technology in EVs. Since the release of the first mass-produced hybrids in the early 2000s, many car companies have released EV models on the market. As shown in Figure 1, a study by the European Federation for Transport and Environment shows that the number of EV models on the European market is expected to increase significantly by the year 2021.

Figure 1 Market Share of Electric Vehicles in Europe



Source: European Federation for Transport and Environment

[6] These factors, which led to the decline of EV sales, also led to the popularity of ICEs. An expanded fuel station network meant that drivers could travel further out from the urban areas to which they were restricted to when driving an EV.

2.2 Classification of Electric Vehicles

There are 3 basic types of EVs: battery EVs (BEVs), plug-in hybrid EVs (PHEVs) and hybrid EVs (HEVs). BEVs use on-board electric motors alone. PHEVs make use of both an on-board motor and a small internal combustion engine, drawing on that engine when more power is required or when the batteries are running low. Hybrid EVs use a conventional internal combustion engine and an electric drive, but differ from plug-in hybrid EVs. The difference is that all the energy for propulsion is generated from fuel, with electrical energy generated by a built-in alternator or regenerative braking[7]. This can help the charge on the car last longer, especially when used in driving conditions such as cities where drivers are required to brake more frequently. Some of the main distinguishing features between the different types of EVs are shown in table 1.

Table 1: Basic Classification of EVs

Electric Vehicle Classification	Pros	Cons
<u>Battery Electric Vehicle (BEV):</u> BEVs run entirely using an electric motor and a battery and must be plugged into an external source of electricity to charge the battery. There is also a minimum amount of recharging via regenerative braking.	• No emissions. • No gas or oil changes. • Conveniently charge at home instead of a gas station. • Lower cost of operation and maintenance that an ICE.	• Shorter range of travel than ICEs, hence needs a charging station network. • Relatively more expensive than ICEs.
<u>Plug-in Hybrid Electric Vehicle (PHEV):</u> In addition to an electric motor and battery that can be plugged into the electricity grid for charging, PHEVs also have the support of an ICE that may be used to recharge the vehicle's battery when it is low. Unlike conventional hybrids, these hybrids can be plugged-in and recharged from an outlet, allowing the vehicle to drive extended distances using just electricity. When the battery is emptied, the conventional engine turns on and the vehicle operates as a conventional, non-plug-in hybrid.	• Longer range compared to a BEV. • More fuel savings compared to a conventional ICE. • Lower emissions than an ICE.	• Source of pollutants from tailpipe. • Maintenance associated with having ICE components. • Relatively more expensive to operate than a BEV since fuel is still used.
<u>Hybrid Electric Vehicle (HEV):</u> HEVs have two complementary drive systems; a gasoline engine with a fuel tank and it also has an electric motor with a battery. Both systems can turn the transmission at the same time and thus operate the car. An HEV cannot be charged from external sources, all its energy comes from regenerative braking and gasoline.	• Longest range compared to BEVs and PHEVs. • Less gas consumption than conventional ICE. • Lower emissions than an ICE.	• Emits pollutants. • Complex mechanics with dual ICE and electric system. • Inability to be charged from an external source • Requires more fuel to operate than BEVs and PHEVs.

[7] Regenerative braking generates a small amount of electricity from some of the energy usually lost when conventional gas-powered cars brake - Clean Air Partnership, *'Building the Corporate Business Case for Electric Vehicles',* 2018

2.3 Charging Infrastructure for Electric Vehicles

The batteries in BEVs and PHEVs are charged by plugging the vehicle into external charging infrastructure specifically designed for EV charging as opposed to the conventional electricity outlets that persons are accustomed to. With the convenience of charging EVs at home and supplemental EV charging at work or public charging stations, both customers and potential EV equipment suppliers need to be familiar with the options for charging stations and the various technologies which exist today.

EV chargers are also known as electric vehicle supply equipment (EVSE) and come in three main categories as highlighted in a report by Mckinsey and Company[8].

- Alternating-current (AC) charging, also known as level 1 or level 2. In this system, a power electronic converter converts AC to direct current (DC), which then charges the battery at either level 1 (equivalent to a US household outlet) or level 2 (240 volts). It can provide power up to roughly 20 kilowatts.
- DC charging, also known as level 3 or direct-current fast charging (DCFC). This charging system converts the AC from the grid to DC before it enters the car and charges the battery without the need for an AC/DC converter. It can provide power from 25 kilowatts to more than 350 kilowatts.
- Wireless charging is a system which uses electromagnetic waves to charge the EV batteries. There is usually a charging pad connected to a wall socket and a plate attached to the vehicle. Current technologies align with level 2 chargers and can provide power up to 11 kilowatts.

The kilowatt capacity of a charger determines the rate at which the battery is charged. AC level 1 and level 2 are most applicable for homes and workplaces because of the long periods that cars remain parked in those locations and the lower cost of installation of these particular chargers. DCFC chargers are most applicable in situations where time matters, such as on highways and for fast public charging. See Appendix One for a discussion on the relationship between charging times and varying EV technologies.

[8]Mckinsey and Company, *Charging ahead; Electric-vehicle infrastructure demand*, (2018)

SECTION 3.0 ADVANCING ELECTRIC VEHICLE ROLLOUT

3.1 Stakeholder perspectives on the Rollout of EV Programs

Uncertainty and gaps in knowledge are often a major hurdle in the early adoption phase of transportation electrification. End-users and industry stakeholders alike can face challenges when adopting these alternative technologies, such as vehicle recharging and management of charging ports. These challenges can act as a barrier to the adoption of new technologies. In this sense, it is essential to understand the factors that may influence mobility preferences and the impact this will have on the transportation and energy sectors.

For electricity utilities, concerns about kilowatt hour (kWh) consumption for EV charging and the immediate and long-term impact on the grid are warranted. According to the International Energy Agency the global electricity demand from EVs in 2017 was roughly 0.2% of all global electricity consumption or 54TWh[9], roughly equivalent to the electricity demand of Greece. European industry experts believe that an uptake in EV sales in the near to medium term is unlikely to cause an increase in total power demand, as batteries become more and more efficient and thus require less electricity to operate.

