

## Article

# A Way Forward for Electric Vehicle in Greater Bay Area: Challenges and Opportunities for the 21st Century

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**Abstract:** The Greater Bay Area (GBA) accounts for a high percentage of pollution due to the large number of internal combustion engines. In the past few decades, there has been a significant increase in internal combustion engines vehicles while electric vehicles have not taken off yet in GBA. To a certain extent, the acceptance of electric vehicles is still questionable from the industrial practitioners and local communities. As such, this research study aims to identify the challenges and opportunities of electric vehicles in GBA to address the future direction of electric vehicles in GBA. In this study, it identifies technology and economy as the main driving forces behind the development of electric vehicles. Furthermore, sustainability, safety, and the life of the batteries may induce the slow adoption of electric vehicles. As expected, the study develops a research agenda and contributes new knowledge in the field of electric vehicle.

**Keywords:** Greater Bay Area; internal combustion engines vehicles; electric vehicles



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## 1. Introduction

One of the major steps that the global technology industry has made over the past 30 years has been making progress on electric vehicle (EV) technology and converting the concept into a feasible product. Environmentalists have been making a case against internal combustion engine (ICE) used for decades. In the recent decade, there has been numerous developments in the ICE industry. Over the years, there has been an increase in ICE vehicles globally due to global demand. Statistics show that 30% of all vehicles worldwide are expected to be EVs by 2032, this is predicted to rise to 50% by 2050 [1]. One of the advancements has been the improvements in ICE technology to increase fuel efficiency and to decrease toxic gas emissions [2]. This has been achieved by improving the filters used in vehicles and developing more effective engines that consume minimal fuel per kilometre. Engine efficiency is tied to combustion efficiency, this has improved gradually over the years. Despite the advancements in ICE technology, the sector remains unsustainable due to the negative impact of greenhouse gas emissions produced by the vehicles. In a recent study of greenhouse emission in the United States, statistics of the U.S. Energy Information Administration (EIA) showed that there was 6558 million metric tons of carbon dioxide equivalent in 2019. This worsened as the impacts of global warming started being felt on a global scale. Rises in sea levels globally, increased temperatures, and forest fires have been occurring at a much higher rate over the past five years. Studies showed that the average land temperature in the United Kingdom has risen by 1.2 °C from pre-industrial levels. In the United Kingdom, the sea level has also risen by 16 cm since 1900 [3].

EVs have been tipped by the United Nations Environmental program to be one of the most important ventures to reduce global pollution. According to the United Nations Action Program-Agenda 21, EVs are the future of the world [4]. Commitment to the production of EVs in the continent is considered a key step in the right direction toward making amends and joining the global community in ensuring climate sustainability. As such, EVs have been considered as the best alternative to solve the ICE problem for a long time. In many cases, EV was only seen as a theoretical concept rather than a viable product. However, the lithium-ion battery has been led to rapid development in the sector. The lithium-ion battery has already been a revelation in the mobile phone industry. It has also been highly successful in the enhancement of efficient EV batteries. More people have been able to create functional prototypes and viable products that have already hit global markets.

Despite the positive aspects that EVs present, they are still a long way from becoming a global reality. There are numerous challenges that EV technology must surmount including consumer attractiveness, cost, environmental concerns, policy, etc. One of the arguments by activists in the region is that EVs have a more intensive process of production that ensures the product has already caused significant damage to the environment before it reaches the market [5]. Studies addressed that the energy implications of making EVs are immense. It takes twice as much energy to manufacture an EV as it takes to manufacture a diesel or petrol vehicle. The intensive manufacturing process mainly utilizes coal fired furnaces in the production process leading to plenty of emissions. Another criticism that the GBA has endured is the increased use of coal fired plants in the production of electricity to be used in EVs [6]. In the next few years, there is likely to be a massive increase in the number of EVs in the market. These will require plenty of electricity to charge and recharge. The effect will be the continued existence of coal fired electric generating plants, and hence inducing further environmental degradation. Coal fired plants release plenty of greenhouse gases which are detrimental to the environment.

