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The Expansion of Electric Vehicles

ICTSD

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LIST OF ABBREVIATIONS

BEV	battery electric vehicle
BNEF	Bloomberg New Energy Finance
CCS	combined charging system
CEM	Clean Energy Ministerial
COP	Conference of the Parties
CTCN	Climate Technology Centre and Network
EGA	Environmental Goods Agreement
EVI	Electric Vehicles Initiative
EVSE	electric vehicle supply equipment
FCV	fuel cell vehicle
FTA	free trade agreement
GHG	greenhouse gas
HEV	hybrid electric vehicle
HS	harmonised system
HS 12	2012 WCO HS nomenclature
HS 17	2017 WCO HS nomenclature
ICE	internal combustion engine
IEA	International Energy Agency
IP	intellectual property
IPR	intellectual property right
LDV	light duty domestic vehicle
LPAA	Lima-Paris Action Agenda
MFN	most favoured nation
NDC	nationally determined contribution
NEV	new energy vehicle
NTL	national tariff line
PHEV	plug-in hybrid electric vehicle
R&D	research and development
SCM	Subsidies and Countervailing Measures (WTO Agreement)
SDG	Sustainable Development Goal
SETI	sustainable energy trade initiative
TEC	Technology Executive Committee
TNA	technology needs assessment
UNFCCC	United Nations Framework Convention on Climate Change
V2G	vehicle-to-grid
WCO	World Customs Organization
WTO	World Trade Organization
ZEV	zero-emission vehicle

FOREWORD

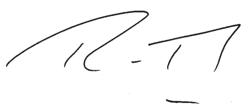
Road transport accounts for about one-fifth of global greenhouse gas emissions and these are growing rapidly, particularly in developing countries. Decarbonisation of transport is essential not only for climate change mitigation efforts but also in tackling the growing problem of air pollution, responsible for millions of deaths annually worldwide. Economic co-benefits such as increased energy security and a reduced oil import bill will be an added plus for many net oil-importing countries.

Electrification of road transport looks set to play a significant role in decarbonisation efforts, especially when accompanied by decarbonisation of the electric grid. Several nations announced in 2017 their intention to phase out sales of fossil fuel vehicles over the next two to three decades. These policy announcements have been matched by private sector cost reduction efforts, with electric vehicle battery and vehicle prices steadily declining and spurring innovation. Road transport looks set to drive into the future on an electric trajectory.

In this scenario, it will be useful to ask what role international trade governance can play in facilitating, or indeed accelerating, this transition towards electric vehicles. Electrification of road transport will have major implications for existing global automobile supply chains and may create new opportunities for production and trade and countries' participation in emerging electric vehicle value chain networks.

There is a need to identify and better understand trade-related issues and knowledge gaps. This includes how various types of trade-measures and policies—by themselves as well as through their interaction with other domestic policies—affect the electric vehicle industry and its value chains. Such an understanding will enable meaningful policy initiatives as well as the elaboration of future trade agreements, including on environmental goods and services, that are supportive of a rapid scale-up and global diffusion of electric vehicles. This paper, authored by ICTSD Senior Research Fellow Mahesh Sugathan, has been conceived as an exploratory scoping exercise with this purpose in mind. It draws on previous ICTSD research under the Sustainable Energy Trade Agreement project.

We believe this work will shine a new light on possible avenues for future trade policy related research on electric vehicles that will be helpful to both policymakers and the private sector. We are confident that the research will also support and encourage constructive dialogue among trade, energy, and industry policymakers as well as the automobile industry. This should eventually lead to supportive trade policies for a dynamic sector that holds great promise in the fight against climate change and in realising the Sustainable Development Goals.



Ricardo Meléndez-Ortiz
Chief Executive, ICTSD

EXECUTIVE SUMMARY

Electric vehicles (EVs)—together with a number of other transport-related developments such as multi-modal public transit, integrated data platforms, vehicle intelligence and autonomy and vehicle sharing—can contribute to decarbonising the transport sector away from internal combustion engine (ICE) vehicles, thereby addressing not only climate change but also air pollution, a growing global health hazard. Electrification of road transport also has a number of economic co-benefits for countries such as reduction in oil imports and the creation of “green jobs.” A global diffusion and scale-up of electric vehicles can facilitate the attainment of four key Sustainable Development Goals (SDGs), namely ensuring healthy lives and promotion of well-being for all at all ages (Goal 3), promotion of sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all (Goal 8), the building of resilient infrastructure, promotion of sustainable industrialisation and fostering of innovation (Goal 9) and taking urgent action to combat climate change and its impacts (Goal 13).

This paper focused on two specific types of electric vehicles: (i) Battery Electric Vehicles (BEVs) that use electric power as their only source of fuel and (ii) Plug-in Hybrid Electric Vehicles (PHEVs) which mainly run on electric power and can be charged from external charging points, while also including a back-up fossil fuel or biofuel engine. These two categories can cover all types of vehicles although the paper will focus on road vehicles for the transport of passengers including bikes, cars, vans and buses.

The world has seen a rapid growth in the number of electric vehicles with sales of electric cars reaching 750,000 in 2016. The majority of this figure was due to 336,000 new registrations in China that year, double the number than in the US and considerably higher than the EU’s 215,000 sales. Globally, the electric car market is still limited to a few nations as 95 percent of electric car sales took place in just 10 countries—China, the US, Japan, Canada, Norway, the United Kingdom (UK), France, Germany, the Netherlands and Sweden. With battery and EV prices set to fall further, Bloomberg New Energy Finance (BNEF 2017) predicts that 54 percent of global car sales and 33 percent of the global car fleet will be electric by 2040 and the sector could enter virtuous growth between 2025 and 2030 without the need for subsidies. In addition, short-term regulatory support in key markets like the US, Europe and China, increased commitment from carmakers, growing consumer acceptance driven by competitively priced EVs across all vehicle classes and the growing role of car sharing, ride hailing and autonomous driving (termed “intelligent mobility”) will all drive increased EV deployment.

Policy-led drivers for EVs comprise “market-pull” policies that incentivise demand for EVs and related parts and components. These are complemented by “technology-push” policies aimed at increasing the supply of EVs and batteries. Policy drivers may be country- or city-led and can include goals (such as a ban on future sales of fossil fuel vehicles by many countries within a specified time frame), mandates, targets and incentives and “EV-friendly” laws and regulations. In addition, global initiatives, declarations and platforms for international collaboration help establish a shared vision while enabling learning, knowledge and best practice sharing. There have also been several private sector-led announcements aiming to promote EVs through industry-led incentives and targets.

Trade policy can play an important role in supporting the global diffusion of electric vehicles by enabling an efficient and optimal global supply chain and better economies of scale with regard to EV production. A brief literature survey reveals that the global automobile supply chain that includes electric vehicles is certainly far from cost-optimal. Import tariffs are still applied to finished vehicles as well as batteries; these are higher in some countries than others. Electric batteries account for more than half of the cost of the EV power train and around one-third of EV cost. While battery costs are declining, removing even small import tariff hurdles that exist along the EV value chain could help in the cost reduction process. Thus lowering or eliminating import tariffs on EVs and their components while maintaining them (to the extent possible and permitted by trade agreements) for ICE vehicles could be an easily implemented trade policy measure to positively incentivise electric vehicles sales relative to their ICE counterparts.

Further research surveying the nature and geography of global and regional value chains for EVs and analysing the impact of such import tariff cuts along the EV supply chain on production costs of EVs would be worthwhile to undertake. Additional targeted research could also help identify specific production and trade opportunities for developing countries, if any, along the EV value chain including for “lower technology” products such as electric bikes.