Thus, while there is likely to be limited impact in the total quantum of electricity generation capacity needed, it is expected that the more immediate impact on the electricity grid will be reflected in the electricity load curve. Peaks in traffic activity in the morning hours have followed periods of low electricity demand during the night which has minimized the need for investment in distribution infrastructure upgrades. However, in the evenings, high periods of electricity demand have followed peak afternoon traffic activity. The evening peak load may have a marked difference as people plug in their EVs at home at the end of the day. This may cause the grid to face some strain in EV hot-spot areas, which is where the reliability of the network have become a cause for concern for that particular time period[10].

[9] A terawatt-hour (TWh) refers to getting power at a capacity of 1 terawatt (10^12 watts) for one hour.

[10] See Deb et al, who have also noted that EV charging loads can have an adverse impact on the operating parameters of a power system, in their paper entitled "Impact of Electric Vehicle Charging Station Load on the Distribution Network", Sanchari Deb, Kari Tammi, Karuni Kalita and Pinakeshwar Mahanta, Energies MDPI, 2018

On the consumer side, the response to monetary and non-monetary incentives can be positively influenced by shaping the public perspective on EVs. The level of EV affordability relative to ICEs and public charging availability are two of the biggest concerns for a potential EV owner. In the early adoption phase, there are continuing concerns that EVs have a more limited range than ICEs, and the market is uncertain about how quickly consumers can overcome their "range anxiety"[11]. Added to this, consumers need to be aware of the technical aspects of EV ownership such as, battery longevity in the vehicle, grid compatibility for charging at different types of ports and the reliability of the electricity network to ensure an uninterrupted supply of electricity to charging infrastructure.

From a governmental perspective, EVs present a job-boosting, revenue-generating, and technology-enhancing economic opportunity that could facilitate long-term gains for a country. Within the energy sector, there is the potential to satisfy EV power needs with domestic renewable resources which may allay any concerns about overburdening the electricity grid. The introduction of renewable energy for residential connections can be augmented by using decommissioned EV batteries to serve as distributed storage devices for the electrical grid.

Conservationists and environmental lobbyists may consider EV adoption as assisting with the mission for long-term reductions in local air pollution; managing GHG emissions and decreasing reliance on fossil fuel consumption by phasing out ICEs.

3.2 Successful EV Adoption Programs

The literature on some of the most successful EV adoption programs globally reveals a number of concurrent policies and strategies to ensure a smooth transition to electric mobility. This includes electrification of vehicles; provision of sufficient charging equipment; incentives to lower carbon footprints; and EV integration with the grid. As of 2019, EVs represented 10% of new car sales in three of the most advanced EV markets in the world: Norway, three Chinese cities and the state of

[11] Range anxiety is the fear that an EV has insufficient range (charge) to reach its destination, with the possibility of stranding the vehicle's occupants.

California in the United States.[12] The experiences in each of these jurisdictions as well as other European examples are discussed below.

Norway

In the Nordic region, policy support has significantly influenced EV adoption. Norway's success has been largely dependent on one key driver: the government. These government driven initiatives[13] have helped propel a commitment to have only zero-emissions cars sold in Norway by 2025. Indeed, a stable policy framework has been a key element in the success of electric car diffusion in Norway[14]. By September 2014, Norway was the world leader in EVs in terms of EV market share. To help sales, the Norwegian government waived hefty vehicle import duties and registration and sales taxes for buyers of electric cars. Owners were also exempt from paying road tolls and had free use of ferries and bus lanes in congested city centers.

The rise of EVs in Norway provides clear evidence of how a government policy mandate to promote EVs (inclusive of the establishment of a specific target for the number of EVs) is a critical success factor for the rollout of EVs. It is also important to note that this has worked in tandem with a heightened level of environmental awareness among the populace as demonstrated by a high level of environmental activism.

It is worth mentioning that though EV adoption rates in Norway have been successful due largely to government subsidies and perks, these initiatives are now being phased out, but only to the point where EVs remain attractive to buy compared with ICEs. This particular ‘reversal of initiative’ can be seen as a measure of success as it suggests that government adoption policies have been effective enough to encourage EV sales. It is evident that there must still be a level of monitoring and evaluation of the impact of these initiatives to ensure that they remain fit for purpose.

China

Another example of successful EV adoption is China which has taken a top-down approach to vehicle electrification. It has established national mandates, subsidized manufacturers, and

[12] https://www.planete-energies.com/en/medias/close/state-electric-vehicle-adoption-worldwide, February 2019
[13] https://www.csmonitor.com/Environment/2018/1219/With-government-incentives-Norway-sees-electric-car-sales-boom
[14] Nordic EV Outlook 2018

nurtured policy competition among its cities. The success of EV adoption in China can be largely attributed to government policy, and in its unique approach, electrified public transport came first, as this was prioritized over passenger car electrification.

In this regard, China's strategy was complete electrification of its bus fleet unlike approaches taken by other countries of only buying electric buses as additions to existing fleets. In 2009, China began prioritizing the electrification of its public-transit system, part of its strategy for dealing with widespread urbanization while reducing fossil-fuel imports. That set in motion a series of comprehensive policies, regulations, and subsidies that birthed a new industry. A decade later, the results are tangible: China is by far the world's single biggest market for electric vehicles of all types. For instance, out of almost 425,000 e-buses worldwide at the end of 2018, some 421,000 were in China as reported by Bloomberg NEF[15].

For passenger cars, growth of EVs in China can be primarily attributed to supportive government policy. This includes public procurement programs, financial incentives; various mechanisms of reducing purchase price of EVs significantly, tighter fuel-economy standards for manufacturers, stringent emission regulations, low/zero emission vehicle mandates and local measures, such as, restrictions on vehicle usage based on emission performance. The rapid uptake of EVs has also been catalyzed through progressive cost reductions and enhanced performance of lithium-ion batteries[16]. As an added measure in anticipation of EV growth, the government has planned ambitious targets for setting-up charging stations to overcome possible range-anxiety.

California, USA

In the United States, a combination of policies and promotional activities with respect to EVs distinguishes the state of California from the rest of the nation. The Zero Emission Vehicle (ZEV) program[17] is a California state regulation that was designed to achieve the state's long-term emission reduction goals by requiring auto manufacturers to offer for sale specific numbers of the very cleanest cars available. These vehicle technologies include full battery-electric, hydrogen fuel cell, and PHEVs. Components of the program include consumer rebates, access to carpool lanes

[15] https://www.bloomberg.com/news/articles/2019-05-15/in-shift-to-electric-bus-it-s-china-ahead-of-u-s-421-000-to-300
[16] Vinay Piparsania, '*Powering Electric Vehicle Dominance-Lessons from China and Norway',* 2018
[17] https://ww2.arb.ca.gov/our-work/programs/zero-emission-vehicle-program/about

on congested highways, extensive electric vehicle charging infrastructure, progressive electric utility policies, greater EV model availability and marketing, and access to high-occupancy vehicle (HOV) lanes.[18] These mechanisms coupled with the continued growth of local EV promotions have spurred an uptake of EVs in California[19] and have even led to nine other states adopting some form of ZEV regulation.