EVs are the future of car technology. There has been an increased urgency for adoption of EV technology globally because of the increasing damage to the environment and the urgent need for alternatives to the ICE vehicles. Ref. [7] indicated that average lifetime emissions from EVs are up to 70% lower than petrol cars as they are 30% more efficient than petrol cars. Statistics show that in 53 out of 59 regions which make up 95% carbon emissions, EVs are already less emission intensive than fossil fuel alternatives [8]. Asia has been under the spotlight globally due to its role in climate change [9]. Political temperatures have often escalated as political leaders are in the spotlight to lead the nation in adopting EVs [2]. In GBA, there has been more focus on sustainability and thus, the EV has been identified as a viable option to achieve this. GBA also stands to benefit from the adoption of EV globally as the region is now an industrial hub and a leader in EV. The EV technology in GBA has also improved drastically since the early 21st century. The world has also become aware of the finite nature of natural resources used in ICE vehicles [10]. GBA have become hubs for advancement of EV technology to act as a guide for the rest of the world. The study has shown that adoption of EV technology can lead to reducing gasoline consumption from 30% to 50% without the need of changing vehicle class [11]. In doing so, EVs make a positive impact on sustainable environment in the long run.

Nevertheless, the topic of EV has been widely published in various academic journals. However, the past research studies mainly focused on modelling, simulation, econometric modelling, experiment, and operations management. Although GBA is recognized as an emerging city, there is very few research studies discussing about the EV development in GBA by using existing data comparisons [12–14]. The GBA is a megalopolis, including nine municipalities of Shenzhen, Guangzhou, Foshan, Zhuhai, Dongguan, Huizhou, Jiangmen, Zhongshan, and Zhaoqing, and two special administrative regions (Hong Kong and Macao) in South China. As expected, Hong Kong plays a leading role to boost the enhancement of the GBA and facilitate the economic development of Guangdong Province [15,16].

To fill a research gap, the study aims to review the evolution of EV in GBA and identify the challenges and opportunities of EV in GBA to support the sustainable growth of GBA in the forthcoming years.

In general, this paper is divided into four main sections. In Section 1, it provides the research background and setting. In Section 2, it discusses the EV development in order to improve the understanding of EV product and concept. In Section 3, it identified the current issues of EVs in a context of GBA. The four main aspects including technology, environment, economy, and the challenges of EV development are also provided. In Section 4, it addresses the key points and provides the future research direction.

## 2. Electric Vehicle Development

The earliest EV was often credited to inventor Anyos Jedlik. He designed a small model vehicle that could move via a small electric motor [2,11,16]. Between 1832 and 1838, another inventor Robert Anderson came up with another motor that was used to drive a carriage. Such early vehicles were unrealistic. Despite their applicability, they were vital in the development of the concept to produce more recent electric vehicles. In the early 20th century, William Morrison came up with a more realistic electric vehicle which was credited for being the first realistic EV [2,11,16]. The United States also became more involved in the development of the EV. With more research studies going into the concept, strides were made in coming up with a breakthrough vehicle [1,11,16]. In 2008, the Tesla revealed the first EV to have a longer range, it could cover up to 200 miles on a single battery charge [16]. Soon after, the Mitsubishi i-MiEV was released. These two vehicles marked the beginning of the modern EV era. They also showed the possibilities that EVs could have if the problem of range was addressed. Later, other companies introduced their own EVs. General Motors launched the Chevrolet Volt, while Nissan released the Leaf. Table 1 summarizes the key achievements of EV in different phrases.

**Table 1.** Key Achievements of EV in Different Phrases.

Phrase	Period	Key Achievements
I	1828	Anyos Jedlik came up with the first EV.
II	1832–1838	Motor that was used to drive a carriage.
III	2008	Tesla produced a long-range EV.
IV	2008-date	Long range vehicles and increased EV applications in the taxi industry and autonomous vehicles.