While there are a number of anecdotal examples of investment restrictions and discriminatory subsidies favouring domestic EV or battery manufacturing firms, there is no clear evidence that such subsidies, or government procurement measures and standards, have hindered production or trade flows in any significant manner. Well-designed subsidy, investment and procurement policies that do not distort efficient trade, either now or in the future, could also help facilitate more cost-optimal EV production. As standards for batteries and charging infrastructure continue to evolve it will be important to ensure that standards-related policies do not hinder trade and are not used in a protectionist manner. At the same time, standards harmonisation efforts should not stifle further innovation and should be responsive to local conditions and needs. Export restrictions and supply constraints on raw materials important for EV production, while not hugely significant at present, could pose a problem for EV production in the future as demand for batteries grows. Such constraints may or may not be a problem depending on specific battery technologies that become dominant.

If the aim is to provide a positive incentive to accelerated deployment of EVs, it may be worthwhile for policymakers not only to identify and address any trade-related links in the supply chain such as import tariffs that currently exist but also, given that it is still early days for the EV industry, work to prevent any distortions related to the above measures from emerging in the future. One way would be to review existing domestic and trade policy measures on goods and services that affect EVs and explore how they could be better designed for a more rapid-scale up and diffusion of EVs. It may also be worth reviewing the consistency of domestic regulatory and policy measures that countries use to promote EVs with existing trade rules and assess if these existing rules offer sufficient clarity and space to pursue policies that address the legitimate needs of the EV industry. EV diffusion should also be considered in the context of a “larger ecosystem” of domestic and trade policies affecting other sectors such as renewable energy and information and communications technologies, given their synergies and operational linkages.

Finally, EVs also represent an excellent example of climate technology whose development and wider dissemination would represent an important building block for climate action and contribute towards fulfilling the technology transfer mandate enshrined in Article 4.5 of the 1992 United Nations Framework Convention on Climate Change (UNFCCC) founding document. It may be useful to examine the importance of various intellectual property rights (IPR) and technology licensing models pursued by the EV industry, and their link with trade and investment policies, further. In addition, financial assistance and capacity building measures (including those for EV infrastructure development and skills for technology absorption) will also be essential, particularly for developing countries. The role that specific mechanisms set up both within the trade realm, such as Aid for Trade, as well as the climate realm, such as the Technology Mechanism and Green Climate Fund, might be able to play in this regard would also be worth exploring.

1. INTRODUCTION: ELECTRIC VEHICLES AND TRANSPORT SECTOR DECARBONISATION

Road transportation accounted for 23 percent of global CO_2 emissions in 2014 and was the second most important contributor to emissions after electricity and heat generation which accounted for 42 percent (IEA 2016). Growth in transport sector emissions in developed countries averaged 0.5 percent from 1990 to 2012, while that in developing countries averaged 4.8 percent, with the likelihood that transport emissions from developing countries will exceed those from developed countries at the end of 2017 (Huizenga and Peet 2017).

Clean transportation will play an important role not only in reaching global greenhouse gas (GHG) emission targets through significant cuts in transport-related emissions, but also in addressing the growing environmental challenge of air pollution, particularly in emerging markets such as China and India. According to the *2017 State of the Global Air Report* co-published by the Health Effects Institute, air pollution, particularly fine particulate matter (less than or equal to 2.5 μm in aerodynamic diameter) also known as PM2.5, was the leading environmental cause of death on the planet causing 4 million deaths worldwide (IHME and HEI 2017). China and India accounted for over 50 percent of this total and witnessed about 2.2 million early deaths in 2015 due to air pollution. Transportation, while not the most important contributor to air pollution (which is coal-burning), is the second most important source of PM 2.5 emissions in China (IHME and HEI 2017). According to the OECD (2014), 50 percent of the health impacts and associated economic cost of air pollution in OECD countries is attributable to road transport.

Electrifying road transport through increased deployment of electric vehicles (EVs), together with a number of other transport-related developments such as the development of multi-modal public transit, integrated data platforms, vehicle intelligence and autonomy and vehicle sharing, is seen as playing a major role in decarbonising the transport sector away from internal combustion engines (ICEs) and thereby addressing climate change as well as air pollution. This is particularly the case when said electrification is also accompanied by decarbonisation of the electricity generation sector through a switch to clean energy sources such as solar PV and wind. Thus electric vehicles will need to be seen within a broad context of factors shaping clean energy generation as well as a transformed mobility system and the rise of mobility services (NITI Aayog and Rocky Mountain Institute 2017a). While not disregarding the significance of these factors, the focus of the present scoping paper will solely be on domestic and trade policies that interact with each other to directly affect electric vehicle deployment. In addition to climate and air pollution-related goals, increased energy security through reducing oil imports is also a major consideration including for net oil importers like China and India, as is the creation of new jobs (Masiero et al. 2016). For example, a recent study by NITI Aayog and Rocky Mountain Institute (2017b) estimates that—even though India’s electric mobility policies are likely to necessitate significant imports of batteries, battery components and raw materials as India scales up its domestic battery manufacturing capacity in the years ahead—the reduction in oil import costs is likely to more than offset the costs of these imports.

Consequently, electric vehicle deployment can help in the achievement of four important sustainable development goals and related targets, adopted by heads of state and government in September 2015 and which came into force on 1 January 2016, as shown in Table 1.

Table 1. Relevance of electric vehicles to the 2030 Sustainable Development Goals and related targets

SDG Goals	Relevant Targets
Goal 3: Ensure healthy lives and promote well-being for all at all ages	3.9: By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination
Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	8.2: Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors 8.4: Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-year framework of programmes on sustainable consumption and production, with developed countries taking the lead
Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	9.1: Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all 9.4: By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities
Goal 13: Take urgent action to combat climate change and its impacts	13.2: Integrate climate change measures into national policies, strategies and planning

Source: www.un.org/sustainabledevelopment/sustainable-development-goals/

Electric vehicles comprise (US Department of Energy n.d.):

(i) **Battery Electric Vehicles (BEVs)** that use electric power as their only source of fuel;

(ii) **Plug-in hybrid electric vehicles (PHEVs)** which mainly run on electric power and can be charged from external charging points and also have a back-up fossil fuel or biofuel engine;

(iii) **Hybrid electric vehicles (HEVs)** which have an electric motor and a gasoline or biofuel-driven engine, but the electric motor cannot be charged from off-board sources and instead is charged using regenerative braking or from the fossil fuel engine;

(iv) **Fuel cell vehicles (FCVs)** that run on hydrogen fuel which is converted to electricity within a fuel cell.

Barriers, incentives and policies for BEVs and PHEVs differ rather substantially from those for HEVs, given that there is no need to plug in an HEV or FCV (OECD 2015).

In addition to electric cars, the EV fleet also consists of electric bikes (predominantly in China) and electric buses (also mainly in China but with increasing commercial deployment in the US and EU). Broadly speaking, electric locomotives, tramways and trolleybuses may also be considered to be electric vehicles but given that they do not use batteries for traction and the technologies are fairly well established, they are not relevant to the purposes of the present paper. The focus of this paper when describing EVs will be mainly on BEVs and PHEVs used for transporting people including electric cars, buses and bikes. Electric freight vans and trucks as well as ships hold out promise,[1] but have not been commercially deployed yet on a meaningful scale. Electric vehicle charging infrastructure at home, work and public locations is indispensable for EV deployment. In the case of electric cars, their high power requirement may entail changes to electricity, production, transmission and distribution infrastructure, or components having to be added. The major EV markets such as China, the US, EU and Japan use various standards around charging infrastructure based on international as well as private sector standards, with a view towards minimising differences and ensuring interoperability.