California has a history of environmental activism and two of its state agencies, the California Air Resources Board and the California Energy Commission, have had a great deal of influence in promoting the rollout of EVs. The State legislature in 2009 also authorized up to USD$120 million per year for a period of seven years to support EV technologies. Electric vehicle sales in California from late 2010, when modern electric vehicles emerged, through the end of 2017 totaled 366,000. Growth in annual sales from 2016 to 2017 was approximately 29% in California versus 28% in the U.S. market as a whole. During this same period the availability of public charging infrastructure, a key consideration for electric vehicle drivers, expanded by about 22% in California (and in the United States overall). Currently the EV charging network in California represents 31% of all U.S. public charging infrastructure.

Netherlands

In the Netherlands, the Dutch government adopted a National Action Plan for Electric Driving in 2009. The plan included USD $89 million allocated to related pilot projects, charge points, research, and development. There was also the establishment of clear targets for the number of EVs. The government also partnered with the private sector with respect to the installation of chargers. This high level of government support which also included the provision of purchase incentives (through tax reductions) has fueled the growth of EVs in that country.

Germany

In 2009, the German government adopted the National Electromobility Development plan, the goal of which was to facilitate Germany’s goal to be the world-leading supplier and market for electric mobility by 2020. The plan targeted certain regions of central government and included

[18] The central concept for High Occupancy Vehicle (HOV) lanes is to move more people rather than more cars. EV access to HOV would effectively serve 2 purposes.

[19] The international Council on Clean Transportation ‘*California’s Continued Electric Vehicle Market Development’,* May 2018

funding for the development of EV fleets and the installation of a network of fast chargers. There was also the establishment of clear targets for the number of EVs.

SECTION 4.0 KEY FACTORS IN DEVELOPING A POLICY FOR ELECTRIC VEHICLE ADOPTION

Successful EV adoption rates and the continued phasing out of ICEs will depend heavily on the government's efforts to drive this change. Indeed, the uptake of EVs in countries with the most successful rollouts to date, are those that have had a range of policies to promote the uptake of EVs as previously discussed. Effective policies have been the key to making EVs appealing to customers and where applicable, to the removal of risks to investors and manufacturers to increase the production of EVs. Policy instruments have ranged from financial incentives to cut the upfront costs of vehicle acquisition, to reduce usage cost (e.g. free parking) to a variety of regulatory measures such as fuel-economy standards and government-led, public-fleet procurement programmes.

Considerations for any energy related policy, EVs included, can best be attributed to energy sustainability which itself is based on the dimensions of energy security, energy equity, and environmental sustainability. Prioritizing each dimension creates an 'energy trilemma' which links together the public and private sectors, governments, regulators, consumers, and economic, social and environmental factors. In accordance with the Paris Agreement and the commitment to reducing harmful emissions into the atmosphere, decision-makers should be conscious of the need to meet the challenge of the energy trilemma while balancing public welfare goals.

4.1 Policy Domains for Electric Vehicles

Government policies are framed with the public interest in mind. This approach is necessary since public interest values must be safeguarded against problems affecting countries on a global scale. The public policy goals identified in table 2 are central to making appropriate energy policy decisions including what priority areas need to be addressed for the adoption of EVs.

Table 2: Policy Domain and Goals for Consideration for EV Adoption

Policy Domain	Policy goal
Climate change	Limit global warming
Energy	Protect energy security/affordability
Transport	Enhance mobility/accessibility
Economy	Increase social welfare
Public health	Improve air quality

ICEs are linked to climate change since combustion of hydrocarbons results in carbon dioxide emissions, which is one of the main contributors to climate change. Through the Paris Declaration on Electro-Mobility and Climate Change & Call to Action, signatories are committed to having at least 20% of all vehicles on the road as electrically powered by the year 2030. These efforts complement other concerted strategies to slow down the global rise in temperature, which can have devastating impacts on ecological systems around the world.

Ensuring long term energy security is one of the dimensions of the energy trilemma. While electricity generated from renewable sources is emission-free, the consistency of supply of renewable energy sources is variable. Variable renewable sources require flexible standby capacity be incorporated into the mix to ensure the overall reliability of the system. GORTT needs to be cognizant that depending on gas-powered standby generation capacity can cancel some of the benefits from renewable energy power. Instead, where renewable energy sources fall short, there is the possibility that EVs can be used to supplement power from EV batteries back to the national grid in a strategy known as Vehicle-to-Grid[20] technology. In the local context, comprehensive

[20] As defined by the US Department of Energy, Vehicle-To-Grid technology can be defined as a system in which there is capability of controllable, bi directional electrical energy flow between a vehicle and the electricity grid. The electrical energy flows from the grid to the vehicle in order to charge the battery. It flows in the other direction when the grid requires the energy, for example, to provide electricity at peak times.

understanding of this technology would require studies by the utility, that is the Trinidad and Tobago Electricity Commission (T&TEC), and the Electrical Inspectorate.

On a global scale, transport is a targeted sector for effective government intervention to further curtail carbon dioxide (CO_2) emissions, so energy policies and corresponding related transport policies, usually involve some measure of integrated electro-mobility for society. A transport policy that encourages movements away from ICEs towards EVs must ensure that, at minimum, end users can perform the same functions that they usually do. In any economy, transport mobility for persons and goods is essential to value creation, so transitioning to transportation electrification must not compromise this.

Economic growth contributes to the enrichment of a country's socio-economic landscape. If sustainability of energy is jeopardized, then commercial activities and the growth of industries and investment opportunities are negatively affected. Formulating policies to support transportation electrification and its resulting industry can support energy sustainability and promote growth of the economy.

