APRIL 2021

DISCUSSION PAPER SERIES NO. 2021-15

Clean Energy Technology in the Philippines: Case of the Electric Vehicle Industry

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April 2021

Abstract

Electric Vehicles (EVs) have gained attention globally as countries pursue the use of alternative technologies that reduce harmful emissions, climate-related effects and reliance on the use of fossil fuels. In the Philippines, policies and programs in support of the EV industry have been implemented, while a pending legislation awaits enactment. In an attempt to contribute insights to the policy discussion on EVs, the study examines the EV industry in the Philippines, current regulations, and challenges faced by the industry. The study finds strengths and opportunities in the EV industry, which include positive industry outlook and prospects for manufacturing in the supply chain. It also identifies weaknesses and threats related to technology utilization and competition. The study also presents recommendations to take advantage of the industry's potentials.

Keywords: electric vehicles, clean technology, clean energy, Philippines

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Clean Energy Technology in the Philippines: Case of the Electric Vehicle Industry

***Maureen Ane D. Rosellon*[1]**

1. Introduction

The government aims to promote efficient utilization and conservation of energy, and to reduce dependence on fossil fuels to minimize harmful emissions and wastes to protect the environment. The action to reduce carbon emissions is not only a domestic deed but also a contribution to the 2015 Paris Agreement's global action towards addressing global warming.[2] Deployment of clean (renewable) energy technologies could be considered the most familiar approach to such objectives.

In other areas, such as the transport sector which is one of the highest consumers of fuel, efficient use and reduced dependence on fuel protects not only the environment but also the industry stakeholders that are affected by fluctuations in the price of imported fuels.

Electric vehicles (EV) have gained attention globally as an alternative transport technology that lessens fuel usage and combustion emissions. Global outlook on EV is positive as organizations and companies project an increasing trend in sales and share in the vehicle fleet in the next 10 to 20 years. Moreover, governments and vehicle manufacturers have set targets for EV sales and production of new models.

In the Philippines, electric jeepneys and tricycles are now traversing the streets of metropolitan areas like Metro Manila and tourist destinations like Boracay. The public utility vehicle modernization program, e-trike projects, fiscal incentives and other policies are being implemented, indicating government's support to the adoption of EVs. Moreover, the Senate Bill on EV and Charging Stations has been proposed to finally establish a national policy and regulatory framework for the use of EVs in the country. It is motivated by the objectives to have energy security and reduce dependence on imported fuel, in this case, the transport sector; to support innovation in clean, sustainable and energy-efficient technologies; and through new technologies, promote more inclusive and sustainable industries (Senate Bill No. 1382).

This study aims to examine the EV industry in the Philippines. Particularly, it looks at the current status of the industry, the government regulations, and challenges faced by the industry. It aims to provide insights and inputs to the policy discussions on EV and crafting of future programs for the industry.

The paper is organized as follows: the next section discusses the EV industry structure, performance and outlook both at the global and Philippine contexts; Section 3 presents an overview of the policy environment in the Philippines; the methodology and results of the

[1] Supervising research specialist, Philippine Institute for Development Studies (PIDS).

[2] The country is developing its first Nationally Determined Contribution (NDC) which is a "*self-determined set of long-term strategies to reduce greenhouse gas emissions"* (Algo 2021). The NDC is considered the 'heart' of the 2015 Paris Agreement as it communicates the actions that countries are willing to undertake to achieve the goal of limiting global average temperature to 1.5^{o}C above pre-industrial levels (Nationally Determined Contributions (https://climate.gov.ph/our-programs/nationally-determined-contributions)).

analysis are discussed in Section 4; and Section 5 concludes and presents the recommendations of the study.

2. Industry Structure, Performance and Outlook

The word "clean" when affixed to technology refers to a broad range of products, services and processes that utilize renewable energy sources, harness natural resources sustainably, and protect the environment by reducing or eliminating emissions, wastes and other negative impacts (NCT 2019; Kachan and Co 2012; Makower and Pernick 2001). There is no standard international definition yet, but clean technology has been described as a broad range of technologies related to:

- renewable energy, e.g. solar, hydro, wind, geothermal, biomass, tidal;
- transportation, e.g. e-vehicles, battery storage;
- water, e.g. treatment and production;
- materials, e.g. green buildings and smart grids; and others.

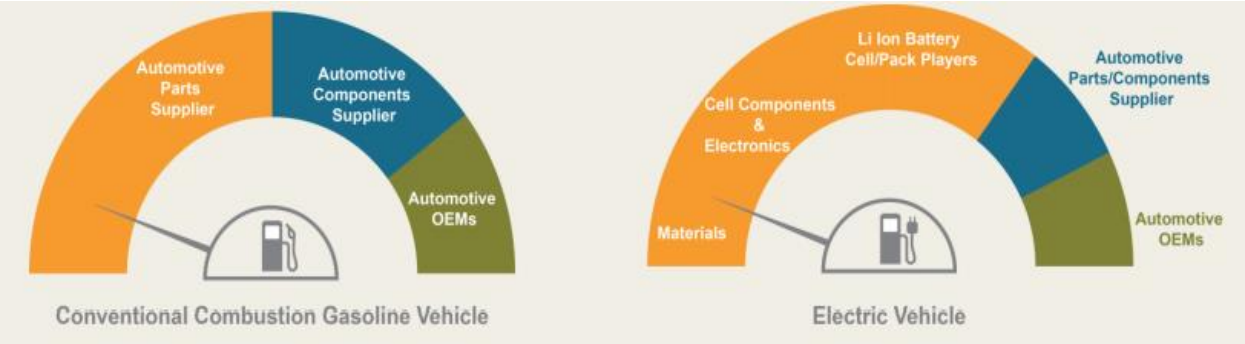
In this study, the focus is on electric vehicles (EV), which is considered herein as a form of clean transportation and clean energy utilization. For many years, countries around the globe have been gathering together in multilateral discussions to reduce harmful emissions that contribute to global warming and overall, manage the risks and impacts of climate change. Among several actions observed in many countries, the manufacture and deployment of EVs have gained attention globally as an alternative transport technology that lessens fuel usage and combustion emissions.

Electric vehicles (EV) are defined as cars and other vehicles with motors that source their power from electricity and not liquid or liquefied fuels.[3] EVs can be classified into three main types: all electric, plug-in hybrid, and hybrid. The battery electric vehicle (BEV) and fuel cell electric vehicle (FCEV) are examples of EV that are solely powered by electricity using battery and fuel cell, respectively (combination of both can also be used). Plug-in hybrid electric vehicle (PHEV) is powered by a combination of fuel and electricity; while, non-plug-in electric vehicle (HEV) uses its braking system to recharge its battery instead of using an external plug. As for vehicle type, electric cars, buses, trucks (light to heavy commercial), vans, mopeds, scooters, and motorcycles are some examples of EVs being manufactured.

In terms of industry composition and players, an outline of the conventional and electric vehicle industries indicates that there are some parts and components that are similar to both (Figure 1). But as expected, there are new systems that are used for electric vehicles which may require new suppliers or retooling by existing suppliers (Todd et al 2013). The electric vehicle supply chain is in some way a reconfiguration of the conventional automotive supply chain.

[3] https://arena.gov.au/renewable-energy/electric-vehicles/.