The number of electric vehicle sales is growing rapidly worldwide with sales of electric cars reaching 750,000 in 2016 (IEA 2017). Of this, China accounted for the largest number of sales with 336,000 registrations, double the number in the US and considerably higher than the EU's 215,000 sales. Globally, the electric car market is still limited to a few nations as 95 percent of electric car sales took place in just 10 countries—China, the US, Japan, Canada, Norway, the United Kingdom (UK), France, Germany, the Netherlands and Sweden (IEA 2017).

According to Bloomberg New Energy Finance (2017), 54 percent of global car sales and 33 percent of the global car fleet will be electric by 2040 as EV prices are expected to continue falling significantly, such that in most economies private EVs will be at cost-parity with ICEs by 2025. BNEF expects global average EV battery costs to fall to about US$109/kWh by 2025 and US$73/kWh by 2030, representing a "tipping-point" beyond which the market would drive increasing adoption with limited need for additional subsidies. In addition, short-term regulatory support in key markets like the US, Europe and China, increased commitment from carmakers, growing consumer acceptance driven by competitively priced EVs across all vehicle classes and the growing role of car sharing, ride hailing and autonomous driving (termed "intelligent mobility") will all drive increased EV deployment (Nikolas, S. 2017).

While a multitude of factors affect the diffusion of EVs, the purpose of this paper is a scoping exercise (i) to specifically explore the links between international trade policy and the production and deployment of electric vehicles and (ii) to map potential challenges that already exist, as well as any that may emerge in the future. The overall objective is to determine whether further research may be necessary in order to identify how trade can play a conducive role in EV scale-up, including by positively discriminating in favour of electric vehicles relative to ICE- driven ones. The results of such research could then allow countries to pre-emptively shape their domestic and trade policies and any trade agreements that they negotiate. This is particularly relevant in the context of ensuring that trade is ultimately supportive of environmental objectives such as climate change mitigation and reductions in pollution.

The rest of the paper is structured in the following manner: Chapter 2 deals with policy drivers for electric vehicle deployment including specific country-based policies and actions as well as global co-operation initiatives, thus providing a broader contextual background to the discussion on international trade. Chapter 3 discusses likely trade policy-related issues and challenges that may arise as countries seek to further expand domestic manufacturing and deployment of electric vehicles. Chapter 4 identifies specific research gaps and issues surrounding trade policy and electric vehicle deployment that merit further consideration.

1 For example, see Tesla's recent announcement regarding the launch of an electric freight-truck (Morris 2017).

2. POLICY DRIVERS FOR ELECTRIC VEHICLE DEPLOYMENT

The UNFCCC Paris Agreement and the underlying nationally determined contributions (NDCs) towards reaching a less than 2-degree Celsius pathway provides a broad overarching mandate for decarbonising the transport sector. The goal is to largely decarbonise this sector and move from 7.7 gigatonne (Gt) emissions a year down to 2–3 Gt by mid-century, in contrast to the business-as-usual scenario, which would see emissions increase to 13–15 Gt by 2050. Among the 160 nationally determined contributions (NDCs) on emissions reduction submitted by the parties to the UNFCCC by 1 August 2016, 75 percent identify the transport sector as a mitigation source, a further 18 percent include transport as a component of the energy sector, 63 percent propose transport-specific mitigation measures although only a much smaller share (9 percent), representing countries with only 3 percent of transport emissions, have actually proposed transport reduction emission targets (Huizenga and Peet 2017).

In addition to the broad global impetus provided by a number of high-level declarations and initiatives, the deployment of electric vehicles has been driven by various country-specific regulatory drivers and incentives. Lutsey (2015) has identified a number of emerging best practice examples for EV deployment based on a study of various country policies. These include consumer incentives that reduce the cost of EV ownership as well as the roll-out of home, workplace and public charging infrastructure. Stringent vehicle efficiency standards, support for research and development (R&D) and national planning appear to be necessary, though insufficient in themselves, to grow the EV market (Yang et al. 2016).

2.1 EV Incentive Types

Electric vehicle incentive types fall into two broad categories, namely subsidies (including income tax credits and vehicle purchase rebates) and vehicle tax reductions (including one-time vehicle tax reductions and annual vehicle tax reductions). Subsidies are relatively more transparent and direct than vehicle tax reductions which are often dependent on tax systems and vehicle specifications. Rebates are the most common type of EV subsidy. With regard to specific incentives, Yang et al. (2016) identify four emerging principles to define the optimal design of EV incentives, namely:

(i) moving incentives upfront to vehicle purchase (immediate rebates or one-time vehicle tax reductions) and making their value visible to dealers and prospective consumers;

(ii) making the value of incentives crystal clear to consumer and dealers;

(iii) ensuring availability of incentives to a larger target or consumer market; and

(iv) committing to durable incentives that allow manufacturers, dealers, public outreach campaigns and consumers to rely on them for at least several years and which also enables a transition to larger markets.

The following sub-sections describe major global as well as country-specific and city-led initiatives to promote EVs.

2.2 Global Initiatives and Declarations

Global initiatives, declarations and platforms for international collaboration help establish a shared vision as well as enable learning, knowledge and best practice sharing. Notable global initiatives include:

(i) **The Electric Vehicles initiative (EVI)**, a multi-government policy forum established in 2009 under the Clean Energy Ministerial (CEM) forum and dedicated to accelerating the deployment of electric vehicles worldwide. The initiative is co-ordinated by the International Energy Agency (IEA) and comprises Canada, China, France, Germany, Japan, the Netherlands, Norway, Sweden, the UK and the United States (US) with additional engagement from India, Korea and South Africa. It has proven an effective forum for knowledge and information sharing on electric vehicles among governments and various partner organisations and also produces analytical outputs on the sector. The EV30@30 campaign launched at the 8th Clean Energy Ministerial set an aspirational goal of a 30 percent market share for electric vehicles among all passenger cars, light commercial vehicles, buses and trucks in EVI members by 2030. (Clean Energy Ministerial Campaign, EV 30@30 n.d.).

(ii) **The Paris Declaration on Electro-Mobility and Climate Change (UNFCCC 2015)** launched during the Lima-Paris Action Agenda (LPAA) Transport Focus at COP 21 brings together individual and collective commitments to increase electro-mobility to levels compatible with a less than 2-degree Celsius pathway. The declaration is endorsed by several international organisations including the IEA as well as two carmakers—Tesla and Renault-Nissan Alliance. It refers to the IEA's finding that such a transition would require, in addition to global rail transport electrification, at least 20 percent of all road transport vehicles globally to be electrically driven by 2030.

(iii) **The EVI Government Fleet Declaration** was announced at COP 22 in Marrakech on 16 November 2016 and signed by the governments of Canada, China, France, Japan, Norway, Sweden, the UK and the US. The declaration emphasises the renewal of government fleets and showcases specific and voluntary commitments of these countries to accelerate the introduction of low-emission vehicles in their vehicle fleets.

(iv) **The International Zero-Emission Vehicle Alliance (ZEV Alliance)** was established in 2015 and is a collaboration of national and subnational governments working together to accelerate the adoption of ZEVs in order to tackle air pollution, limit global climate change and reduce oil dependence (UN Environment n.d.). Actions include setting and achieving ambitious targets, as well as sharing data and best practice to inform target-setting. The ZEV Alliance members is comprised of governments within the jurisdictions of Canada (British Columbia, Québec), Germany, the Netherlands, Norway, the UK and the US (California, Connecticut, Maryland, Massachusetts, New York, Oregon, Rhode Island, Vermont). The ZEV's Secretariat is hosted by the International Council on Clean Transportation (UN Environment n.d.).