Currently, there are many real-life applications of the electric vehicle. Some of the applications include the electric taxi, personal vehicle market, electric buses, electric motorcycles, and electric trucks [17]. To the best of authors' knowledge, the electric taxi is one of the most common applications today due to taxis account for a large number of vehicles operating in towns. In Hong Kong, taxis are one of the main public passenger transport service providers. Such passenger transport service providers offer a custom-made point-to-point transport service for passengers. Currently, there are 18,163 taxis in Hong Kong [18]. Taxi companies have also been among the first in the automobile industry to embrace EVs broadly [19]. An illustrative example is the BYD e6 electric cross-over sedan taxis that launched in Hong Kong in 2013 [20]. Other EV taxi companies include Ola, Connexion, and Blue Smaert Mobility. In a recent study conducted in the United States, 58.9% of interviewed taxi drivers stated that they have a moderate to strong interest in purchasing an EV taxi [21]. Another application is the electric truck. Electric trucks have been already deployed in various locations including in the United States, Stockholm, GBA. Apart from electric trucks, there is a growing popularity of personal electric vehicles. These are similar to personal vehicles powered by Internal Combustion Engines. They are growing in popularity as a result of the global environmental campaigns by the United Nations and other NGOs to conserve the environment. However, the irrational planning of transportation infrastructure also generates negative effects, such as ecological destruction,

increased traffic accidents, climate change, CO<sub>2</sub> emissions, and lower transport efficiency. In case of the transport infrastructure sector has been faulted, for being unsustainable in the long run due to the negative impact it has on the environment. The electric grid on the other hand is considered to be a sustainable resource that remains largely untapped. Studies show that by 2050, the population of inhabitants of urban areas will grow to 2.6 billion people [20]. This leads to a need for sustainable mobility and sustainable energy solutions to solve the challenges.

Ref. [22] highlighted the changes that have taken place in EV in the past century. There has been dramatic decline in the cost of EV and the range of EVs has also improved significantly. Based on the research studies, one of the main findings is that there is low interest in EVs due to the high purchase costs involved. Today, EVs, especially electric passenger cars, are generally more expensive than ICE passenger automobiles of a similar class, in terms of similar seating capacity and cruise range. In the United Kingdom, the purchase price of average electric passenger cars is around £5000 (i.e., deducted the £3000 subsidy for EVs that cost below £50,000 through the British government's Plug-in Car Grant) more than a comparable ICE passenger automobile [23]. However, by improvement of battery's production cost, the average lifetime ownership cost of electric passenger automobiles in the United Kingdom is £52,133, compared to £53,625 for an equivalent ICE passenger car. On average, based on the purchase price and ownership costs over 14 years, an electric passenger automobile would cost £3752 a year over the course of its life, compared to £3858 for an ICE passenger car, resulting in an annual savings of £106 per year. In addition, [24] pointed out that one of the major drivers of EV adoption is the low running costs involved in the running and maintenance of EV. Ref. [25] also discussed that experience with EVs significantly changed perception by the public and encouraged more people to show interest in purchasing EVs. The concept of sustainability is one of the main drivers of the EV industry. EV vehicles provide more energy saving and minimize environmental pollution. This is the basis for the argument that EVs are more sustainable and more applicable in the future compared to ICE vehicles.

Since the turn of the century, there have been many developments in EVs. A study by Kim et al. highlighted the "importance to take into account electric vehicles' special characteristics (e.g., range limit) in predicting their routing behaviour and charging infrastructure design networks" (Jing et al., 2016, p. 3) [11]. After the start of the COVID-19 pandemic, there was a significant improvement in the charge times for EVs. Today, some of the best systems are 800 volts that ensure charge times of less than 30 min. Examples of systems that are capable of achieving this are the Porsche Taycan/Audi e-tron GT platform, as well as the new Hyundai E-GMP architecture. The main problem with fast charging has always been how to find a balance between faster voltages used to charge batteries and ensuring that thermal cooling is achieved. Higher voltages often lead to heating of the lithium-ion batteries. Finding a feasible way to cool the batteries while maintaining high voltages is vital. Another key trend has been the challenge of EV batteries causing fires. This led to the recall of more than 100,000 vehicles by both General Motors and Hyundai.

According to Transport Department (2022) [18], it highlights and summarize different strategies for increasing the adoption of EVs in Table 2.