Figure 1. Industry Composition and Players: Conventional vs Electric

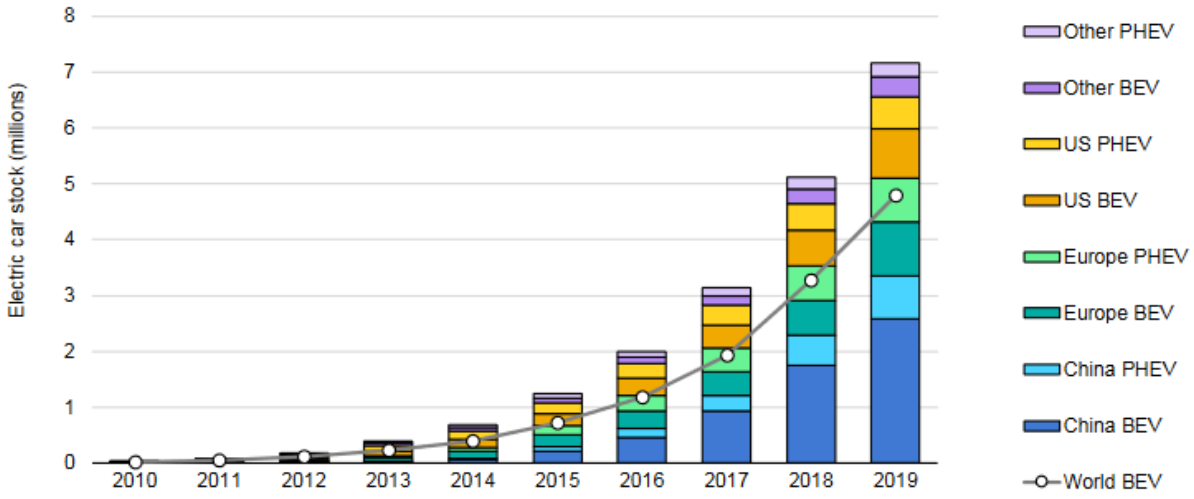


Source: Figure 5, Todd, J., J. Chen, and F. Clogston, 2013, Creating the Clean Energy Economy: Analysis of the Electric Vehicle Industry, International Economic Development Council, Wasington, D.C.

2.1. Global EV Industry Structure, Performance and Outlook

In 2019, passenger vehicle global sales reached 2.1 million, thereby increasing EV global fleet to 7.2 million (IEA 2020). This is a huge increase from 450,000 sales in 2015 (BNEF 2020). China has been leading in global sales and fleet, and in 2019 it composed nearly half of EVs on the road globally (Figure 2).

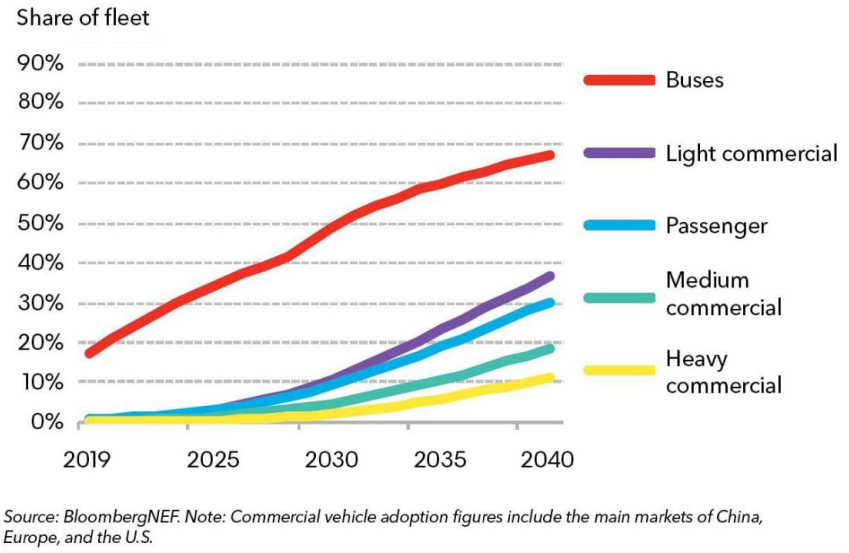
Figure 2. Global fleet of EVs, 2010-2019



Source: Figure 1.1, IEA (2020).

In their report on EVs, BloombergNEF (2020, p.1) revealed that there are over "500,000 e-buses, almost 400,000 electric delivery vans and trucks, and 184 million electric mopeds, scooters and motorcycles on the road globally." The projections in their 2019 report indicate that the demand for each segment of the EV fleet will be on an upward trend especially in the next 10 to 20 years (Figure 3). In particular, by 2040, BloombergNEF (2019) projects that 56 percent of light commercial vehicles and 31 percent of medium commercial vehicles in China, the US and Europe will be electric.

Figure 3. Electric Vehicle Share of Global Fleet by Segment



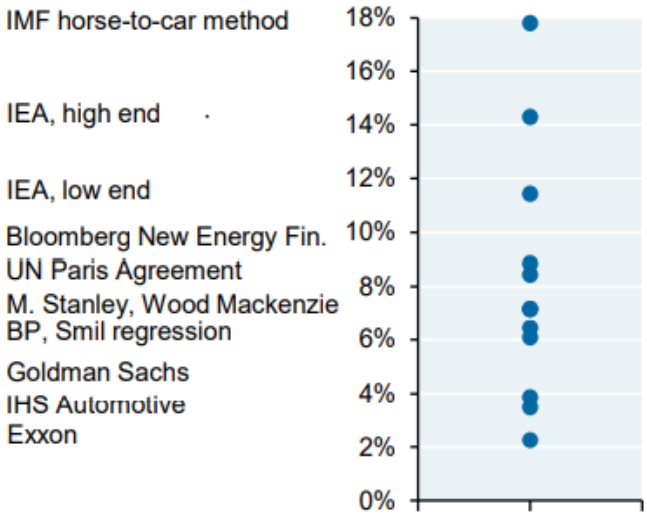
Source: BloombergNEF. Note: Commercial vehicle adoption figures include the main markets of China, Europe, and the U.S.

Source of figure: BloombergNEF Electric Vehicle Outlook 2019.

Global sales and stock of EVs are projected to continually increase in the future. While the BloomberNEF's Electric Vehicle Outlook 2020 expects EV sales to decline to 1.7 million in 2020, it projects sales to reach 8.5 million in 2025, 26 million in 2030 and 54 million in 2040. The largest share of sales, again, to come from China, followed by Europe.

The relatively small share of EV in total vehicle sales is also projected to improve increasingly (BNEF 2020). In 2020, the estimated share of EV in total vehicle sales is 2.7 percent; while the projected share will reach more than half (58%) in 2040. Meanwhile, the share of EV in global fleet is also projected to rise. Projections by different organizations and companies on the penetration of EVs range from 2 to 18 percent by 2030 (Figure 4; Cembalest 2018). In particular, BloombergNEF estimates that the share of EVs on the road will increase to 10 percent in 2030, and will reach 31 percent by 2040.

Figure 4. Share of EV in global fleet size, 2030

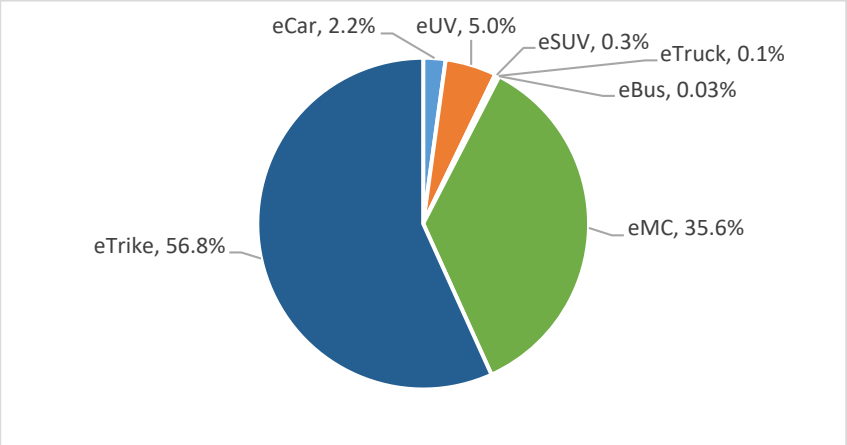


Source: Cembalest (2018)

2.2. *Philippine EV Industry*

In the Philippines, EVs have already been plying across the roads in the metro and countryside. From 2010 to 2019, there were 11,950 EVs registered with the Land Transportation Office (LTO); and as of December 2018, 19 charging stations (Aldaba 2019). The EV industry is composed of the following segments: e-jeepney (four-wheeled), e-quad, e-trike (tricycle), e-bike, and e-car. E-trikes or e-tricycles dominate electric transportation at 57 percent, while electric cars compose 2 percent (Figure 5).