2.3 Country-Specific Policy and Regulatory Drivers

Country-specific EV promotion policies such as consumer incentives and support for charging infrastructure have all spurred EV deployment. Many countries have set national goals and targets for EV sales as shown in Table 2.

Countries such as Norway, the Netherlands and the US state of California have seen the most comprehensive EV promotion actions resulting in EV deployment that is more than 10 times the global average. In the case of Norway, the initial plan to ban sales of all petrol and diesel cars by 2025 now appears to have been pushed back to 2030 (MoneyControl News 2017). France and the UK had earlier announced a ban on all petrol and diesel cars by 2040 (Lambert 2017).

Recently, two of the biggest developing country GHG emitters, India and China, have come out with bold visionary statements on transitioning to EVs. India wants to have 100 percent EV sales by 2030 and is preparing a new automobile policy including a roadmap for electric vehicles (Reuters 2017b). China will set a deadline for car manufacturers to end sales of fossil fuel-powered vehicles, becoming the biggest market to do so in a move that will accelerate the push into the electric car market led by local companies such as BYD Company Limited (the largest EV manufacturer worldwide, also producing EV charging solutions, grid electricity storage solutions and solar panels) and BAIC Motor Corp (Bloomberg News 2017b). China is targeting 35 million vehicle sales by 2025 and wants new energy vehicles (NEVs) to make up at least one-fifth of that total (Reuters 2017a).

Table 2. Targets of selected countries for the promotion of electric vehicles

Country	Target
China	• Share of alternative fuel vehicles of at least 20 percent of sales in 2025, which would correspond to more than 7 million cars • Target of 2 million electric cars in 2020
European Union	• EV chargers at parking spaces of 10 percent of buildings by 2023 • Emission reduction target for new cars of 95 gCO_2 per km by 2021 • Several EU member states have individual targets for electric car diffusion
France	• Ban of petrol and diesel car sales by 2040
Germany	• Federal Council has passed a position to ban petrol and diesel car sales by 2030 but the government rejected the demand • Goal of million electric vehicles by 2020 (dismissed) and six million by 2030
India	• Ban sales of petrol and diesel cars by 2030 • Increase EV fleet to 6 to 7 million vehicles by 2020
Netherlands	• Ban on petrol and diesel car sales by 2025 was passed in the lower house of the Parliament but not (yet) in the senate
Norway	• Ban petrol and diesel car sales by 2025
UK	• Ban petrol and diesel car sales by 2040

Source: Schneider (2017)

India's former Minister of State for Power and Renewable Energy, Piyush Goyal, recently announced that India would sell only electric cars by 2030. The Indian government's National Electric Mobility Mission Plan aims for annual sales of electric and hybrid cars in India to hit 6 to 7 million by 2020 (Wattles 2017). Initial estimates suggest that shifting to a shared, electric and connected passenger mobility paradigm in India may avoid as much as 1 Gt of CO2 emissions between 2017 and 2030, and result in a US$60 billion in annual petrol/diesel cost saving in 2030 (NITI Aayog and Rocky Mountain Institute 2017a). In comparison to the fewer than 1,800 HEVs sold in 2013 in India, the demand for electric bikes, scooters and motorcycles powered by lead-acid batteries was 500,000 units in 2013 and is expected to rise to 1.1 million by 2018 (OECD 2015).

Rebates are widely used in countries such as China, France, Japan, Korea, Sweden and many US states and Canadian provinces. Many of these also provide full or partial tax exemptions and tax reductions, with the exception of the US and Canada who apply low levels of federal taxes compared to other regions. Other than Sweden which provides a set amount for all vehicles eligible for EV subsidies, countries or specific regions also define one or multiple factors determining the level of subsidy for each vehicle. These include vehicle category (BEV or PHEV), battery capacity, battery range, CO_2 emissions, buyers' income levels or some combination of all these factors. For example, in China, the Tesla Model S and BYD e6 are the only two models eligible for the maximum subsidy level due to their long battery range. In Japan, the level of electric vehicle subsidy is decided based on the price gap between the electric vehicle and a specific counterpart conventional vehicle (Yang, Z. et.al. 2016).

While **preferential incentives for EVs within efficiency and CO_2 regulations** are limited, stringent efficiency standards can be highly effective in accelerating the deployment of electric vehicles if accompanied by smart built-in incentives, clear targets for electric vehicles and complementary consumer policies (Lutsey 2017). In addition, consumer awareness campaigns have proven effective as well. A number of states in the US are **also supporting plug-in electric vehicle research, development and pilot projects**. For example, Massachusetts is working with communities around the state to pilot vehicle-to-grid (V2G) technology in school buses. They are also **directly purchasing EVs** for use in their vehicle fleets and installing charging stations at state-owned buildings.

Apart from one-time single grants, many US states have funding streams with the potential to provide recurring, stable funding for transportation programmes. Proceeds from emissions budget trading programmes, system benefit charges, gross receipts taxes and vehicle or registration fees are relatively stable sources of funding that US states may use to support PEV programmes (Powers, C.2015).

2.4 City-Specific Incentives and Drivers

Global electric vehicle sales reveal heavy concentration in certain specific metropolitan areas—14 metropolitan areas account for just 1.5 percent of the global population and only 5 percent of annual global passenger vehicle sales, but make up a third of the global EV market. The metropolitan areas with the highest electric vehicle sales in 2015 in terms of total volume were Shanghai (41,179 vehicles), Los Angeles (23,652), Beijing (18,065) and Shenzhen (17,699). The metropolitan areas with the highest share of electric vehicles sold in 2015 relative to total passenger vehicle sales were Oslo (27 percent), Utrecht (15 percent), Shanghai (11 percent) and Shenzhen (10 percent).

Fourteen leading metropolitan centres around the world including Oslo, Utrecht, Shanghai, Shenzhen, Amsterdam, San Jose, San Francisco, Copenhagen, Beijing, Stockholm, Zurich, Los Angeles, Paris and London have enjoyed two to more than 30 times the average global EV sales rate in 2015, helping increase EV uptake in terms of EV sales and market share by specific local initiatives. Such city-led initiatives have included common elements such as provision of charging infrastructure, tax exemptions and grants for EVs and provision of free parking areas, while also tailoring certain other measures to local realities and requirements including access to congestion zones, tunnel and ferry-fee exemptions (in Norway) and preferential registration for EVs and exemption from vehicle registration lotteries (in Shanghai), see Hall, Moultak and Lutsey (2017) and Lutsey et al. (2015).

2.5 Private Sector Announcements

In addition to government-set targets and mandates, a number of car manufacturers have also made major announcements with regard to how they intend to promote EVs through incentives and targets. These are summarised in Table 3, taken from Schneider (2017).

This chapter reveals that policy support and incentives, including subsidies, will in many if not most cases play a crucial role in supporting the EV industry, given that it is still in its early stages. All of these may be considered as “market-pull” policies as they incentivise demand for EVs, related components and services, whether domestically or from abroad. In addition, governments may also pursue “technology-push” policies that aim to increase the supply of EVs and batteries. These include government support for R&D at early stages of innovation and for product development and manufacturing at later stages. Such policies can, depending on their design and implementation, have trade effects along the supply chain, whether positive or negative. Some of these challenges are discussed in the next chapter.