Public health, especially in urban centres, is becoming increasingly problematic because of declining air quality. ICEs emit fine particulates in exhaust fumes which contain compounds that can affect the respiratory and cardiovascular system. These compounds in exhaust fumes and soot emission can also contribute to acid rain. According to the World Health Organization the total contribution of transport to particulate air pollution can vary widely, from 12%-70% of the total pollution mix[21]. This is reason enough to embrace EVs since they are emission free and may help to improve air quality by reducing the number of harmful particulates in the air.

4.2 Strategic Approaches to Policy Formulation for Electric Vehicles

In order to encourage the uptake of EVs, policy formulation must remove the key barriers which impede the uptake of these vehicles and also provide incentives to make them more easily accessible to consumers. Policies can be broadly categorized as demand focused and supply

[21] https://www.who.int/sustainable-development/transport/health-risks/air-pollution/en/

focused. Demand-focused policies encourage consumers to purchase EVs and essentially focus on strategies that seek to change public perception with the hope that EVs would become the preferred choice over ICEs. Examples include offering financial or non-financial incentives to consumers, making EVs more attractive through unsubsidized fuel pricing and improving charging infrastructure availability.

Supply-focused policies encourage suppliers such as automakers/importers to make EVs available to consumers, to increase access and ownership potential. Examples include specifying a minimum share of vehicles sold to be EVs or requiring that vehicles sold meet a fleet average emissions intensity. Such policies can also target fuel suppliers, requiring them to reduce the carbon intensity of the fuels they sell in an area, which has the potential to indirectly encourage EV adoption.

4.2.1 Demand-Side Policy

The following considerations should form the basis for structuring demand-side policies.

- **Availability of Public Charging** - public confidence in EV ownership can be boosted with strategic placement of charging infrastructure. The challenge to this is identifying stakeholders to invest in early phase provision of charging services in public spaces. Consideration should be given to including incentives to help offset the costs of installing charging infrastructure in the early stages. Studies suggest that 80% of EVs are charged at home with supplemental charging at work. To alleviate range anxiety, potential EV owners need to actually see these chargers already installed in places outside of their main (preferred) charging locations. Major public spaces such as shopping malls and parks should be assessed for traffic patterns and charger placement options. In fact, the absence of adequate recharging networks can indicate signs of market failure and may help explain low EV uptake in many countries. Ensuring greater interoperability is also important, that is, the ability of a car’s recharge technology system to communicate and operate with that of the recharge station and its billing mechanism. In the United States, California has fostered recharger access thus promoting a more streamlined rollout of EV charging stations, enhancing user friendliness.
- **Reduction in the up-front cost of EVs** – given that the success of EV adoption depends on the rate of phasing out of ICEs there must be motivating factors for consumers to choose EVs over ICEs. A key consideration would, therefore, be lowering the up-front costs of purchasing

an EV. Government schemes geared towards easing the financial constraints of EV ownership may help push the demand for EVs. In order to make the cost of EVs comparable or even more affordable than ICEs, policies that directly help the consumer, such as purchase rebates or indirectly, such as tax exemption on EV imports, are key.

- **Fuel Pricing** – in countries where fuel subsidies exist, arguably one of the least publicly acceptable policy measures would be the complete removal of such a fuel subsidy. This would effectively increase the price of fuel at the pumps for ICEs. While some may argue that removing the fuel subsidy on electricity generation will also affect consumers because electricity rates may increase, it must be noted that any increase in electricity rates due to fuel subsidy removal may not take place as quickly as increasing the prices of fuel at the pumps. Policy-makers should be mindful that the rate at which fuel prices are increased may not necessarily lead to an immediate and proportional EV uptake.
- **Building Codes** – with specific reference to urban commercial buildings, considerations should be given to the location of EV parking spaces in major business centres and the challenges of retrofitting parking garages with adequate charging stations and maybe even outfitting these garages with solar powered panels. In order to reach a larger market share, many countries are ensuring that building codes embed requirements for 'EV-ready' parking. This allows EV owners access to charge their vehicles easily and thus enhances the availability of charging infrastructure.
- **Designated EV Access** – some countries have designated EV lanes on highways and main motorways, in collaboration with other traffic management programs, to allow unrestricted access to EVs. During peak commute hours, the convenience of EV access to HOV lanes adds to the attractiveness of EV ownership. This option may be more applicable to Trinidad & Tobago over the medium to long term, as the road network infrastructure is expanded or enhanced in parts of the country.

4.2.2 Supply-Side Policy

The following considerations should form the basis for structuring supply-side policies.

- **EV mandate** – possibly the most transformative path to EV uptake from a supply side would be to target both EV and ICE import quotas and subsequent import fees and taxes. Requiring car dealers and importers to sell a minimum number of EVs is a low-cost option but there may be 'buy-in' challenges. In Trinidad and Tobago, it may be much more feasible for GORTTs transportation electrification policy to mandate that a certain percentage of government vehicles be transitioned to EVs within a defined timeline. This includes fleets for messenger vehicles, official ministry vehicles, sanitation trucks, and public transport buses.

- **Standards for EV Charging** – Standardizing the charging infrastructure in terms of the source of charging power and the technical specifications, stabilizes the electricity supply aspect of EV charging. Partnerships between the electricity utility and renewable energy service providers would essentially ensure that charging stations are up to code and have the capability to supply electricity from the national grid or even from battery storage if the grid experiences temporary failure. Charging EVs with electricity derived from renewable sources of energy sends signals that EV adoption is not only about switching to another type of 'fuel' but there is also an aspect of sustainability of electricity supply.
- **Resources to sustain the EV industry** – this refers to both the human resource and the equipment/materials necessary to sustain the EV sector. Policies geared towards tertiary and vocational training of personnel and implementing protocol for EV maintenance will foster a qualified EV workforce inclusive of general technicians, repair specialists and battery diagnostics technicians. In turn, this will allay the public's fear about availability of maintenance support services for their EVs.
- **Vehicle Emission Standards** – in many countries where vehicle manufacturing represents a major industry this is a critical performance indicator. Specification of a maximum limit on tailpipe emissions in light-duty vehicles may increase the market share of EVs, as suppliers strive to meet and exceed targets. While this option may seem to be of limited use in Trinidad and Tobago as there is no car manufacturing industry, this requirement can easily be extended to car dealerships which then require them to source low emission vehicles.