Figure 5. Electric Vehicles in Philippine Transport



Source of data: LTO presentation in the Philippine EV Summit 2020[4]

The Department of Trade and Industry (DTI) targets that EVs comprise 21 percent of total vehicles by 2030 (Cahiles-Magkilat 2020). Initial targets include about 10,000 E-jeepneys on the road and 200 power charging stations in SM and Shell outlets by 2022. [5] Meanwhile, the industry association, Electric Vehicle Association of the Philippines (eVAP), projected that EV sales will reach 200,000 units by 2025 (Bajo 2019).

EV industry players in the Philippines include 28 vehicle manufacturers (8 of them have foreign equity); 11 parts and components manufacturers; and 7 importers, dealers and traders. (Table 1).

Table 1. EV Industry Players in the Philippines

Industry Players	No. of Companies
Vehicle manufacturers (with foreign equity)	28 (8)
Parts and Components manufacturers	11
Importers, dealers, traders	7

Source: Electric Vehicle Association of the Philippines (eVAP) Proposed Roadmap 2014-2024; BOI (2018)

[4] Source: eVAP (https://www.evap.com.ph/resources).

[5] SM is a group of companies engaged in shopping mall development and management, retail, real estate development, banking and tourism; Shell refers to the oil and gas company. Petroleum companies are one outlet for charging facilities. In the Philippines, Unioil Petroleum Philippines was the first petroleum company to set up charging stations for EVs (Saulon 2018).

MMC (2019) documented about 15 e-jeepney models, 21 e-trike models, 11 electric car models (including SUVs, vans, pick-ups) and 61 motorcycle models (two-wheel, three-wheel, quadricycle) in the Philippines as of March 2019.

Examples of hybrid electric car models available in the Philippines include BYD Qin (2018), Honda CR-Z and Legend (2018), Toyota Prius (2018), and Lexus CT200h (2018), Mitsubishi Outlander PHEV (2020).[6] All-electric models from Hyundai, the Kona Electric and IONIQ Electric, are also available in the Philippines; and waiting to arrive in 2021 is the Nissan LEAF.[7] Chinese manufacturers, Levdeo, Geely and MG Motors, will also be introducing their EVs to the Philippine market (eVap 2020). Meanwhile, local manufacturers such as ToJo Motors, Philippine Electric Utility Vehicle (PhUV) and PinoyAko Corporation, and distributors like Global Electric Transport Inc. (GET) have released e-jeepney and e-trike models (MMC 2019).

The Philippines has an existing automotive industry, with vehicle manufacturers and assemblers, parts and component manufacturers, importers and dealers. In the automotive global value chain (GVC), "the participation of the Philippines is in the production of parts and components, particularly in wiring, electronic components, and aluminum components; and in the production of systems modules, particularly in electrical and electronics system (ignition, chassis electronics and interior electronics), and chassis system (drive trains, rolling chassis, wheel and tire assemblies, front and rear end modules, and vibration controls" (BTIPR 2017, p.1). The capabilities of the industry in terms of vehicle assembly, production of parts, components and systems, especially of electronic components and electrical and electronics system, show promising opportunities for participation in the EV supply chain and overall, the development of the EV industry.

3. Policy Environment

In many countries, adoption of EVs is encouraged through the granting of incentives and implementation of tighter regulations on emissions (BNEF 2019). Several governments have also announced specific goals for EV sales and dates for banning internal combustion engine (ICE) sales. Several countries in Europe have set EV goals, and most of them announced the end of ICE sales in the next 10 to 20 years. Moreover, countries in Asia and South America also declared their target for EV sales (Table 2). Countries in ASEAN have also set targets for EVs. It is observed that the target statements refer to the production or sales of EVs and not on the ban of ICE, except for Singapore.

Table 2. Announced policy goals for vehicle sales, selected countries

Country	Goal
China	ICE ban pending; cap-trade policy targets EV sales of 5% by 2020
Brazil	EVs 30% of sales by 2030
Canada	EVs 30% of sales by 2030
Italy	EVs 30% of sales by 2030
Japan	EVs 30% of sales by 2030
Mexico	EVs 30% of sales by 2030
South Korea	EVs 30% of sales by 2030
Netherlands	End ICE sales by 2025

[6] Sources: "Outlander PHEV…" (2020); and "Electric cars available…" (2020).
[7] Source: "Hyundai electric vehicles…" (2020); and "Nissan to bring Leaf EV…" (2020).

Country	Goal
Norway	End ICE sales by 2025
Germany	End ICE sales by 2030
India	End ICE sales by 2030
France	End ICE sales by 2040
United Kingdom	End ICE sales by 2040
ASEAN	
Philippines	EVs 21% of sales by 2030, 50% by 2040
Indonesia	2.1 million motorcycles and 2,200 electric cars by 2025
Malaysia	100,000 electric cars, 100,000 motorcycles, 2,000 electric buses by 2030
Singapore	Phase out ICE by 2040
Thailand	EVs 30% of annual car production (750,000 units) by 2030
Viet Nam	100,000 electric cars by 2020

Source: Table on Government Policy Goals in Cembalest (2018); for ASEAN – MMC (2019), Partnership on Sustainable Low Carbon Transport (2020), Author update
Note: ASEAN announcement dates: PHP-Sep.2020, IDN-Jan.2019, MYS-Aug.2017, SGP-Feb.2020, THA-Mar.2020, VNM-Aug.2013

Meanwhile, the big vehicle manufacturers also announced their targets for EV sales and new electric models in the near future to 10 years (Cembalest 2018).[8] The government and private sector goals for the industry together indicate great prospects for continued and even intensified demand for EVs, and growth for the industry overall.

In the Philippines, the government announced a target of 21 percent EV composition of total vehicles by 2030, and 50 percent by 2040 (Cahiles-Magkilat 2020). To support the EV ambitions of the country, various programs and regulations have been formulated and proposed. These include:

- Investment Priorities Plan (IPP) and Inclusive Innovation Industrial Strategy (i3S)

Under the IPP and i3S, the government offers income tax holiday to entities that will venture into manufacturing of EVs and operation of charging stations. In addition, the EV industry being part of the top priorities under the inclusive innovation industrial strategy (i3S) can expect fiscal and non-fiscal support from the government.

- Public Utility Vehicle Modernization Program (PUVMP)

The modernization programs for public utility vehicles aim to provide a safer, healthier, cleaner and environment-friendly transport system for commuters. Under the PUVMP, all PUVs aged 15 years or older will be replaced with modern PUVs powered by either brand-new Euro 4 compliant diesel engines or electric motors (Mercurio 2019). The program includes, among others, a Scrappage Program for end-of-life vehicles.[9]

[8] Companies include Chinese OEMs, Toyota, Volkswagen, Renault-Nissan, Hyundai, GM, Ford, Honda, Daimier, BMW, Volvo, Tesla.
[9] Source: An article on PUV Modernization in the LTFRB website - https://ltfrb.gov.ph/puv-modernization-2/ (accessed march 2021).

- Comprehensive Automotive Resurgence Strategy (CARS) Program and Eco-PUV Program

The CARS program aimed to attract new investments, stimulate demand in the automotive industry, and develop the country as a regional automotive manufacturing hub (Executive Order 182, s.2015). The program provides time-bound and output/performance-based fiscal support for the manufacture of three models of four-wheeled motor vehicles, with investments in the manufacture of automotive parts. Two models, Vios by Toyota Motors Philippines Corporation and Mirage G4 by Mitsubishi Motors Philippines Corporation, are participating in the program. There being no third participant, the DTI is allotting the unutilized portion of the CARS budget for the Eco-PUV program which will support the manufacture of eco-friendly PUVs under the PUV Modernization Program (Mercurio 2018; Desiderio 2018).

- Philippine National Standards for EVs

The DTI's Bureau of Philippine Standards (BPS) has adopted as Philippine National Standards (PNS) various standards on electric vehicles from the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC). Standards include general requirements, safety requirements, technical specification, terminology and test procedures related to EV conducting charging system, battery swap system, electric mopeds and motorcycles (DTI 2020) [Table 3].