Table 3. Announcements by major carmakers with respect to electric vehicles

Carmaker	Announcement
BMW Group	• 100,000 electric vehicles sales in 2017 • 15-25 percent electric vehicles share by 2025
Chevrolet	• 30,000 electric vehicles sales in 2017
Chinese OEMs	• 4.52 million electric car sales by 2020
Daimler	• 100,000 electric car sales by 2020 • 15-20 percent battery electric vehicles share of sales by 2025 • 10 percent hybric electric vehicles share of sales by 2025 • 10 new electric vehicle models by 2022 • Investments of EUR 10 billion until 2022 into electric vehicles
Ford	• 13 new electric car models by 2020
Honda	• Electric vehicles with a share of two thirds of sales in 2030
Renault-Nissan	• 1.5 million electric car sales by 2020 • Investments of EUR 4 billion into electric cars as announced in 2009
Tesla	• 500,000 electric vehicle sales in 2018 • 1 million electric vehicle sales in 2018
Volkswagen	• 2-3 million electric car sales by 2025 with 30 new battery-powered car models, which would correspond to 25 percent of vehicle production • Investments of EUR 9 billion until 2022 into electric vehicles
Volvo	• 1 million electric car sales in 2025 • No new car model without an electric motor from 2019 on

Source: Schneider (2017)

3. TRADE POLICY–RELATED ISSUES AND CHALLENGES TO ELECTRIC VEHICLES EXPANSION

Trade policy can influence economies of scale in goods and services production by enabling firms to set up and operate an efficient and cost-optimal supply chain network that is global in scope, thereby bringing down EV production costs. The US Department of Energy for instance estimates that increasing production volumes for a BEV 100 kWh battery pack from 25,000 units to 100,000 units would allow a cut in production costs by 13 percent per kWh (IEA 2017). Domestic policies such as those based on standardisation may need to strike a balance between responding to legitimate differences in local environmental conditions in different countries and encouraging innovative efforts in alternative battery technologies while also ensuring a cost-optimal and efficient production scale for EVs internationally. This chapter underscores the need to better understand the nature of EV supply chains and trade-related issues and challenges.

3.1 Supply Chains and Trade Flows

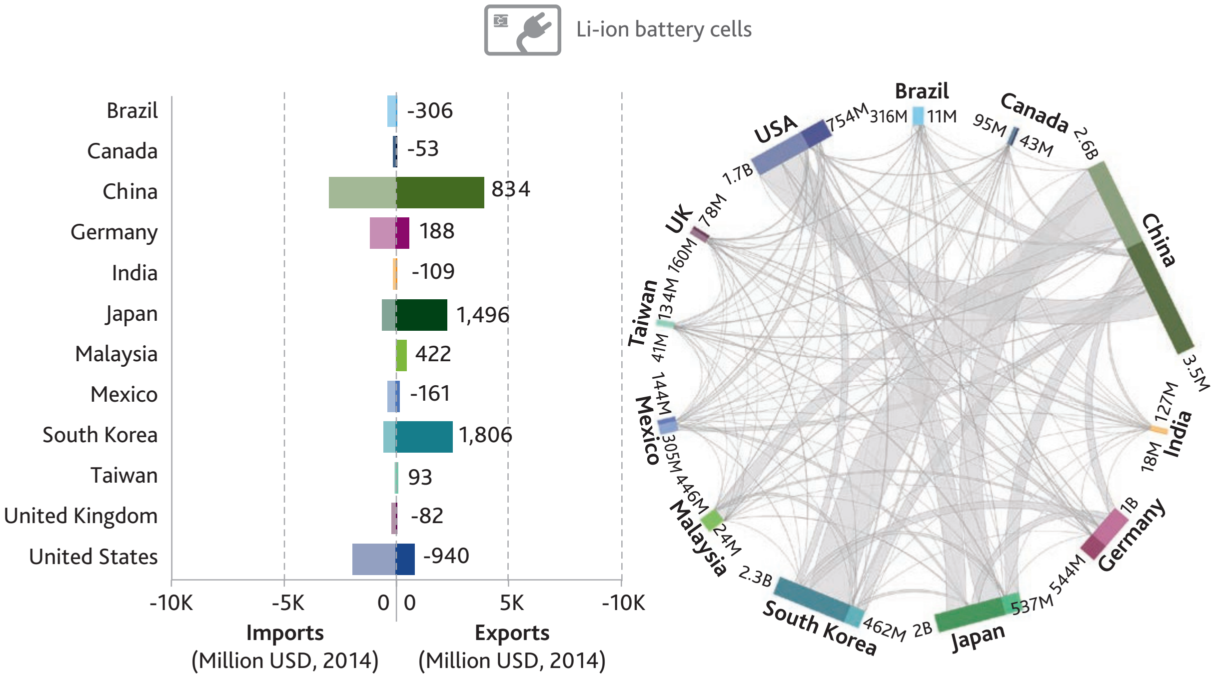
A modern passenger car comprises more than 30,000 working parts and while car manufacturers assemble final vehicles, 70 percent of the components are outsourced to external suppliers. However, the EV power train involves considerably fewer components (200) than does an ICE power train (1,400). Almost a third of the automotive supply chain is power train-related and, according to an ING report, is threatened by a shift to electric power trains. Even as EV production would require fewer components they would entail more raw-materials and less labour, compared to ICE vehicles. There would also be opportunities for suppliers of EV components and a strengthening of demand associated with mobility-related services helped by the lower operating costs of EVs. (ING 2017). Further, with growing automation in production and lower operating costs expected compared to an ICE vehicle, questions arise with regard to the number of EV automotive and maintenance-related jobs as well as the nature of such jobs that will be available in the future.

The battery of an EV accounts for about 30 percent of the final cost and also defines the sales price, safety and range of an EV. Initially, the trend was one of vertical integration, with car manufacturers developing batteries in-house. They are now moving towards partnerships with and outsourcing to battery manufacturers. In other cases, battery manufacturers themselves have entered the car production business to leverage advantages of their batteries, with BYD being a notable example from China. As of 2016, one company, Panasonic, was responsible for 32 percent of battery production used in electric vehicles (Kane 2016). It is too early to say which model will eventually prevail in the EV industry.

Two factors, according to the OECD (2015), favour the creation of a domestic supply chain for batteries—first, just-in-time manufacturing practised by most auto makers, and secondly, the heavy weight of batteries which make them cheaper to assemble locally than import from abroad. This also has implications in terms of production and deployment of EVs on a rapid scale outside the traditional manufacturing hubs of Asia (China, Japan and Korea), the EU and US where EV battery production is presently concentrated. A similar finding is also revealed in a recent study by the Clean Energy Manufacturing Centre, which found that the proportion of domestic value-added retained for lithium-ion battery cells used in light duty domestic vehicles (LDVs) was quite high. It was, however, lower in the case of electrolytes, anodes and separators used in these battery cells, suggesting a greater degree of trade in these components (CEMAC, 2017).

As illustrated in Figure 1, CEMAC data for 2014 shows that China, followed by Japan and South Korea, were the leading net exporters of lithium-ion battery cells (trade figures shown are for all end uses, however, and not solely for light duty vehicles), with Malaysia and Chinese Taipei also experiencing small net export surpluses. The biggest net importers were the US, followed by Germany, Brazil, Mexico, India, the UK and Canada.

Figure 1. Balance of trade and trade flows for lithium-ion battery cells



Darker shade represents exports and lighter shade represents imports
Note: Trade figures show all end uses for lithium-ion battery cells as it is not possible to disaggregate by end use
Source: CEMAC (2017, xvii) http://www.manufacturingcleanenergy.org/benchmark/

There also existed significant excess global production capacity for lithium-ion cells since, according to the CEMAC report, the rate of utilisation was only 41 percent. However, this is expected to be taken up rapidly in the future and any new capacity created is expected to be utilised to meeting ever-growing battery-demand not just for EVs but also for electricity storage (Economist 2017).