**Table 2.** Strategies for Improving the Adoption of EVs.

	Seoul	Tokyo	California
The decrease in recurring tax/fee for owning EVs	A subsidy on annual car tax (130,000 won (HK\$871) for personal use; and 20,000 won (HK\$134) for commercial use.	No	No
Electricity charging fee incentive/arrangement	Up to 50% discount on battery charging for residential users.	Free of charge at some government car parks and some privately-owned car parks open for public use.	1. Residential users may opt for the time-of-use (“TOU”) electricity rates (i.e., higher rates are charged during the peak hours, and vice versa) or standard rates. Commercial users are required to be on a TOU plan. 2. A vehicle stationing at off-street parking facility could be towed away if it is not connected for charging purpose.
Parking fee incentive	A 50% discount on parking fee at public parking lots.	A 50% discount at some car parks (hourly rental).	Free of charge in public car parks in some cities (e.g., San Jose, Santa Monica).
Toll fee incentive	Only exemption at Namsan Tunnel.	No	Reduced rates or exemptions on high-occupancy toll lanes.
Road use privileges	No	No	Access to high-occupancy vehicle lanes.

### 3. Current Issues of Electric Vehicles: A Context of Greater Bay Area

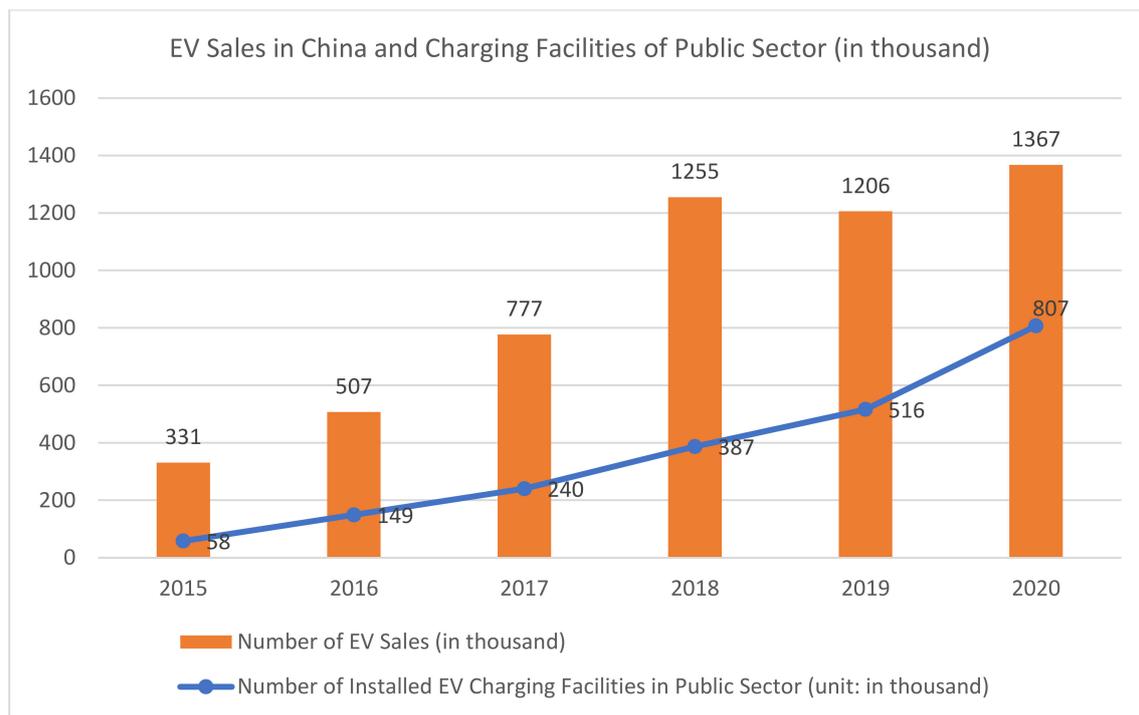
Policies are designed to ensure that different sectors perform efficiently and to keep different areas of the economic growth. Regulation is highly important if EVs are to become a reality. Even more important is to ensure that policies are tailored to the developmental goals that they seek to achieve. Researchers have pointed out the importance of policymaking in the EV industry. Ref. [26] identified that most market failures are combined to hinder the development of EV. Policies are developed and geared towards reducing the negative impact of EV technology on other markets while reaping the benefits of EV. However, it is often challenging to find a balance between a pro-active market policy and the impact it could have on other markets such as electricity supply. A proactive market policy is one in which the major players actively participate in the production, marketing, and sale of EVs. An example is the approach to EV taken by India in the adoption of EV where the government has been actively marketing electric vehicles [27].