Table 3. Philippine Standards on EVs

Standard	Description
PNS IEC 61851-1:2019	Electric vehicle conductive charging system – Part 1: General requirements
PNS IEC/TS 62840-1:2019	Electric vehicle battery swap system – Part 1: General and guidance
PNS IEC 62840-2:2019	Electric vehicle battery swap system – Part 2: Safety requirements
PNS ISO/TR 13062:2019	Electric mopeds and motorcycles – Terminology and classification
PNS ISO 13063:2019	Electrically propelled mopeds and motorcycles – Safety specifications
PNS ISO 13064-1:2019	Battery-electric mopeds and motorcycles – Performance – Part 1: Reference energy consumption and range
PNS ISO 13064-2:2019	Battery-electric mopeds and motorcycles – Performance – Part 2: Road operating characteristics

Source: DTI (2020)

- Executive Order 488 (2006)

The EO imposes zero tariffs on components, parts and accessories for the assembly of hybrid, electric, flexible fuel and compressed natural gas (CNG) motor vehicles (Aldaba 2019).

- Tax Reform for Acceleration and Inclusion (TRAIN) Law or RA 10963[10]

[10] The TRAIN restructured the tax schedules including the excise tax for automobiles. Ad valorem tax rates directly applied to the net manufacturer's price/importer's selling price are imposed on automobiles instead of marginal tax rates. (Source: Official Gazette; NTRC (2018)).

Net Manufacturer's Price/ Importer's Selling Price (PHP)	Tax Rate
Up to 600,000	4%
Over 600,000 to 1,000,000	10%

The TRAIN law, enforced on January 1, 2018, states that "purely electric vehicles and pickups shall be exempt from the excise tax on automobiles, and hybrid vehicles shall be subject to 50 percent of the applicable tax rates on automobiles" (Section 45).

- Proposed: Senate Bill 1382 or the Electric Vehicles and Charging Stations Act of 2018

The Bill proposes a national policy and regulatory framework for the use of electric and hybrid vehicles and the establishment of electronic charging stations in the country (Rivera 2019; Casayuran 2019). The bill is motivated by the country's objective of having energy security and reducing dependence on imported fuel, in this case, the transport sector; supporting innovation in clean, sustainable and energy-efficient technologies; and promoting inclusive and sustainable industrialization such as by attracting investments, stimulating participation and growth in MSMEs, and generating jobs through these new technologies (Senate Bill No. 1382).

The proposed legislation intends to prepare the infrastructure, policy and regulations necessary for adoption of EVs. Provisions in the Bill include role of key government agencies[11] and local government units (LGUs), designation of parking slots for EVs, open access installation of charging stations, manufacturing fiscal incentives, non-fiscal incentives (e.g. related to vehicle registration).

Moreover, other House and Senate Bills propose incentives, particularly: excise duty exemption; VAT exemption for raw materials, parts and capital equipment that will be used in EV manufacturing; priority in registration and issuance of plate number; exemption from unified vehicular volume reduction scheme; free parking space; priority in PUV franchise application; and, space for charging stations (Aldaba 2019).

- EV Roadmap

The DTI and eVAP are developing a comprehensive roadmap for the EV industry that sets out the targets and strategies for the industry including the goal of making the Philippines the third auto manufacturing hub in the ASEAN region and a global manufacturing hub for low cost transportation and commercial vehicles (Cahiles-Magkilat 2020). The roadmap's target is 21 percent EV share in total vehicles by 2030 (largely public utility vehicles), and 50 percent by 2040.

The DTI also proposes an EV Incentive Strategy (EVIS) which aims to provide comprehensive fiscal and non-fiscal support to jumpstart the development of the EV manufacturing industry in the Philippines (Lopez, 2020). The EVIS will be built on an EV ecosystem which consists of regulations (e.g. standards, requirements, protocols, testing, verification); information, education and communication; incentives and industry development (e.g. tariff elimination or reduction, EV program, incentives for parts and components, charging infrastructure); human resource development (to support local and global requirements); and R&D (e.g. next generation vehicles, smart transport).

Over 1,000,000 to 4,000,000	20%
Over 4,000,000	50%

[11] Government agencies include Department of Energy (DOE), Energy Regulatory Commission (ERC), Department of Transportation (DOTr), Department of Trade and Industry (DTI), Department of Environment and Natural Resources (DENR), Department of Public Works and Highways (DPWH), Department of Science and Technology (DOST).

4. Industry Analysis

This study uses the SWOT method in the analysis of the EV industry. Through this approach, the status and challenges of the industry can be determined. Strengths and Weaknesses are internal attributes of the industry that can either get the industry moving or slow it down. Threats and Opportunities refer to characteristics of the external environment that can challenge or support industry development. These weaknesses and threats if interacted with strengths can help the industry take advantage of opportunities.

4.1. EV industry Structure and Value Chain

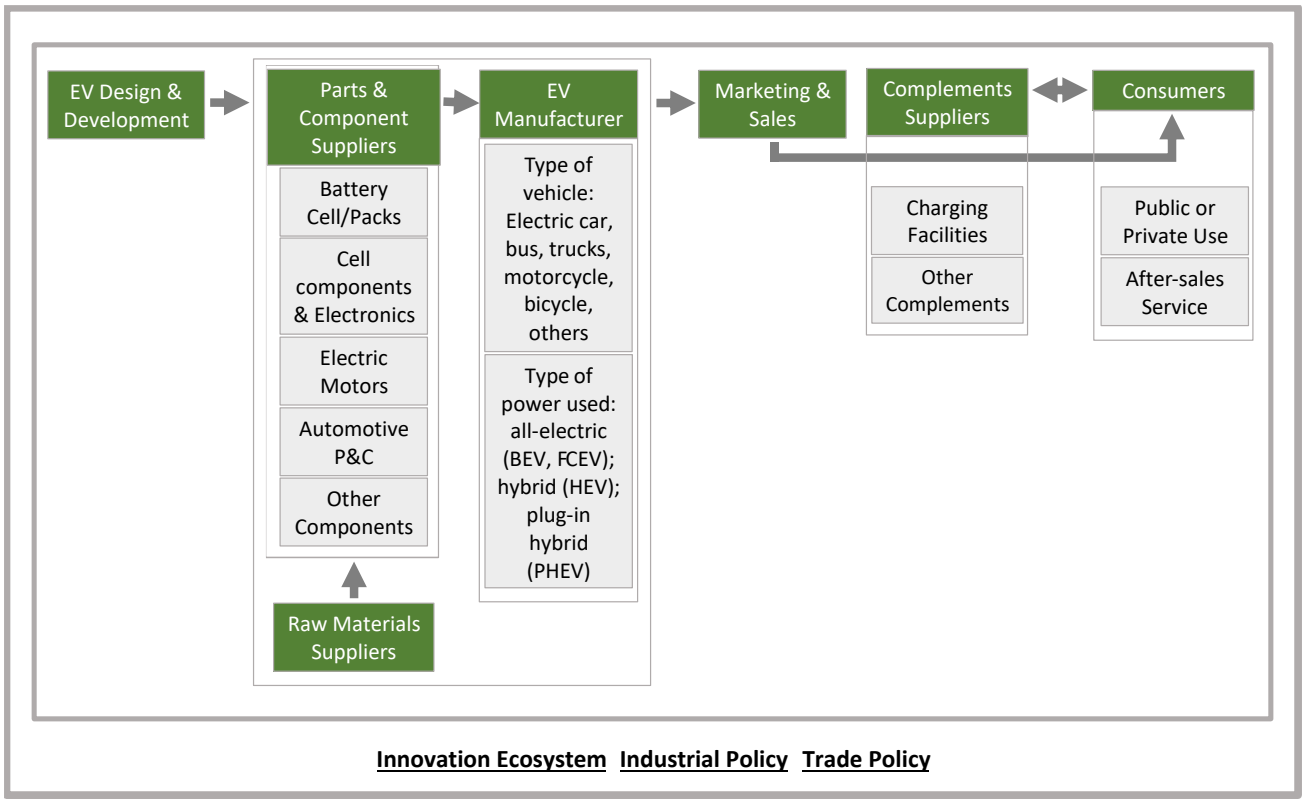
Identification of the strengths, weaknesses, threats and opportunities in the EV industry is guided by the EV industry structure and value chain, which is compiled in this study based on the Philippines' automotive industry structure and EV structure outlined in the literature (Figure 6).