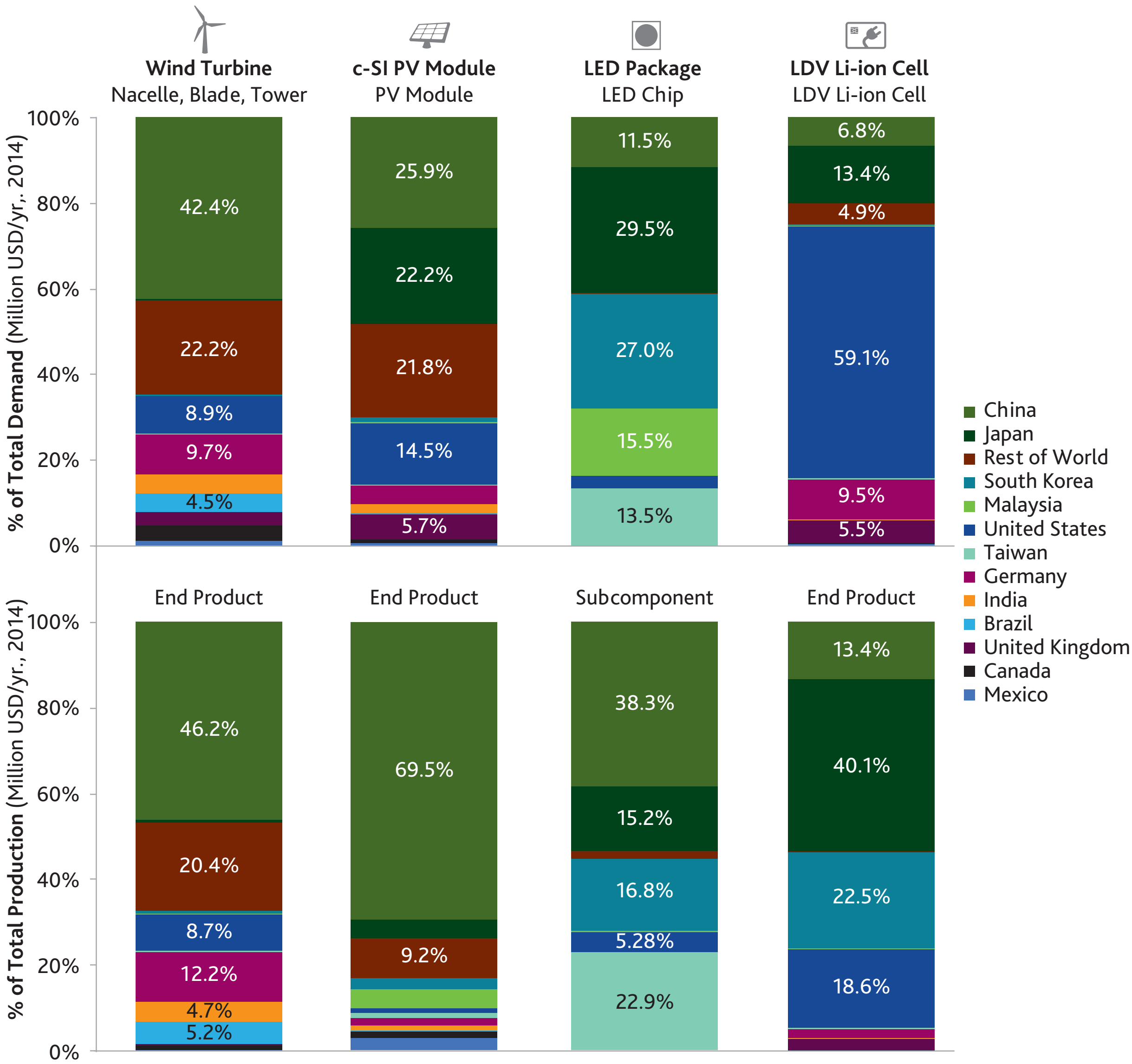
The major production centres for lithium-ion battery cells and major demand centres were not necessarily fully aligned in 2014, with Japan accounting for most of the production and the US for most of the demand. Figure 2 shows both the market demand and production shares according to CEMAC (2017) for four clean energy technology segments, including lithium-ion battery cells.

The manufacturing landscape has already changed, as both Chinese production of and demand for batteries ramps up in response to the massive growth of electric vehicles in China, including through the establishment of what may become the world's biggest battery factory (Sanderson et al. 2017). China's cell production already has a larger share of global production than Japan's, and China's global market share is projected to rise to more than 70% by 2020. (Perkwoski, J.2017)

Less is known about the value chains for products like electric bikes, which could offer opportunities for developing countries (including those outside Asia) to participate in value chains. In any event, trade policies will certainly shape the location of supply chains for all types of EVs. The CEMAC (2017) report emphasises the importance of policy makers having a deep understanding of the entire supply chain of clean energy technologies, because even where the end product manufacturing is concentrated, the upstream components and materials may be sourced from many economies.

Detailed information on the geography of EV supply chains, how production bottlenecks are created or avoided by trade policies and how cost structures are influenced by countries' trade and investment policies will ultimately

Figure 2. Market demand and production shares in four clean energy technology end products including lithium-ion cells



Note: LED chip (subcomponent), rather than LED package (end product) data reported, due to lack of economy-specific LED package production data. Demand and Production values are shown as shares of the aggregate demand and production, respectively, of the 12 economies assessed.

Source: CEMAC (2017, xx) http://www.manufacturingcleanenergy.org/benchmark/

help in the design of trade rules and agreements that facilitate cost reduction for EVs. It will also help determine whether trade policy, such as through targeted lowering of applied most-favoured tariffs, can provide positive discrimination in favour of electric vehicles by providing them a preferential advantage, however small, relative to ICE ones.

Trade policy issues and challenges to an optimal global EV supply chain, some of which are currently relevant and others which may emerge in the future, can be categorised under some broad sub-headings as set out in the following sections.

3.2 Tariffs

Tariffs still discourage imports of assembled motor vehicles in general in a number of countries. For instance, India imposes a 60 percent duty on finished cars costing less than US$40,000 while the duty on knocked-down kits is only 10 percent if the vehicle is assembled in India (Furtado 2016). Despite the difference in power train-related components between ICE vehicles and EVs as noted earlier, given that certain parts and components (such as wheels and furnishings) for ordinary motor vehicles and EVs may be the same, tariffs that affect this segment of motor vehicle cost would also affect EVs.

With regard to harmonised system (HS) classifications used in international trade, electric vehicles for the transport of persons were previously hidden within HS code 870390, a basket item that includes all vehicles which are not named elsewhere under heading 8703 (Vossenaar 2010a). This made it rather difficult to track global trade in finished electric cars. Certain countries, however, have specific tariff nomenclatures for electric vehicles and thus some country specific trade-flows could be mapped.

In 2017, the World Customs Organization (WCO) made effective accepted amendments to the HS nomenclatures (HS 17). These amendments have now created separate HS six-digit codes for various types of EVs, such as HEVs, PHEVs and BEVs as well as motorcycles (including mopeds and bikes), with an electric motor for propulsion (WCO 2015). This will make it easier to identify tariff barriers and to track global trade flows in EVs in the future as presently trade data reflecting the HS 17 amendment is not yet available. These amendments will also facilitate identifying any possible correlation that may exist between specific trade policy and other domestic policy measures and changes in trade flow numbers on EVs. Table 4 shows the three major four-digit motor vehicle HS headings and the new six-digit hybrid, plug-in hybrid and/or pure electric vehicle HS codes created under these three headings by the World Customs Organization as part of its HS 2017 revision; a full listing of all current headings is shown in the Annex (Table A 3).