4.3 Suggested Institutional Capacity for EV Adoption

The considerations for policies focused on demand-side and supply-side of EVs in Section 4.2 need to be effected through a collaborative effort by stakeholders in this relatively unfamiliar landscape. Effective EV adoption and its associated benefits require, as has been shown, a number of concurrent strategies to ensure a smooth transition process such as: access to electrification of vehicles; provision of sufficient charging equipment; incentives to lower carbon footprints (EVs can create additional demand for electricity which can be met with renewable energy); and EV integration with the grid (cumulative lifetime of parked car [22], combined with battery storage capacity, can enhance the flexibility of the grid). The following core concerns should form the basis for discussions on establishing institutional relationships and linkages among the stakeholders in the rollout of EVs.

i. **Clear Government Mandate -** The countries with the most successful rollout of EVs have well-established plans which include clear targets for the number of EVs and network charging as well as budgetary support. This is supported by co-operation at all levels of government, industry suppliers and support at the regulatory level.

ii. **Incentives for the purchase of EVs -** A variety of incentives (fiscal and otherwise) coupled with communication channels to support the purchase of EVs. This also includes customer awareness where support for EVs is often high in countries where there is a high level of environmental awareness, underscoring the need for consumer education.

iii. **Availability of Charging Stations** – There is often direct government support for the installation of charging (inclusive of fast charging) infrastructure. This is usually supported by technology (mobile apps) to inform customers where charging stations can be found.

The establishment of an appropriate institutional structure to facilitate the rollout of EVs and to ensure that strategies are successfully implemented is critical in binding together various policy considerations. As discussed below, key stakeholders in the transport and energy sectors play key roles in how these institutional relationships can be managed.

Government/Ministry - define and commit to electric mobility through the establishment of appropriate targets and development of a National Plan; ensure continuity of government goals for the energy and transport sectors; operate with transparency in discussing with other stakeholders the direction of EV adoption.

[22] According to studies compared on https://usa.streetsblog.org/2016/03/10/its-true-the-typical-car-is-parked-95-percent-of-the-time/, cars can spend as much as 95% of their lifetime parked.

Utility regulator - incentivize utility to maintain a reliable and safe network for flexible EV charging; discourage discrimination in charging station locations and type; assess efficient investment of charging infrastructure proposals; standardize the EV charging platform to prevent interoperability issues. Regulation will need to adapt to provide predictability to the EV market and protection to EV users. Given the scale of uncertainty around uptake and charging behaviors, alongside the blurring of typically separated sectoral boundaries (energy and transport), this represents a challenging prospect for regulators as it pertains to developing a framework for EV adoption. The regulator may also have to advocate for amendments to its mandate in relation to regulating renewable sources of energy for EV charging. In this instance, the regulator may have a critical role in taking part in the procurement of DER, and the administration of licenses to small-scale generators. Concomitant with these responsibilities are matters related to interconnection disputes, which the regulator may be required to mediate.[23] With large scale roll-out of EVs, if all EVs were to be charged at the same time this would increase peak demand on the grid and contribute to overloading and hasten the need for upgrades at the distribution level. In this regard, the regulator would have to consider shifting EV charging to off-peak which would require dynamic pricing for electricity consumption.[24]

Electricity utility – be a first mover in investing in EV charging stations; capacity planning for expected increase in consumption as the EV industry moves across adoption phases; action plan to power homes with battery storage in the event of power outages during natural disasters. Electricity flows will become increasingly complex and bi-directional, particularly if EVs are used to feed power back to the grid through Vehicle-to-Grid (V2G) technology. This concept, as previously discussed, will need to be addressed by both the utility and the regulator as it relates to tariffs for EV charging and compensation for feeding energy back to the grid. Inflexible EV charging could add to peak electricity demand and require expensive network reinforcements. Flexible charging could contribute to cost-effective decarbonisation of the transport sector, by ensuring that the electricity grid is used in a smarter way. Connecting EVs to the distribution grid

[23] Kwylan Jaggassar-Eccles, *'Regulating for Sustainability in a Disruptive Environment Changing the Business Model',* (October 2018)

[24] For example, in the German City of Hamberg, the local distribution system operator, Stromnetz Hamburg, ran a load development analysis to identify critical situations for uncontrolled charging of EVs with charging point loads of 11 kW and 22 kW. It estimated that 60,000 EVs loading in private infrastructure, will cause bottlenecks in 15% of the feeders in the city's distribution network. See B. Pfarrherr (2018) Controlling private e-mobility charging points in public low voltage grids. Stromnetz, Hamburg Vienna.

as both a load and DER offers integration challenges, but also has the potential to increase network reliability and add geographic diversity in power generation sources.

Electrical inspectorate - educate the public about safe practices for installing charging stations and proper care and maintenance.

Private sector entities – includes vehicle importers, charging technology companies and the urban business community. Successful coordination efforts would ensure that the policy actions of the government can be applied fairly to these stakeholders which would encourage continued investment and innovation in the industry

4.4 Assessing Local Conditions

Currently, the BEVs and PHEVs markets in Trinidad and Tobago are minuscule when compared to the existing ICE market. With respect to HEVs, anecdotal evidence suggests that there are approximately 20,000 HEVs currently in Trinidad and Tobago.[25] Attempts were made to ascertain the actual numbers from several agencies, however, this number has not been corroborated. Based on discussions with local stakeholders involved in the EV market, the number of fully electric vehicles currently registered for use in Trinidad and Tobago is very small at this time.

Notwithstanding the above, there are number of "barriers" that will need to be addressed before there is likely to be any meaningful roll out of BEVs and PHEVs and these are discussed below.

- **EV prices are currently higher than gasoline and diesel cars**. In today's market, EVs are less affordable than their gasoline counterparts, even with additional fiscal incentives.

In Trinidad and Tobago, GORTT (Budget 2018) removed all tax incentives on hybrid passenger vehicles (new and used not older than 4 years) with engine sizes exceeding 1599cc. Engine sizes less than 1599cc can still benefit by paying no Value Added Tax (VAT), Motor Vehicle Tax (MVT) and Import Duties. New and used electric vehicles with engine size of 179kw also benefit

[25] Interview on the TV Programme "Morning Edition" dated July 18th 2019 with representatives of the Trinidad and Tobago Automotive Dealers Association.

from tax exemptions. Prior to the proposed amendments, new and used hybrid passenger vehicles (not older than four years from the year of manufacture with an engine size not exceeding 1999 cc) qualified for exemptions from Value Added Tax (VAT), Motor Vehicle Tax (MVT) and Import Duties. This exemption applied to new or used electric vehicles and new or used hybrid vehicles for private and commercial use imported from January 2015.