The industry value chain starts with design and development and ends with the consumers and after-sales service. In between, vehicle manufacturing involves players such parts and components suppliers, raw materials suppliers, the manufacturer, distribution and sales, and complements suppliers. Some components are similar between the conventional and electric vehicles, but there are new systems and components in the manufacture of EV which include new gear boxes, electric power steering, water pumps (for cooling the electric engine), battery packs, cell components, and basic materials for batteries (Todd et al 2013).

Several types of electric vehicles can be manufactured, e.g. passenger cars, vans, buses, trucks, two-/three-wheeled motorcycles, bicycles, etc.; and all-electric or hybrid for power used. Moreover, similar to automotive, marketing, sales and distribution is part of the value chain, but for EVs an additional component in the chain is the charging facility.

The innovation ecosystem and policy environment are important elements in the development of the industry. Policies could either be an enabler or a hindrance to its growth. Programs and regulations related to innovation, industrial development and trade impact on the operations and aspirations of players in the EV industry.

Figure 6. A Compilation of the Electric Vehicle Industry Structure and Value Chain



Source: BTIPR (2017); Todd et al (2013); Wu et al (2018); compilation by the author.

4.2. SWOT Analysis

Table 4 outlines the strengths, weaknesses, opportunities and threats to the EV industry in the Philippines based on data and information collected for this study.

Table 4. SWOT: EV Industry in the Philippines

Strengths	-Strong government support; EV strategy; legislation; national standards for EV -Presence of local EV manufacturers -Active industry association/players; positive outlook by the industry; positive response from the financial sector -Partnership established by the government and the private sector -Zero tariffs on components, parts and accessories for the assembly of hybrid, electric, flexible fuel and CNG motor vehicles -Manufacturing capabilities useful in EV sector (e.g. auto electronics & assembly, semiconductors) -High consumer outlook; EVs have been introduced into the transport sector
Weaknesses	-Relatively low level of technology utilization in manufacturing and infrastructure -Low number of charging stations -Consumer concerns in using EVs
Opportunities	-Battery manufacturing (nickel) -Participation in the value chain Asia and the world; Trade and investment -Transfer of technology; R&D; Technical cooperation

	-Decline in price of battery -Electrification is a global trend
Threats	-Increased competition in the region for trade and investment -High cost of EVs; Possibility that price of raw materials will not decline, even increase, in the short to mid-term -Charging infrastructure or technology not catching up with the growth in production and adoption of EVs

Source: Compilation by the author based on data and information collected

4.2.1. Strengths

The strengths of the EV industry in the Philippines largely rest on the government support, stakeholder outlook, and automotive manufacturing capabilities.

The policies and proposed legislation for the EV industry, previously discussed, indicate the strong support from the government. Development of the EV roadmap sets the strategic actions and goals for the industry. Having a positive outlook on the future of EVs in the Philippines, the industry has also been very active in advocacy, in participating in government programs, and in trade and manufacturing activities; hence, together with the contribution of the industry, the government was able to make some accomplishments in promoting EV in the country.

For instance, a year after its launch in 2017 the PUV Modernization Program covered 3,393 modern units from 132 participating franchises in different routes in the country. The modern PUV units were composed of 2,297 public utility jeepneys, 424 buses or mini-buses, and 624 UV Express [van-type] (San Juan 2018). Moreover, the modernization efforts also received positive reaction from the financial sector, with private banks expressing interest to offer financial packages for modernizing PUVs (Mercurio 2019). Other projects include the Tricycle Replacement Program of the DOE which deployed to different LGUs 3,000 e-trikes that were produced by BEMAC, a local electric tricycle manufacturer (based on a February 2020 article [eVAP 2020]).

The government partnered with the Asian Development Bank (ADB) in the 'Market Transformation through Introduction of Energy-Efficient Electric Vehicles Project,' which aimed to introduce clean, energy efficient electric tricycles or e-trikes that will replace gasoline-powered tricycles in the country.[12] In 2019, e-trikes were deployed in Metro Manila and other urban areas such as Cagayan de Oro, Marawi City, and Brooke's Point. Under this project, a unit can be acquired through a lease-to-own agreement which required drivers to pay a daily boundary to their respective local governments (Clapano 2019; Cordero 2018; Mercurio 2014).

Meanwhile, EV players have taken advantage of the zero tariffs imposed on components, parts and accessories for the assembly of hybrid, electric, flexible fuel and CNG motor vehicles. From 2017 to July 2019, there was a total of USD 248.35 million worth of imports of EV parts, components and/or accessories (details in Appendix A).

[12] The e-trikes use electric motor and rechargeable lithium-ion battery. More information about the ADB Project can be found at: https://www.adb.org/projects/43207-013/main.

Another strength is the current manufacturing capabilities in automotive and electronics manufacturing. The country can leverage on its capabilities in auto-electronic, electronic parts and components manufacturing, semiconductors manufacturing, and automotive assembly. It has capabilities related to the EV industry, such as power electronics and controllers, power modules and convertors, PCB/semiconductor assembly, power supply design, transmission electric control unit, next generation invertors for hybrid and electric vehicle, safety electronics (airbag control, auto cameras, sensors, etc.), motorcycle and automotive assembly, among others.[13] The Philippines has been a key manufacturer-exporter of wire harnesses which is a vital component of electrical systems in vehicles.

Moreover, there are EV technologies present and being utilized in the country. Local EV manufacturers such as BEMAC, PhUV, PinoyAko Corporation, Star, ToJo Motors have been producing e-trikes and e-jeepneys. To some extent, there is existing capability in EV product development and manufacture which can be exploited and upgraded.

MMC (2019) finds that the presence of major automotive software companies reflects presence of software development base in the country. Local network of marketing and sales are also the country's strong points.

Partnership between EV firms also show strength and is reflective of positive outlook for the industry. Below are some examples:

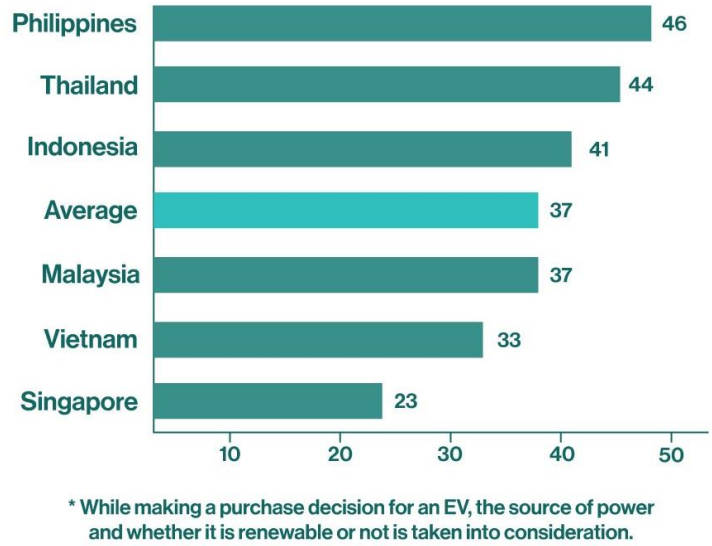
- Joint venture in 2015 between Ropali Corporation, a top motorcycle dealer in the Philippines, and TECO Electric and Machinery Co., Ltd,[14] a Taiwanese company that develops and manufactures electric motors. Their partnership, called ROTECO (combination of both company's names), aims to produce e-vehicles that feature safety, power, efficiency, comfort and stability. Their e-trike and e-jeepney line was first launched in 2015 in Subic Bay Freeport, Philippines (SBMA 2015).
- Partnership of ToJo Motors, a local manufacturer, with Jiangsu Highstar Battery Manufacturing Company, a Chinese firm, for the local assembly of EV batteries; and with the Power Battery Application Committee of China Industrial Association of Power Sources (CIAPS-PBA) for the sourcing of battery cells (Crismundo 2020).
- Partnership between Mitsubishi Motors Philippines Corporation (MMPC) and Meralco which aimed to build EV quick charging stations in four DTI and DENR offices (Eusebio 2018).[15] The project was commissioned by MMPC, with Meralco (through its subsidiary, MSERV) building the charging stations. The first installation was done in DENR Regional Office in Davao City.