China is among the most developed regions globally. They are also major hubs for environmental pollution due to the dense population and the number of internal combustion engines running simultaneously. Ref. [28] highlighted that the United States, Russia, China, Brazil, India, and the European Union bear the responsibility of promoting the aggregation of carbon dioxide and require to take the moral duty to adapt and minimize the impact of climate change. Statistics explained that the number of cities that accommodate at least 1 million people as of 2018 was 548. This number is expected to grow to at least 706 by 2030. Similarly, a growth is forecasted in the number of cities accommodating between 500,000 and 1,000,000 people by 2030. As expected, this number will significantly increase from 597 cities in 2018 to 710 cities in 2030 [29]. To this end, this will pose a negative impact on the environment if alternatives such as EVs are not adopted. A study by the World Health Organization (WHO) found that 4.2 million deaths annually could be attributed to ambient (outdoor) fine particulate matter air pollution [30]. The sources of this pollution include agriculture, industries, and the transport sector which relies on burning fuel to run ICEs. At the moment, there are few policies in Hong Kong that attempt to minimize the use of ICEs or aim to increase the number of vehicle owners opting to purchase EVs. Hong Kong has different statutes that act as a framework for environmental pollution control. One of the popular statutes is the Air Pollution Control Ordinance (Cap 311) (APCO) which is crucial to the regulation of air quality. This policy has been broadly used and applied in

different sectors including in industries and in motor vehicles. This ordinance plays an important role in making sure that any manufacturer that performs a key role in releasing gases into the air ensures that the air is treated, and that the quality of released gases is within the acceptable limits. Yasar et al. (2014, p. 1) [2] elaborated that “the number of all toxic components in the exhaust gas exceeds the maximum permissible standards by tens and hundreds of times”. This has been faulted on the failure to achieve complete oxidation by ICE engines in vehicles. Another statute is the Noise Control Ordinance (Cap 400) which is tasked with ensuring that different sectors including the factories, transport industry, and commercial sector are regulated. It also places Caps on the period when highly noisy exercises can take place. Noise control is related to EVs because they are less noisy than ICE vehicles. In the GBA where the number of vehicles is significantly large in cities, noise levels are a major hazard. However, EVs offer a viable solution to the problem [31].

The fast-growing EV market has increased the demand for charging piles. Despite the backdrop of slowing down for EV subsidies in China, policy support for the EV industry has not disappeared, but the focus has shifted to infrastructure construction, and the construction of charging networks is one of the key points. The financial subsidies to support construction of EV charging infrastructure and related operating services were to be implemented at provincial level and city level. The policy also promoted efficient collaboration between EV and renewable energy. Wind power, EV, and solar energy are expected to coordinate with each other through well-organized scheduling. Construction of multifunctional integrated stations of solar energy storage and EV charging are specifically encouraged and financially supported.

The rapid development of the charging pile industry is inseparable from policy support. In September 2015, the General Office of the State Council issued the ‘Guiding Opinions on Accelerating the Construction of Electric Vehicle Charging Infrastructure’, which for the first time clarified the policy direction of the charging pile industry. Subsequently, the relevant departments of the state and provinces and cities have introduced policies to promote the development and construction of the charging pile industry. In the past few years, the National Energy Administration worked with relevant departments to strengthen the supervision and implementation of action plans related to charging infrastructure and solidly organize and promote the development of charging infrastructure, especially to encourage innovation for both technology breakthrough and business models. Based on the statistics announced by Ministry of Industry and Information Technology (MIIT) and China Automotive Technology and Research Centre (CATARC), the Figure 1 below illustrates the increase in EV sales and charging facilities in 2015 to 2020 in China.