It is noteworthy that GORTT has provided similar types of incentives for the Compressed Natural Gas (CNG) vehicle market. The added attraction is that for tax purposes, individuals receive a 25% tax credit on the cost of converting a vehicle to use CNG. For potential customers, these fiscal incentives coupled with a strategic network of CNG fueling stations (about 20 supply points) can shift focus away from buying an EV. Appendix Two summarizes the fiscal incentives offered to EVs and CNG vehicles over the period 2012-2019.

- **Fuel Pricing** – The existence of fuel subsidies and cheap fuel has tended to promote the growth of ICE vehicles in Trinidad and Tobago. The complete removal of the subsidy is likely to favour the rollout of EVs and CNG vehicles. It is noteworthy to mention that the latter is also dependent on subsidized fuel. However, electricity prices in Trinidad and Tobago also benefit from below market prices for the natural gas used in electricity generation. GORTT has already taken steps in this direction and the price of Super gasoline was increased by 11% in October 2017 and by 25% as of October 2018. GORTT has noted that at an oil price of US$73 per barrel, the unsubsidized price of super gasoline is TT$5.47 per litre and the unsubsidized price of diesel should be TT$4.96 per litre.[26]

- **Public charging stations are extremely limited**. Currently, there is virtually no public charging network in Trinidad & Tobago[27]. Without such infrastructure, the rollout of EVs will be limited even in the presence of appropriate fiscal incentives (as has been the experience thus far);

[26] See "Focus on Trinidad &Tobago Budget 2019" by EY, published October 1, 2018.
[27] The RIC offers access at its compound to the public to its charging station, and at least one car dealership offers access to charging however, these are exceptions with the majority of electric vehicles in the country having to charge at home.

- **Consumer choice is limited** - EVs are currently available in only a few vehicle makes and models. In contrast, there are a wider variety of gasoline models available;

- **Access to EV charging is constrained** - Research suggests that access to EV charging at home is important to EV uptake and is linked to consumer interest;

- **Availability of EVs at dealerships is low** - Only a fraction of dealerships is certified to sell electric vehicles and an even smaller number keep models in stock and make them available for test drives;

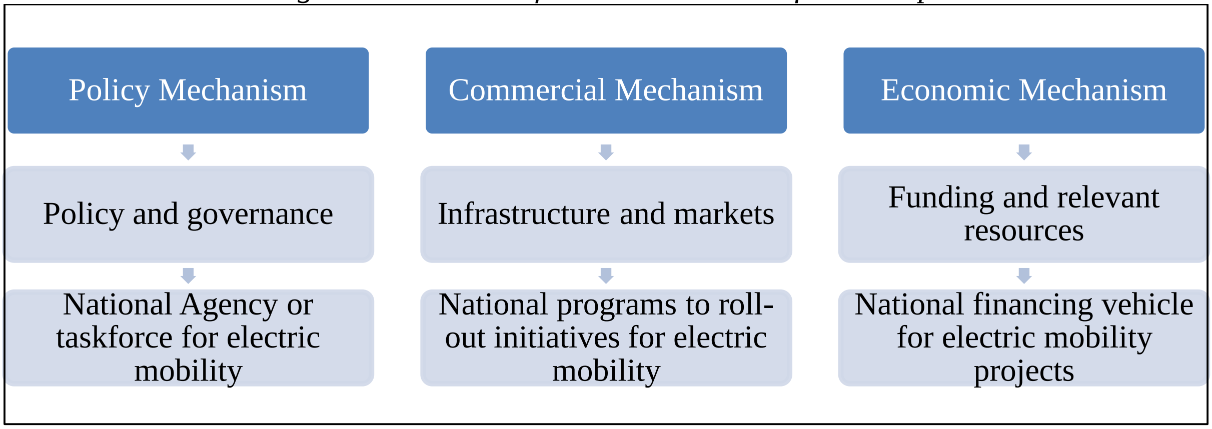
- **Consumer awareness is low** - Citizens are not cognizant of the benefits of EVs and generally unfamiliar with EV technology and how to 'refuel' an EV. Moreover, citizens need to be made aware of the various incentives if they are to take advantage of these; and

- **Lack of legislative framework** - appropriate legislative amendments will be needed that specifically address the technical and administrative aspects of a functioning EV sector.

SECTION 5.0 RECOMMENDATIONS FOR A NATIONAL ELECTRIC VEHICLE ADOPTION POLICY

Vehicle electrification may be seen as 'disruptive' to some industries in the country, meaning that it is a relatively new technology that can unexpectedly displace an existing technology or convention. Therefore, EV adoption has the potential to be an inherently slow process. As a result, there have to be strong commitments to enforcing policy and enabling technologies in the early adoptive years of the transition period. One of the key issues would be how to best manage the transformation of the transportation sector. To accomplish this transition efficiently, a three-pronged strategy, as summarized in Figure 2, presents the strongest approach to overcoming barriers to EV adoption in the country. These action items are intended to operate across both the demand-side and supply-side of the EV roadmap by providing solutions to barriers to adoption.

Figure 2 Overview of Recommendations for EV Uptake



Priority 1 – Policy Mechanism: Development of an appropriate Policy Framework and Institutional Structure

Recommendation –Establish a National EV Unit

As a first step, GORTT must establish an overarching policy framework for the sector. This policy framework should outline the proposed institutional framework to oversee the growth and development of the sector. In this regard, a centralized national unit is needed to spearhead and recommend appropriate policy mechanisms and relevant activities to encourage the uptake of EVs within Trinidad and Tobago. This National EV Unit should ideally be located within a separate national renewable agency, in order to maximize the use of resources. The autonomy of this EV unit and by extension the renewable energy agency is important because it must recommend policies and directives to propel the EV industry forward without bias toward any vendor, special interest group, etc.

One of the first deliverables for this entity would be to conduct a comprehensive sector study. In addition to an assessment of the current electro-mobility market, this study should provide justifications for specified EV adoption targets. Another deliverable of this entity would be to craft a National EV Roadmap, and determine a path for attaining the goal of successful EV uptake. With this main goal in mind, the Unit would be required to facilitate collaboration between public and private entities such as the appropriate ministries and private developers, raise awareness of the advantages of EVs to stakeholders and facilitate discussion on the provision of supply-side requirements. In order for the Unit to achieve its mandate, it may require appropriate regulatory and legislative change so as to boost private sector efforts to develop the EV industry.