Consumer reception and enthusiasm is also one strength of the EV industry in the Philippines. E-trikes, e-motorcycles and e-jeepneys are becoming increasingly visible in the streets, hence EVs are not something new or unfamiliar to Filipinos. Supporting this observation is the market research by Nissan and Frost & Sullivan in 2018 which revealed that 46 percent of Filipino consumers are open to buying EV as their next vehicle. The percentage was highest among six

[13] Assessment by Nomura Research Institute in 2018.
[14] TECO Electric and Machinery Co. is reported to have gained success in the electric car market in Taiwan. It is one of the prominent companies in Taiwan that are engaged in green technology (Flores 2013).
[15] DTI office in Makati City; and DENR Central Office in Quezon City, Regional Offices in Cebu and Davao. MMPC donated five iMiEV and five Outlander Plug-in Hybrid Electric Vehicles (PHEV), and four Chademo EV chargers to DENR and DTI (Eusebio 2018).

countries in ASEAN including Indonesia, Malaysia, Singapore, Thailand, Viet Nam (ASEAN Post Team 2020b).

Figure 7. Intention to Buy an EV as the Next Vehicle Purchase, Selected ASEAN Countries (In percent of consumers)



Source of figure: ASEAN Post Team (2020b) based on market research by Frost & Sullivan in 2018.

4.2.2. Weaknesses

A weakness of the manufacturing industry in general is in the level of technology utilization and infrastructure. A 2019 firm survey by the DTI on the SMART Manufacturing Maturity Index[16] revealed that 79 percent of respondents (114 of 144 firms) are from very low to low level of technology utilization (Aldaba 2020). In particular, 40 percent of respondents are in Level 1 (with spreadsheet management) and 38 percent are in Level 2 (stand-alone database management system with legacy applications).[17] The results of the survey somehow signal the level of capability and capacity of the manufacturing industry to absorb, manage and exploit new technology.

The inconsistent importation of parts and components of EV (see Appendix A) may be an indication of the level of technology that is available in the country as far as manufacturing of intermediate inputs and assembly of EVs are concerned. Moreover, while there have been R&D departments established by some companies in the country, the top producers or hubs of automotive and electronics in the ASEAN such as Thailand and Indonesia would have relatively more presence of R&D branches of manufacturing companies.

Overall, the innovation situation in the Philippines puts the country in the 50th rank out of 131 countries in the Global Innovation Index (GII) in 2020 (DOST 2020), and at an R&D

[16] The index assesses technology utilization status of manufacturing firms in different dimensions (from planning and scheduling to cybersecurity), and provides understanding on where firms are in terms of Industry 4.0 preparedness (Aldaba 2020).
[17] Level 0 to 4, where 4 is highest. Level 0 = Purely manual; Level 1 = with spreadsheet management; Level 2 = stand-alone database management system with legacy applications; Level 3 = Mostly manufacturing execution system used in this layer; Level 4 = Industry 4.0, manufacturing execution system + industry internet of things (IIot), Big Data, machine learning, robotics, etc.

expenditure to GDP ratio of 0.35 percent.[18] The government has long recognized the level of innovation in the country and had incorporated innovation into the comprehensive industrial strategy. The actions made by the government and the private sector must have borne fruit as seen in the improvement in the GII – from 100th rank in 2014, 73rd in 2017 to 50th in 2020; and in the R&D expenditure to GDP ratio – from 0.14% in 2013, 0.20% in 2017 to 0.35% in 2020, though it is relatively lower than the one percent prescribed benchmark by UNESCO.

It is noted that in the GII the Philippines performed much better in innovation outputs than innovation inputs, which could imply that with the resources available, the country was able to produce above average knowledge and technology outputs. Still, outcomes could even be better with greater innovation inputs. The GII showed the Philippines performed above average in business sophistication and knowledge and technology outputs; and below average in institutions, human capital and research, infrastructure, market sophistication, and creative outputs (Global Innovation Index 2020).

The EV charging infrastructure in the Philippines is also relatively low, with 19 charging stations in 2018. While international studies have observed that EV charging is done at home 50-80 percent of the time (Hardman et al 2018; Funke et al 2019), the presence of adequate public charging stations (at the workplace, public places) can affect the viability of EV adoption. There is no standard minimum acceptable ratio of EV to charging points, but industry specialists suggest ratios ranging from 10 EVs to 25 EVs per charging station in the medium term (McDonald 2019)[19] – not exactly the scenario in the Philippines. When passed and implemented effectively, the proposed EV law incentives for charging stations would help address supply concerns in this infrastructure.

Related to charging, electricity cost is an important part of the discussion. In the Philippines electricity prices are not the cheapest (one of the highest power rates in Asia). This comes as a disincentive to users and potential buyers of EVs. The study by MMC (2019) projects that the life cycle energy cost of an EV is lower compared to conventional/ICE. In ADB's e-trike project in the Philippines, fuel cost savings amounting to an average of PHP 200 a day was projected for e-trikes (compared to gasoline-powered tricycles).[20] These findings illustrate how an EV user can save on energy costs. High power rates is a continuing concern. And so, while it is still being addressed, these studies provide valuable information that can be used in advocating EV adoption amid concerns about energy/electricity costs.

Meanwhile, results from a Frost and Sullivan survey revealed that range anxiety (how far the vehicle will go) and safety are top concerns of potential EV buyers in ASEAN countries including the Philippines. Findings also revealed that 63 percent of respondents with these concerns were less than 40 years old (Aldaba 2019).

MMC (2019) reported that mini-compact EVs can reach around 100 kms; mid-sized vehicles and SUVs up to around 300 kms (though there are Tesla models with 499 kms range). On average, e-trikes run from 35 to 50 km, but there are models that can reach 100 kms. While the

[18] Philippine Development Plan (PDP) 2017-2022 Results Matrices (https://www.neda.gov.ph/pdp-results-matrices/2017-2022/).
[19] The International Energy Association (IEA) recommended a European ratio of 10 EVs to 1 charging station (McDonald 2019).
[20] Refers to the Market Transformation through Introduction of Energy-Efficient Electric Vehicles Project. Information is based on the Project Administration Manual (ADB 2012).

power of EVs can run at such distances, availability of a charging facility along the road would concern consumers.

Meanwhile, different articles have mentioned questions and concerns related to safety such as the risk of fire and electric shock – both related to the battery of EVs. On the one hand, risk of fire is said to be less likely in EVs than in ICE vehicles because there are no flammable substances such as gasoline and diesel. In addition, batteries have protective boxes for voltage insulation (from the rest of the parts of the vehicles) and isolation especially in the case of crash (prevent shocks to the passenger and emergency response personnel); and the charging plug and socket are carefully designed to protect the car when in contact with water or dirt particles (Larsson *et al.* 2017; Neill 2020; Autocar 2021). On the other hand, there is concern about the chemical components of lithium-ion batteries that make them susceptible to cause, at worst-case, fire or explosion during extreme heat (150-200^{o}C) (Neill 2020; Meidl 2021). While improved materials (e.g. of electrode, electrolyte) are being used to safeguard from battery cell malfunction, there is a call for continuous examination of incidents and research about the safety and stability of EVs as a non-traditional and developing automotive technology (Larsson *et al.* 2017; Meidl 2021).

4.2.3. Opportunities

The positive outlook on the global demand and production of EVs and the overall global trend towards electrification in the transport sector provide high prospects for the EV industry in the Philippines. There is great opportunity for trade in vehicles and parts and components; and investment in manufacturing plants, R&D, distribution and sales, logistics/supply chain management, among others.