**Figure 1.** EV Sales in China and Charging Facilities of Public Sector (in thousand). Source: [32].

Nevertheless, the EV industry in Hong Kong will address the lack of EV charging points for EV owners. Statistics indicated that as of the end of June 2021, there were 4362 EV chargers for public use including 2200 medium chargers and 702 quick chargers, covering all 18 districts of Hong Kong [33]. However, this is far from the benchmark that the HKSAR government has set for itself. Currently, Hong Kong has an estimated 878,539 thousand vehicles [34]. At least a third of these should be EVs by 2025 as per the benchmark set by the HKSAR government. The number of existing public charging points therefore remains a long way from the benchmark and there is a need for more charging stations and charging points for EVs to ensure the efficiency and sustainability of the project. Setbacks are common in new industries; the EV industry is tipped as being the best energy source for the future. Vehicle users are used to the efficiency of the current vehicles in terms of fuel refilling. Vehicle drivers can stop and refuel their vehicles at ease wherever they are due to the sheer volume of gas stations that service the industry. This is not the case for EVs. There is currently limited infrastructure for vehicle owners to use. A study by McKinsey found that by 2030, the energy demand for EV charging is likely to increase from 20 billion kWh to 280 kWh [35]. This is a significant gap that shows why nations must increase their energy production capacity to match the growing demand for EVs. Over 100 miles, no EV currently developed can make the return trip without recharging [36]. The lack of enough charging points makes this an inconvenience since it could lead to vehicle stalling and inconvenience the owners.

Hong Kong is one of the most technologically advanced cities in the world. This makes EVs one of the technologies that will have a major impact on the entire economic block. Electric taxis replacing conventional ICE taxis will be a source of jobs in Hong Kong. Other applications of EVs such as autonomous vehicles and electric trucks in Hong Kong will also create different kinds of jobs. A couple of such new professions (e.g., electronics engineers, designers, battery engineers, researchers, and data analysts) result from the development of EVs. Additionally, EVs will lead to a further reduction in the importation costs of oil and other gasoline products into Hong Kong. The result is reduced income to foreign countries, leaving more income to build the Hong Kong local economy. Currently, Hong Kong is a leader in the manufacturer of EVs in the Asia region alongside China. China's

macro-economic policy which includes the aggressive development of EV technology in the GBA aims to improve the region's economy by creating more jobs [37]. Other nations globally lack the capacity required to develop and deploy electric vehicles in the scale of China. The GBA is a major part of this, massive development of EV infrastructure will lead to rewards for the GBA. Export of GBA infrastructure to other nations with lower manufacturer capacity will benefit the region. Studies show that China is likely to suffer financially in the short term, however, in the long term, the cost savings will lead to further profits that will boost the Chinese economy.

Hong Kong and the GBA has similar policies that are vital to the implementation of EV technology in the region. Some of the policies are similar to those employed in Hong Kong; however, they are also aligned to the strategic goals and the legislation in China. The GBA utilizes Chinese policies on the EV. One of the most important policies affecting EVs in the GBA is the Chinese macro-economic policy, "Made in China 2025". This is a policy that intends to make China as the global manufacturing hub by 2025 [37]. The policy incorporates the manufacturing of modern EVs as an important part of China's vision for the future. Under the policy, manufacturing and industry are considered to be the main concept for the future of China. Currently, China has already embarked on a visionary journey to implement the policy by upscaling its manufacturing and adoption of EV in the industry. Another policy in the GBA is the zero-Emission Vehicle program. The policy is supposed to ensure that 20% of the vehicles sold in the area by 2025 are zero-emission vehicles [38]. China also imposed a mandate on automakers requiring that EVs make up 40% of all sales by 2030. To achieve this, the EV program currently under way is vital. The GBA must also comply with new policies on charging infrastructure, battery reuse, and recycling and Fuel cell electric vehicles (FCEV) deployment that were rolled out in 2020. Other policies in Hong Kong include having renewable energy sources account for 25% of total energy consumption by 2030, reducing carbon intensity or the amount of carbon emitted per unit of GDP by more than 65% by 2030, and installing enough solar and wind power generators to have a combined capacity of 1.2 billion kilowatts by 2030 [39].

### 3.1. Opportunities of Electric Vehicle Development

In this section, it mainly discusses the various opportunities of EV development in the 21st century. Broadly speaking, three main driving forces behind the development of EV, namely technology, environment, and economy. Figure 2 shows the three opportunities are crucial to the future of EV.