Consumer education will also be a key activity for the entity. This should focus both on making stakeholders aware of the GORTT's Policy to promote rollout of EVs as well as spark greater interest and demand for EVs by creating awareness of the benefits of EV ownership. The entity may also be tasked with consolidating ideas and coordinating efforts between GORTT and private sector stakeholders which would result in the buy-in of electric mobility on a nationwide scale.

Priority 2 – Commercial Mechanism: Creating an enabling environment for Market Development

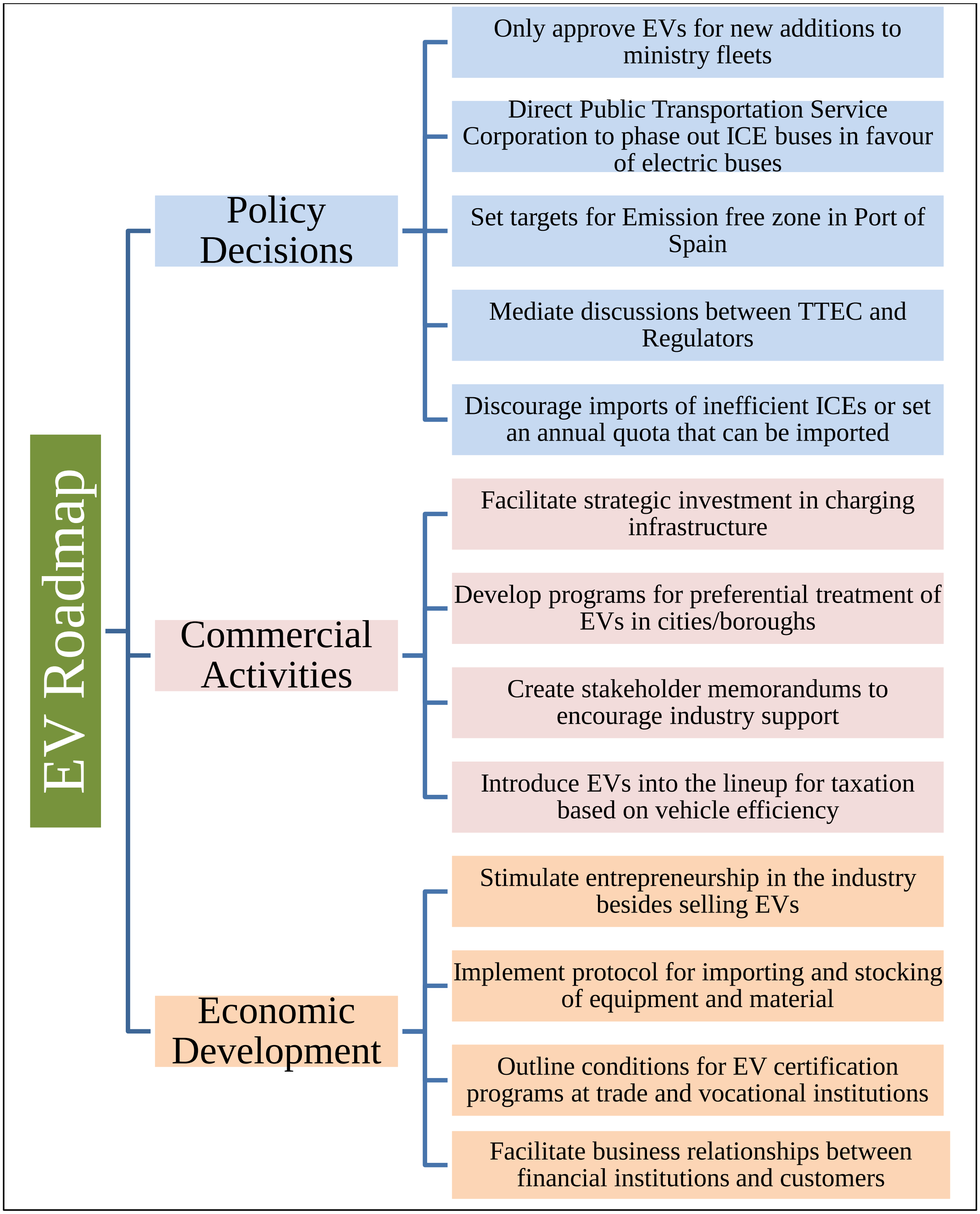
Recommendation – Create a National EV Roadmap Implementation Strategy

Although there are no legal barriers to owning an EV, there are hurdles obstructing the progression of the industry. A comprehensive, national implementation strategy to support EV adoption through proactive government initiatives would chart a course to shift from policy to action and thereby operationalize activities for charging infrastructure and EV market development. Determined by the aforementioned National EV Unit, an implementation strategy would provide a framework to guide decision making with regard to EV development in the country. At the outset, it should define the Unit's vision statement, visionary goals, overall objectives, projects and specified timelines, where possible.

In order to focus the National EV Unit's efforts on boosting EV adoption, the implementation strategy should, at the very least, contain legislative, financing, regulatory and institutional mechanisms needed to operationalize the EV Roadmap. Objectives of the implementation strategy should outline the path to legislative change, mechanisms for both government and customer acquisition and operation of EVs. These objectives would also address safety considerations for EVs and types of charging infrastructure, facilitating investment in public charging infrastructure and conducting market assessments and feasibility studies for specific initiatives. It is important to note that while the National EV Roadmap may not be designed to prescribe specific, detailed actions to be taken in any of the sub-sectors identified, these aspects should be thoroughly discussed in the Implementation Strategy.

As long as the goal of the EV Roadmap is structured to efficiently promote EVs and to foster infrastructure and market development, implementation strategies such as those illustrated in figure 3, would result in increased electric mobility, coordinated efforts across infrastructure and markets and greater uptake of EVs.

Figure 3: Initiatives to Enhance EV Uptake in Trinidad & Tobago



Priority 3 – Economic Mechanism: Funding the Development of the EV Industry
Recommendation – Facilitate Resources for Funding and Development of the EV Industry

As a relatively new industry, there is an institutional gap between supply and demand of EVs. The National EV Unit can spur action to EV uptake with the help of a financing vehicle which is needed in order to make relevant projects economically viable. Under this umbrella the focus would be on securing financing resources, overseeing fiscal incentives and providing funding for developing human capacity to service the EV industry.