The Philippines can take part in the EV value chain in Asia, which would be expected to be large as China has been leading the production and sales of EVs as well as the construction of charging stations. Other countries in the region such as Japan and South Korea, though quite far from the projections in China, are also expected to have large production in electric cars.[21] In Southeast Asia, vehicle ownership is estimated to increase by more than 40 percent by 2040 (ASEAN Post Team 2020a). The Philippines can attract investments and position itself in the value chain, not only in Asia but the rest of the world as well. As previously discussed, the country has capabilities in automotive and electronics manufacturing. These attributes are valuable in the EV value chain, and they also present a strong foundation for necessary upgrades to new technologies used in EVs.

There are also positive investment prospects for battery production in the Philippines, being one of the top suppliers of nickel ore which is a key raw material used in EV batteries. Such prospects have been identified by eVAP, which has henceforth started talks with the Philippine Nickel Industry Association (PNIA) and the China Battery Association (representing Chinese firms) to explore the manufacture of lithium ion batteries in the Philippines. The nickel mining industry is optimistic about the role that the Philippines can play in addressing the anticipated increase in demand for nickel for battery production ("PH could tap growing nickel demand" 2019). The PNIA was also reported to have partnered with Power Battery Application Committee of China Industrial Association of Power Sources (CIAPS-PBA) to advance the

[21] Projected electric car production in 2022: China – 10.156 million units; Japan – 1.685 million; South Korea – 881,000. Source: https://www.statista.com/statistics/270537/forecast-for-electric-car-production-in-selected-countries/.

participation of the Philippine nickel industry in the GVC for battery production (Crismundo 2020).

Cross-border partnerships between firms or industry associations serve as channels for transfer of technology. It would be important for the EV industry in the Philippines to take advantage of private sector collaborations to acquire knowledge and technology, and to learn from the innovation strategies of industries in other countries. An opportunity opened up as the eVAP led the creation of the ASEAN Federation of Electric Vehicle Associations (AFEVA). Establishment of the association was a byproduct of the several Philippine EV Summit events which have been hosted by eVAP. AFEVA is regarded as a venue for sharing of best industry practices and R&D initiatives, and networking that have so far resulted in joint-venture projects (eVAP 2020).

4.2.4. Threats

Previous sections suggested there is optimism in the EV industry locally and worldwide. However, there are threats to adoption related to cost and price, and threats to the Philippine EV industry related to competition.

Analysis by some industry experts showed pessimism about the decline in the price of EVs in the near future. Vehicle and battery producers, they observed, are sensitive to raw material costs. According to JP Morgan (2018), the expansion of the EV industry will have an impact on the demand and the price of EV components. They estimated that (proportionally) the cost of raw materials will increase over time relative to the total cost of a battery pack. Lee and Clark (2018) also remarked that the price of raw materials might not decline, even potentially increase in the short to medium-term. The authors explained the possibility that the extraction and production of mineral and metal resources used in EVs (e.g. lithium, nickel, critical metals in batteries) will be concentrated on a few players, which could push prices up if they control and monopolize supply.

In the Philippines, BEVs are estimated to cost 1.7 to 2.4 times as much– and for PHEVs, 1.4 to 1.99 times as much as ICE cars [22] (MMC 2019). While retail price is higher, the study by MMC (2019) assessed that the life cycle cost of electric cars is competitive (lower) – a significant factor is lower energy cost (and maintenance cost to some extent) compared to ICE cars.

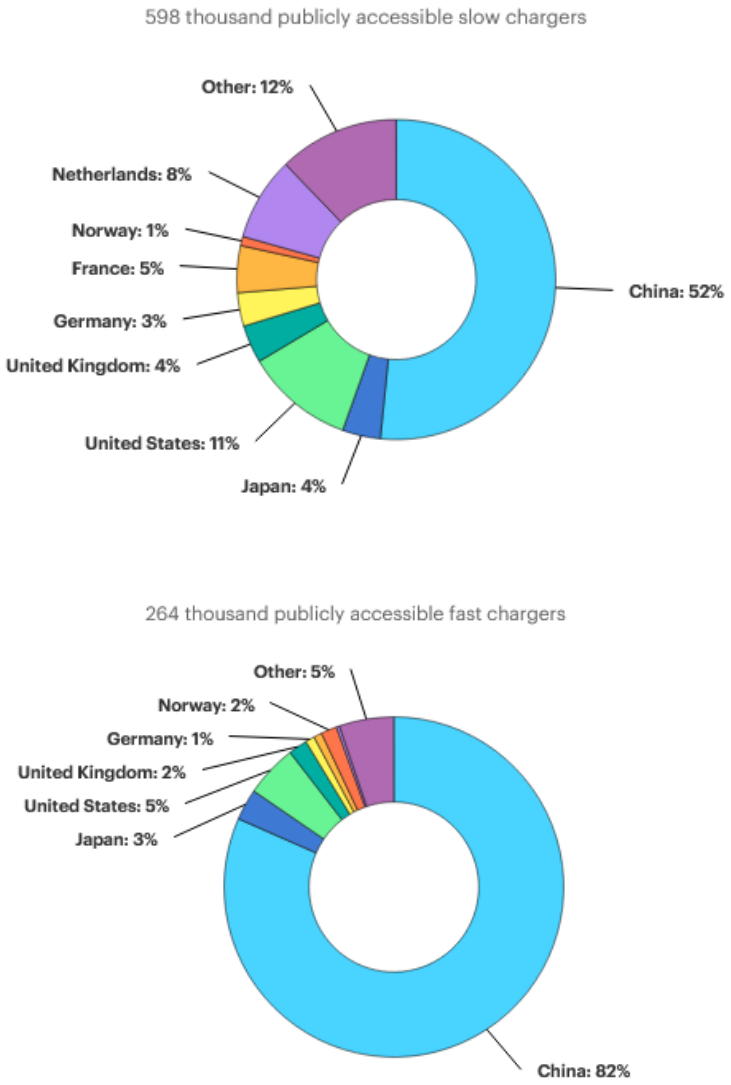
With the projected growth in EV production, there are also concerns about the adequacy of charging infrastructure. In 2017, there were about 440,000 installations of publicly accessible EV chargers (fast and slow) globally (IEA 2019). Analysts assessed that more would be required to catch up with the growth in EV production (JP Morgan 2018).

However, it is also expected that with advancements in technology and presence of EV-supportive policies, concerns about battery prices and charging infrastructure can be addressed. Utilities, oil and gas companies and automakers have been actively installing charging facilities, and this has improved the number of charging facilities globally. As of 2019, 862,000 publicly accessible EV chargers (fast and slow) have been installed globally, which is an

[22] Projected cost multiplier varies depending on the car classification (sedan, SUV, pick-up, van; mini, compact, mid/full-size, etc.).

increase of 60 percent from 2018 [Figure 8] (IEA 2020). China accounted for 515,000, surpassing the global number in 2017.

Figure 8. Number of Publicly Accessible Electric Vehicle Chargers in Selected Countries by Type (Slow or Fast), 2019



Source: IEA (2020), Figure 1.8.

While the trend in battery prices is quite uncertain and challenges in the industry are present, the Philippines is somehow in an advantageous position given the presence of EV technology in the region. China is leading in EV sales and charging infrastructure. In terms of EV charger intensity, or the number of EV charging station per 100 km of paved road, data indicate that countries in Asia, particularly, China, Japan, Singapore and South Korea have ranked among the top (McCarthy 2018, based on IEA data). But what the country must also prepare for is the increased "competition" in inward investments in the region. Countries would be keen on hosting investments in EV technology and value chain. In ASEAN, for instance, countries have abundant natural resources used as raw materials in battery manufacturing, and have close economic partnership with the top EV producers in Asia. An example is Indonesia, which has

started talks with potential Chinese and South Korean investors and has attracted investment via a new vehicle assembly plant from the Hyundai Motor Group (ASEAN Post Team 2020b), which could likely involve EV-related production. Investments, especially to strengthen the supplier base that will support the industry would be crucial. There is relatively lower number of automotive suppliers in the Philippines compared to auto hubs in the region, e.g. Thailand and Indonesia; and cost of manufacturing motor vehicles in the country is also higher compared to these countries. The Philippines's policy stance and actions signal how serious the country is in advancing EV in the country.