Rechargeable batteries, including those used in EVs, are classified under HS 8507 (electric accumulators), with lithium-ion batteries having their own HS six-digit code, HS 850760. However, it may not be easy to identify the end use of such traded batteries given the large number of applications other than transportation. Such analysis may require an examination of national statistics in cases where separate national tariff lines (NTLs) for EV lithium-ion batteries exist.

An examination of most favoured nation (MFN) applied tariffs in Annex Table A 1 shows that most major economies, with the exception of Japan and the USA (in the case of electric motorcycles), do not provide duty-free treatment for electric vehicles and apply fairly similar tariff protection for both electric and spark-ignition ICE vehicles, a situation that does not appear to have changed since the last decade (see for instance, Vossenaar 2010b). Japan has the most open trade regime for automobiles among the major economies and applies zero duties for both spark-ignition ICE as well as electric vehicles.

The assessment shows that there is good potential for lowering applied MFN tariffs on electric vehicles so as to provide a cost advantage for EVs relative to ICE vehicles. While electric vehicle costs may be high, these are set to decline further in the future as battery costs decline. An immediate reduction in MFN applied tariffs for EVs would therefore constitute a “low-hanging fruit” that could be implemented fairly easily by major economies. Given the political sensitivity of the automotive sector in general for most economies, such a reduction may of course not be easy and still involve protracted trade negotiations.

Import tariffs on electric accumulators (storage batteries) used for transport vehicles are relatively low, with few exceeding ad valorem rates of ten percent. Certain countries have created separate tariff headings at the national level for accumulators used to power electric vehicles. Canada, for instance, applies zero duties based on the end use whereas the US and Mexico apply different tariffs based on technology rather than end use (OECD 2015).

Tariff escalation is common in many developing countries, with a higher duty placed on

Table 4. Amendments to the HS system introduced by the 2017 HS revision

New HS code numbers	HS descriptions
I. HS 8702	Motor Vehicles for the transport of 10 or more persons, including the driver
HS 8702.10	With only compression-ignition internal combustion piston engine (diesel or semi-diesel)
HS 8702.20	With both compression-ignition internal combustion piston engine (diesel or semi-diesel) and electric motor as motors for propulsion
HS 8702.30	With both spark-ignition internal combustion reciprocating piston engine and electric motor as motors for propulsion
II. HS 8703	Motor-cars and other motor vehicles principally designed for the transport of persons (other than those of heading 87.02) including station wagons and racing cars
HS 8703.40	Other vehicles, with both spark-ignition internal combustion reciprocating piston engine and electric motor as motors for propulsion, other than those capable of being charged by plugging to external source of electric power
HS 8703.50	Other vehicles, with both compression-ignition internal combustion piston engine (diesel or semi -diesel) and electric motor as motors for propulsion, other than those capable of being charged by plugging to external source of electric power
HS 8703.60	Other vehicles, with both spark-ignition internal combustion reciprocating piston engine and electric motor as motors for propulsion, capable of being charged by plugging to external source of electric power
HS 8703.70	Other vehicles, with both compression-ignition internal combustion piston engine (diesel or semi-diesel) and electric motor as motors for propulsion, capable of being charged by plugging to external source of electric power
HS 8703.80	Other vehicles, with only electric motor for propulsion
III. HS 8711	Motorcycles (including mopeds) and cycles fitted with an auxiliary motor, with or without side-cars; side-cars
HS 8711.60	With electric motor for propulsion

Source: WCO (2015)

finished goods than on parts and components. Increasingly, regional groupings and free trade agreements (FTAs) such as NAFTA, ASEAN, the EU-Korea and EU-Mexico agreement have driven duty-free trade on a non-MFN basis in all automobiles, but certain non-tariff measures such as certification processes for automobile parts in Korea still remain. Certain other FTAs such as the ASEAN-China FTA also contain exemptions for automotive parts (OECD 2015 and VDA n.d.).

Given the policy significance that electric vehicles have now assumed, it may be incumbent on all countries to review whether there are situations where they may be disadvantaged as far as trade policy is concerned relative to fossil fuel vehicles. Further, they could consider whether fully assembled electric vehicles as well as certain parts and components could be given a tariff advantage through trade policy frameworks and sustainable energy trade initiatives (SETIs). For example, regional trade agreements could include an accelerated liberalisation time line. Such initiatives for positive discrimination should bear in mind of course that some parts and components (such as tyres or interior furnishings such as seats) may be the same as those used in fossil fuel vehicles. Given the significant share of battery cost (at around 75 percent) in the EV power train (Wolfram and

Lutsey 2016) which amounts to one-third of the purchase price of an electric vehicle (NITI Aayog and Rocky Mountain Institute 2017b), zero-tariffs on EV batteries—even if existing applied tariffs are already low—could help with EV cost reduction. It may be worthwhile undertaking an analysis of what a zero import duty would mean for the purchase cost of an EV in various markets. Positive discrimination in favour of fully assembled EVs, as well as their parts and components, might then mark a significant departure for trade policies that have by and large treated electric and non-electric vehicles in the same manner. In the event that all tariffs are reduced to zero across all vehicle categories, possibilities for accelerated dismantling of non-tariff measures affecting EVs could also be explored.

The treatment of electric vehicles and related infrastructure in the latest iteration of the list of goods being negotiated under the plurilateral Environmental Goods Agreement (EGA) for zero tariffs is not publicly known at the time of writing, given the restricted nature of the information. An earlier 2015 iteration of the consolidated list proposed by EGA members did, however, contain hybrid, plug-in hybrid, pure electric and hydrogen-fuelled vehicles (including not only passenger cars but also commercial vehicles such as crane lorries and motorcycles) as well as battery-powered boats. It also included charging-related equipment such as charging stations and sockets and various types of batteries including lithium-ion batteries, according to ICTSD interviews with trade delegates and T&E (2015). However, for the moment the future of the EGA is rather uncertain and there is no way to predict how talks may evolve or what future lists might contain.

A small but symbolically important step has been the undertaking by Bahamas, Saint Lucia and Saint Vincent and the Grenadines to reduce import duties on certain types of vehicles, including hybrid and electric cars, as part of their nationally determined contributions under the Paris Agreement (Brandi 2017). Thus, countries can always autonomously lower their tariffs along the value chain as India did in 2011 on EV parts such as battery packs and chargers (although not extending the cuts to fully assembled EVs or hybrids, see ICTSD 2011).

3.3 Investment Measures and Incentives for Domestic Industry

Several countries are actively promoting their domestic electric vehicle industry as well as battery manufacturers, sometimes to the detriment of maintaining a liberal investment regime and more open markets for trade. For example, in China foreign EV companies are required to enter into a joint venture with Chinese manufacturers and subsidies are often designed to benefit local battery producers. Local content incentives are also used, such as purchase subsidies for HEVs and BEVs that are restricted to locally assembled vehicles (McKinsey 2015). In addition, many countries (including the EU as a bloc)—both developed as well as emerging economies—are now considering supporting local battery manufacturing through subsidies for that but also for R&D support and more (Sanderson et al. 2017).