**Figure 2.** Opportunities of Electric Vehicle Development.

#### 3.1.1. Technology

The EV technology is unique as it is considerably different from the ICE. In the place of the fuel tank, the EV has a battery. In the place of the ICE, the EV has an electric motor. The technology of EV is largely based on the interaction of the battery and the electric motor. The battery drives the electric motor which then drives the wheels of the vehicle. EVs run on different technologies across different regions. Such as ICE engines employ different technologies including two stroke engines, four stroke engines, hybrid engines, V-engines, and turbo charged engines among others. Electric vehicles also use various technologies that are dependent on the region where they are produced and the manufacturer. The major technology that differentiates different manufacturers and EVs is the battery technology used. Although most EVs running on lithium-ion batteries, the quality and efficiency of the

batteries varies. This explains the difference in charge times for EVs and the life expectancy of the batteries. The technology also explains the cost of the vehicle. An example is the lithium-ion batteries of the Nissan LEAF which accounted for a third of the cost of the entire vehicle [16]. Different regions including the GBA rely on numerous technologies based on the model of the vehicle and the marketing plan they intend to use.

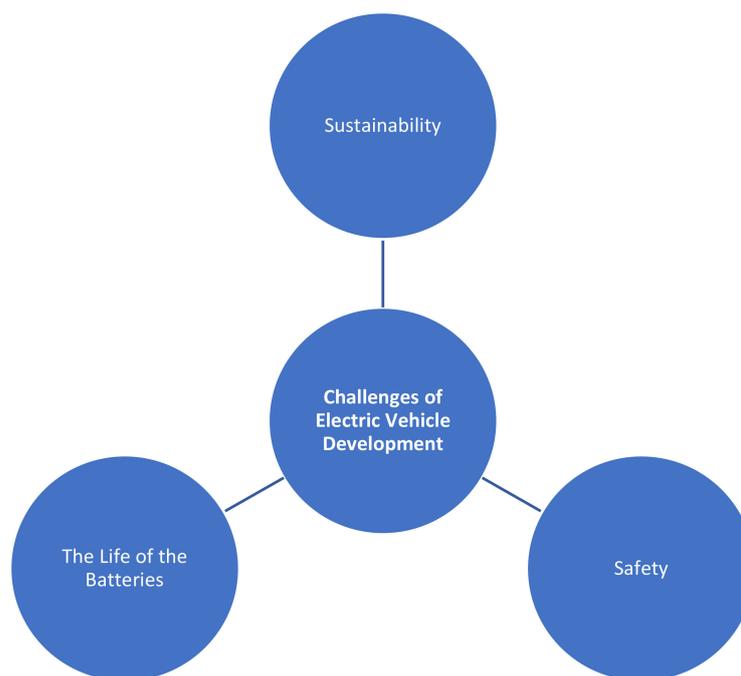
One argument has been that for EV has been that in order for the population to effectively buy into the EV idea, the technology has to match the ICE vehicles in most key areas. The EV charging efficiency may never match the ICE refuelling efficiency. However, despite that, increasing the charging time and recharge efficiency steadily over time can increase confidence and reduce doubt from potential clientele. Different EV technologies are also applied in the GBA. In Huizhou, technology used in EVs has been incorporated with both hardware and software to operate autonomous vehicles. Huizhou is one of the cities in the GBA where there is plenty of activity into the development of EV technology. The company developing the technology is Guangzhou-based EV maker Xpeng Motors working for the company-Desay [40]. In the GBA, most of the components required to develop EV technology is sourced from mainland China to the GBA. Most of the components needed pertaining to battery parts, motors, metal sheets, and electrical components such as copper wire and automation components for electric autonomous vehicles. Other key technologies in EV in the GBA contains smart control and driving technology, new batteries, and energy storage devices [37]. All cities in the GBA including Macao, Guangzhou, Shenzhen, Zhuhai, Foshan, Zhongshan, Dongguan, Huizhou, Jiangmen and Zhaoqing have also scaled up the production of EV technology. Different companies in the region have also specialized in the manufacturing of key parts used in the vehicles.

### 3.1.2. Economy

A green economy is characterized by low carbon, resource-efficient, and socially inclusive society. The use of EVs are considered one way to generate a green economy that is both sustainable and leads to a thriving economy for the entire world [41]. However, in the future, EVs are recognized as the new normal due to the impending depletion of natural resources. The GBA views EVs as a step in the right direction toward a sustainable green economy. In Hong Kong, the EV is part of a 30-year vision that should lead to job creation for part of the population. Some of the applications of the EVs could lead to job creation in some areas including car servicing, EV taxis, and in electricity generation. With the EV, the goal that the GBA strive towards reversing the impact of global warming caused by greenhouse gases. This is likely to lead to lower sea levels, less flooding, and forest fires among other benefits. These have a massive impact on the economy as resources can be redirected towards more constructive goals such as employment creation and healthcare. A review by the International Renewable Energy Agency (IRENA) shows that “renewable energy could power economic growth post-COVID-19 by spurring global GDP gains of almost US\$100 trillion between now and 2050” [42].