5. Conclusion and Recommendations

Energy efficiency, environment protection and clean technology adoption have brought people's attention to EVs, and these vehicles are going to populate the streets in the future based on projections for the industry.

The EV industry in the Philippines has strong potential for growth, given the support from government policy, active engagement of the industry and private stakeholders, and automotive and electronics manufacturing capabilities, among others. But the country is faced with a relatively low technology utilization, general concerns about EV infrastructure, and strong competition for investments.

To take advantage of the strengths and opportunities and address the weaknesses and threats in the EV industry as identified in this study, the following are recommended:

- Fast-track the deliberations on the EV bill. Having an EV law is a strong signal for current players and potential investors that the government is serious about advancing EV in the country and including it in the priority area for industry development. An EV law sets the national policy and overall framework for regulations related to standards, incentives, infrastructure, and role of key government agencies. The EV industry is an active and fast-moving industry, hence, in order to not be left behind, including the bill in the priorities for deliberation would be crucial.

- Develop market and feasibility studies for manufacturing prospects, including a battery manufacturing roadmap, and a charging infrastructure plan, that are linked to the comprehensive EV roadmap. In addition, one area that the government and industry players can study is the viability of focusing on a specific type of electric vehicle –e.g. choose from passenger car/van, bus or truck; or technology –full-electric or hybrid, and make the Philippines a manufacturing hub of that specific EV.

  Furthermore, in-depth studies looking at the potential impact on the power sector and contribution to air pollution control will be helpful in recognizing further the prospects for the industry.

- Start deliberating on appropriate fiscal incentives to stimulate demand. The data indicate that most EVs are in the public transport sector (e-trikes, e-jeepneys), and ownership of private electric cars is low. Financial incentive packages, e.g. for EV purchases, charging points, electricity consumption, scrappage/recycling of old vehicles should be explored. It would be helpful to have a review of these incentive schemes that are being implemented in other countries, and determine which would be applicable or adaptable to the local setting.

- Establish an EV strategy committee/council which is composed of representatives from the government and the private sector and will lead in defining the goals and plans for the industry (the EV bill mentions establishment of dedicated offices but in different government agencies – DOE, DOTr and DTI, for the implementation of the EV law). The committee/council would cooperate and consult with stakeholders, thereby forming a network with a shared objective of supporting the development of the EV industry. The network would not only include the government and the industry players, but also other entities which may include the media, power companies, non-government organizations (NGO), financial institutions which all, in one way or another, play a role in the growth of the EV industry. For instance, the media is an important partner for public awareness on EVs (ownership pros and cons, developments in the industry, etc.). Power companies are partners for building charging stations. NGOs, such as the international ones, provide opportunities for technical assistance and grants. Financial institutions are critical as source of funds for manufacturing, technology acquisition and R&D activities of firms.

- Include the EV sector in the areas for technical cooperation and trade missions. The country can use the existing as well as future technical cooperation, science and technology cooperation, joint economic conference, trade and investment framework agreement or free trade agreements (FTAs) as channel for knowledge and technology transfer from countries with active and advanced EV industry. Technical cooperation will provide opportunity to upgrade the knowledge and skills of the country's workforce; and for trade missions, exploration of opportunities for partnership with local EV players and for foreign direct investments in the Philippines.

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Appendix A. Imports of EV products, 2017 to July 2019

		Value of Imports (CIF value in USD)			
PSCC 2015	**Commodity Description**	**Jan-Dec.2017**	**Jan-Dec.2018**	**Jan-Jul.2019**	**Total**
8702909201	A. Components, parts and/or accessories imported from one or more countries for assembly of motor vehicles by participants in the Motor Vehicle Development Program with certificate from BOI for the assembly of hybrid (electric and gasoline/diesel), electric, flex-fuel (bio-ethanol and bio-diesel), compressed natural gas (CNG), hydrogen or other alternative fuel vehicles	3,381,613	149,765	-	3,531,378
8702909301	A. Components, parts and/or accessories imported from one or more countries for assembly of motor vehicles by participants in the Motor Vehicle Development Program with certificate from BOI for the assembly of hybrid (electric and gasoline/diesel), electric, flex-fuel (bio-ethanol and bio-diesel), compressed natural gas (CNG), hydrogen or other alternative fuel vehicles	4,434,048	-	-	4,434,048
8702909401	A. Components, parts and/or accessories imported from one or more countries for assembly of motor vehicles by participants in the Motor Vehicle Development Program with certificate from BOI for the assembly of hybrid (electric and gasoline/diesel), electric, flex-fuel (bio-ethanol and bio-diesel), compressed natural gas (CNG), hydrogen or other alternative fuel vehicles	2,936,027	-	-	2,936,027
8702909501	A. Components, parts and/or accessories imported from one or more countries for assembly of motor vehicles by participants in the Motor Vehicle Development Program with certificate from BOI for the assembly of hybrid (electric and gasoline/diesel), electric, flex-fuel (bio-ethanol and bio-diesel), compressed natural gas (CNG), hydrogen or other alternative fuel vehicles	16,478,448	-	-	16,478,448

		Value of Imports (CIF value in USD)			
PSCC 2015	**Commodity Description**	**Jan-Dec.2017**	**Jan-Dec.2018**	**Jan-Jul.2019**	**Total**
8702909901	A. Components, parts and/or accessories imported from one or more countries for assembly of motor vehicles by participants in the Motor Vehicle Development Program with certificate from BOI for the assembly of hybrid (electric and gasoline/diesel), electric, flex-fuel (bio-ethanol and bio-diesel), compressed natural gas (CNG), hydrogen or other alternative fuel vehicles	31,999,416	1,249,812	-	33,249,228
8704909101	A. Components, parts and/or accessories imported from one or more countries for assembly of motor vehicles by participants in the Motor Vehicle Development Program with certificate from BOI for the assembly of hybrid (electric and gasoline/diesel), electric, flex-fuel (bio-ethanol and bio-diesel), compressed natural gas (CNG), hydrogen or other alternative fuel vehicles	88,825,316	2,282,968	-	91,108,284
8704909201	A. Components, parts and/or accessories imported from one or more countries for assembly of motor vehicles by participants in the Motor Vehicle Development Program with certificate from BOI for the assembly of hybrid (electric and gasoline/diesel), electric, flex-fuel (bio-ethanol and bio-diesel), compressed natural gas (CNG), hydrogen or other alternative fuel vehicles	7,774,683	38,391	-	7,813,074
8704909301	A. Components, parts and/or accessories imported from one or more countries for assembly of motor vehicles by participants in the Motor Vehicle Development Program with certificate from BOI for the assembly of hybrid (electric and gasoline/diesel), electric, flex-fuel (bio-ethanol and bio-diesel), compressed natural gas (CNG), hydrogen or other alternative fuel vehicles	2,417,003	120,439	-	2,537,442

		Value of Imports (CIF value in USD)			
PSCC 2015	**Commodity Description**	**Jan-Dec.2017**	**Jan-Dec.2018**	**Jan-Jul.2019**	**Total**
8704909401	A. Components, parts and/or accessories imported from one or more countries for assembly of motor vehicles by participants in the Motor Vehicle Development Program with certificate from BOI for the assembly of hybrid (electric and gasoline/diesel), electric, flex-fuel (bio-ethanol and bio-diesel), compressed natural gas (CNG), hydrogen or other alternative fuel vehicles	9,511,502	-	-	9,511,502
8704909901	A. Components, parts and/or accessories imported from one or more countries for assembly of motor vehicles by participants in the Motor Vehicle Development Program with certificate from BOI for the assembly of hybrid (electric and gasoline/diesel), electric, flex-fuel (bio-ethanol and bio-diesel), compressed natural gas (CNG), hydrogen or other alternative fuel vehicles	72,755,446	-	-	72,755,446
ALL		240,513,502	3,841,375	-	244,354,877

Source: Philippine Statistics Authority (PSA)