One financing option the National EV Unit can use to make passenger EVs more competitively priced to ICEs is a battery lease scheme. In this scheme, there is a partnership with car dealerships, auto loan finance institutions and similar lending agencies. The battery cost is basically omitted from the cost of the EV (thus making it comparable to the cost of an ICE) and instead, the cost of the battery is amortized over the life of the EV. The car manufacturer Renault, has been using this approach with its very popular "Zoe" model in Europe (it is the number one selling car in that market, selling more than all other EVs combined).

For commercial EVs, a zero-emission vehicle funding program similar to the one administrated by the US Department of Transportation can provide a mechanism for commercial drivers to acquire commercial EVs for public transportation. In this instance, funding covers a portion of project costs with the caveat that EVs must be designated for public transportation use and must be designed to significantly reduce energy consumption or harmful emissions compared to a comparable standard ICE vehicle[28].

The establishment of a national financing vehicle to link procurement with funding activities is critical for bridging the gap between what GORTT wants to achieve and how the private sector can help finance that process. Overcoming barriers to adoption would require joint efforts between government and industry for investment, with discussions focusing on optimal levels of investment to balance the elements of supply and demand. The goal would be to stimulate innovation in an industry that is unfamiliar to this country with objectives to fund critical infrastructure projects, reduce viability gaps and promote entrepreneurship in the EV market place.

[28] Guide to Federal Funding, Financing, and Technical Assistance for Plug-in Electric Vehicles and Charging Stations

APPENDIX ONE

Pod Point are the UK's leading provider of electric vehicle charging. Since forming in 2009, they have manufactured and sold over 40,000 charging points and developed one of the UK's largest public networks, connecting EV drivers with hundreds of charging stations nationwide. Their expert analysis on factors that influence charging time is presented below.

- A typical electric car (60kWh battery) takes just under 8 hours to charge from empty-to-full with a 7kW charging point. The bigger your car's battery and the slower the charging point, the longer it takes to charge from empty to full.
- Most drivers top up charge rather than waiting for their battery to recharge from empty-to-full.
- For many electric cars, you can add up to 100 miles of range in ~35 minutes with a 50kW rapid charger.

Empty-To-Full Time to Charge with Different Charge -Point Speeds

Vehicle			Empty to full charging time				
Model	Battery	Pod Point Confidence Range[29]	3.7kW slow	7kW fast	22kW fast	43-50kW rapid	150kW rapid
Nissan LEAF (2018)	40kWh	143 miles	11 hrs	6 hrs	6 hrs	1 hr	*Can't charge on this kind of charger*
Tesla Model S Long Range (2019)	100kWh	255 miles	27 hrs	15 hrs	6 hrs	2 hrs	1 hr for 300 miles
Mitsubishi Outlander PHEV (2018)	13.8kWh	24 miles	4 hrs	4 hrs	4 hrs	40 mins	*Can't charge on this kind of charger*

[29]Pod Point Confidence Range is the maximum distance they are confident driving on electric power between charges. Real range will depend on various factors including driving conditions, personal driving style, outside temperature, heating / air conditioning, etc.

As an electric vehicle driver, it's useful to know how many miles of range you are getting during the time your vehicle is charging so you know you can get to your next destination. Pod Point's analysis shows that range per hour varies depending on how efficient your car is. Small full battery electric cars (e.g. Renault Zoe) are the most efficient and get 30 miles of range per hour charging at 7kW. The biggest full battery electric cars (e.g. Audi e-tron Quattro) are heavier and get ~20 miles of range per hour at 7kW. (Plug-in hybrids are usually less efficient than full battery electric vehicles). How efficient a car is, also depends on environmental factors like temperature. This means electric cars are more efficient and get slightly better range per hour in summer than they do in winter.

Miles of range added per hour of charging				
3.7kW slow	**7kW fast**	**22kW fast**	**43-50kW rapid**	**150kW rapid**
Up to 15 miles	Up to 30 miles	Up to 90 miles	Up to 90 miles in 30 mins	Up to 200 miles in 30 mins

APPENDIX TWO

Listing of the incentives offered to EVs/Hybrid Vehicles and CNG Vehicles 2012-2019

Year/Gasoline Price	Hybrid	Compressed Natural Gas (CNG)
2012 *Premium gasoline was increased from TT$4.00 per litre to TT$5.75 per litre from October 2012.*		A reduction in Import Duty (ID) by 50% on vehicles which are manufactured to use natural gas and have an engine capacity smaller than 2300 cc. This reduction in duty will cover the period from January 1st 2011 to December 31st 2015. With effect from January 1st 2012, a wear and tear allowance of 130% of expenditure incurred on the acquisition and installation, in a motor vehicle, of a compressed natural gas kit and cylinder.
2013		No changes proposed.
2014		A tax allowance of 100% on the cost of converting motor vehicles of either individuals or companies to use CNG up to a maximum expenditure of $40,000 per vehicle. This is effective from January 1, 2014.
2015 *Super gasoline increased from TT$2.70 per litre to TT$3.11 per litre.*	New or used hybrid and electric powered vehicles for private or commercial use, not older than 2 years, exempted from MVT and VAT for a period of 5 years. With effect from January 1, 2015.	No changes proposed
2016 *April 2016 – Super gasoline increased from*	No changes proposed	Motor Vehicle Import Duty Relief (CNG vehicles) – 50%

TT$3.11 per litre to TT$3.58 per litre.		
2017 *Super gasoline increased from TT$3.58 per litre to TT$3.97 per litre..*	New and Used electric private & commercial vehicles (not older than 4 yrs) Engine size 179kw exempted from Import Duty, Motor Vehicle Tax and VAT New and Used Hybrid Private & Commercial Vehicles (not older than 4 yrs) Engine size <1599cc. exempt from Import duties, Motor Vehicle Tax and VAT	All New and Used CNG Private & Commercial Vehicles (not older than 4 yrs) exempt from Motor Vehicle Tax and VAT. Import Duties 50%.
2018 *Super gasoline increased from TT$3.97 per litre to TT$4.97 per litre.*	No proposed changes.	All New and Used CNG Private & Commercial Vehicles (not older than 4 yrs) Engine size <1599cc. exempt from Duties, Motor Vehicle Tax and VAT.
2019	No proposed changes	No proposed changes