### 3.2. Challenges of Electric Vehicle Development

In addition, the enlargement of EV may face unconsidered challenges. In general, four key challenges create the barriers of EV development, namely infrastructure, sustainability, safety, and the life of the batteries. Figure 3 exhibits the four main challenges of EV development in the forthcoming years.



**Figure 3.** Challenges of Electric Vehicle Development.

### 3.2.1. Sustainability

Another challenge that the EV industry in Hong Kong is likely to face is sustainability. EVs have been tipped to be more sustainable than ICE vehicles. Concerns have been raised over their sustainability due to the different raw materials used to produce the EV batteries and their availability. Some of the components used to manufacture EVs include nickel, cobalt, and lithium. Most of the methods used to mine these materials are considered unsustainable. The mining of cobalt in the DRC in particular has been criticized due to the methods used and is considered to be unsustainable due to the emissions involved during mining [36]. These are major concerns that the Hong Kong EV industry is facing.

### 3.2.2. Safety

Another challenge that EVs face is in relation to safety. Despite most researchers conquering that EVs are considerably safer than ICE vehicles, the public is yet to be convinced. In the GBA, one of the major concerns for potential consumers of EVs has been the potential for inflammation of EVs. EVs use lithium-ion batteries as the main source of power for the electric motor. Like all batteries, lithium-ion batteries can short circuit and cause inflammation of the vehicle. In the GBA, lithium-ion battery fires are not a new concern. There have been cases of Samsung lithium-ion batteries and other phone batteries catching fire and leading to injuries. Like phone batteries, EV lithium-ion batteries use extremely energetic reactive materials and flammable organic electrolytes [43]. These can catch fire and cause injuries to users. In the GBA, there has been concern on how manufacturers can guarantee that the vehicles are safer for users. A study by Forbes found that if lithium-ion batteries heat up to 150–200 °C, they undergo a variety of decomposition and other associated exothermic, electrochemical reactions that can lead to detonation [44]. For consumers to be more willing to purchase EVs, more must be done to reduce the concerns that the public has on the safety issue. More research also must be conducted to generate data that backs up the assumption that lithium-ion batteries are generally safer.

### 3.2.3. The Life of the Batteries

The last challenge is the life of the batteries. If the batteries are charged every day or twice a day, they will last only a couple of years. This depends mainly on the context of vehicle usage, which is not very well suited for traveling long distances every day. Indeed,

the EV owners use level 3 fast-charging stations which leads to reduce batteries' lifespan. In the long-term, it may influence the battery's longevity and reliability [45–48].

#### 4. Conclusions

The use of EVs are one of the best solutions for the future of the world. This is because of their potential to reduce greenhouse gas emissions to the environment. The EV battery is the most dividing topic when discussing EVs. This is because of the various components that are used to manufacture the rechargeable battery. Most of the materials used are toxic to the environment and could have long-lasting environmental effects. Policies are designed to ensure that different sectors perform efficiently and to keep various areas of the economy in check. Regulation is highly important if EVs are to become a reality. Even more important is to ensure that policies are tailored to the developmental goals that they seek to achieve. GBA accounts for a high percentage of global pollution due to the dense population and the number of internal combustion engines running simultaneously. The EV could have a positive impact on the local economies and the well-being of the environment [49].

This research study addresses the main trends, challenges, opportunities, and future direction of EV in the GBA. In the future, we may develop a large-scale survey for investigating the behaviours and attitudes of people towards EV. The target respondents include car users, car owners, EV producers, and transport operators who are in 11 GBA cities. In addition, the taxi industry contributes to a considerable number of vehicles operating in cities. The implementation of the electric taxi is largely determined by the sound infrastructure (i.e., EV charging facilities). In following research, we may develop an optimization of the charging station map for the application of electric taxis in GBA. In doing so, it may support the enlargement of electric taxi operations to build up a sustainable city in the forthcoming years.

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