Consumer-based incentives such as those highlighted in section II are not likely to run afoul of WTO rules as long as they are non-discriminatory and available for all EVs, whether domestically manufactured or imported. On the other hand, in the case of certain Chinese cities or provinces, incentives are provided to local carmakers that are based in that place itself, which arguably discourages investors from other Chinese regions or international ones. Such subsidies could run afoul of the WTO's Subsidies and Countervailing Measures (SCM) Agreement which prohibits trade-distorting subsidies specific to a particular geographical region, in case they impact trade. There is limited evidence from China that such practices may be changing (Masiero et al. 2016).

In other cases, investment-related performance requirements may benefit EV scale-up and climate mitigation efforts, but could throw up broader trade implications. One example is a draft law being considered by China, which would require all automobile companies to have as much as eight percent of their vehicle sales in China be electric vehicles as early as 2018. Companies missing their targets would be forced to buy "credits" from competitors who overshot. The policy is designed to eventually enable the quota-trading scheme to replace subsidies to domestic manufacturers of EVs (Clover and Fei Ju 2017). It is not clear, however, whether such sales could also include imported electric cars or whether they would need to come from electric cars manufactured domestically in China. Early indications are that China may revise this law following private sector feedback that such targets appear unrealistic (Bloomberg 2017a). However, these facts underscore that EV policies are only just taking shape and need to be actively moulded so that they are supported by, as well as supportive of, trade- and market-friendly policies while they try and advance climate mitigation targets.

The issue of whether certain types of incentives such as local content measures, even if trade-supportive, help support the development of a strong manufacturing sector has been hotly debated. For example, in the case of the renewable energy sector, Kuntze and Moerenhout (2013) argue that a number of initial basic conditions determine the feasibility of creating domestic industries and, perhaps, subsequent innovators. These include a stable and sizeable market, adequate financial support and a not too restrictive local content rate that is associated with learning benefits. Finally, when technologies are still in their infancy, the potential of local content requirements to reduce costs through learning-by-doing is higher. Could local content requirements under certain conditions be used in conjunction with the development of a global innovator that can compete on the international market and push down technology costs in the medium-term? Kuntze and Moerenhout argue that such conditions are country- and technology-specific and complex. Further, such potential positive spillover benefits have not been modelled or demonstrated.

Even so, some experts believe that China's approach to creating EV battery production capacity, for example, has echoes of its approach to solar power a decade earlier where it came to dominate the industry by lowering costs and driving prices down by 70 percent. While this could mean lower costs for electric cars and batteries, it could also mean a drastic loss of market share for manufacturers in the rest of Asia, Europe and the US (Clover and Fei Ju 2017). Whether countries will allow such policies to be undertaken in the future without initiating trade disputes remains to be seen.

3.4 Export Restrictions on Critical Raw Materials

EV battery production depends on the use of certain critical raw materials such as lithium, cobalt, graphite, nickel, manganese and aluminium. A number of EV battery technologies exist such as lithium-ion, lead-acid, nickel-based, sodium-based and flow batteries. While lithium-ion technology is currently dominant for EVs, ongoing research into alternative battery chemistries could provide a viable alternative and also perhaps alleviate demand pressure on lithium from battery manufacturers (Eckhouse 2017, Economist 2016).

Lithium, cobalt, nickel and graphite face supply-related concerns being geographically concentrated in a handful of countries as in the case of lithium (mainly Argentina, Bolivia and Chile and with production capacity yet to ramp up in Australia) and cobalt (65 percent comes from the Democratic Republic of Congo (DRC)). Battery makers are struggling to secure supplies of key ingredients in these large power packs—mainly cobalt and lithium. Supply deficits in cobalt are starting to emerge and a shortfall in production in the DRC due to the unstable political situation led to a 90 percent jump in the cobalt price to US$61,000 per tonne earlier in July 2017. Demand for other key battery ingredients, such as graphite and lithium carbonate, is also outstripping supply. The current shortage of lithium has seen a doubling of prices since 2015. Global lithium demand stood at 184,000 tonnes in 2015, with battery demand accounting for 40 percent. According to analysts at Deutsche Bank, demand could increase to 534,000 tonnes by 2025, with battery manufacturers accounting for 70 percent (West 2017). According to some experts, while there are plenty of lithium deposits available to meet the needs of electric cars in the future, there is a shortage of lithium mines. Despite this, there would not be a major impact caused by a lithium supply crunch on overall battery costs as some experts estimate that even if the price of lithium rises by 300 percent, battery pack costs would rise only by about 2 percent (Shankleman et al. 2017).

Restrictions placed by countries on exports of certain minerals can also lead to global supply shortfalls. For instance, in 2014 Indonesia banned nickel exports, leading to a price rise of nearly 50 percent (Desjardins 2016). The WTO has previously ruled against Chinese restrictions on rare earth minerals such as tungsten and molybdenum (ICTSD 2014), but disputes around export restrictions are not likely to stop. On 13 July 2016, the US and EU filed a complaint at the WTO Dispute Settlement Understanding regarding China's export restrictions on a range of minerals such as antimony, cobalt, copper, graphite, lead, magnesia, talc, tantalum and tin, used in sectors such as aerospace, automotive, electronics and chemical industries, among others (ICTSD 2016). A panel was subsequently established on 8 November 2016.[2]

For the EV industry, graphite is an important battery component, with 65 percent of flake graphite being mined in China. The importance of graphite is illustrated by the fact that there are at least 54 kg of graphite in the battery anode (85 kWh) of each Tesla Model S vehicle. Desjardins (2016) states that according to a forecast by Benchmark Mineral Intelligence, "the battery anode market for graphite, both natural and synthetic, will triple in size from 80,000 tonnes in 2015 to at least 250,000 tonnes by the end of 2020" with rising demand also influencing price levels. Any disruptions in supply due to export restrictions could thus threaten the viability of many EV battery industries.

Environmental and social considerations are also coming to the fore. The environmental impact of mining raw materials could affect the overall environmental footprint of an electric vehicle. UNICEF, Amnesty International and African Resources Watch (Afrewatch) have highlighted the plight of children working in cobalt mines in southern DRC and that major companies, including certain automobile firms, using cobalt in their products were failing to do basic checks to ensure they were not using cobalt mined by children. Such concerns, if not addressed, have the potential to affect smooth supply chain operations and future international trade in these raw materials. One response among some battery manufacturers has been to switch to alternatives. Two South Korean battery makers, Samsung SDI and LG Chem, for example have responded to the cobalt shortage crisis by stepping up development of new power packs that use more nickel and less cobalt (West 2017). Another response to work towards ensuring ethical environmental and social practices would simply be better corporate social responsibility reporting by automotive as well as mining companies. A further plausible scenario could be that environmental and social labelling, as currently available for many agricultural and manufactured products, could also be provided for EVs by the industry if these issues continue to be of concern to consumers and the general public.

3.5 Government Procurement Measures

Government procurement in many countries constitutes an important part of the package of incentive measures for EVs and provides an opportunity for kick-starting the market

2 See www.wto.org/english/tratop_e/dispu_e/cases_e/ds508_e.htm.

and scaling up production and deployment, in addition to showcasing their reliability, safety and environmental advantages.

It is difficult to discern to what extent procurement policies have favoured domestic producers, although according to the OECD, (OECD, 2015) statistics from the US and China reveal the proclivity of governments to purchase vehicles from national manufacturers. A closer analysis of government procurement laws as well as conditions surrounding the procurement of EVs may be required to ascertain a conscious preference for domestic manufactures or even “national” brands. If public procurement is carried out in a discriminatory manner, so that it effectively constitutes a barrier to a swifter scale-up of EVs, it must be addressed.

Moreover, government procurement may be a powerful tool that governments could actively use to give a preference to environmentally friendly products over their less environmentally friendly counterparts, as long as discrimination is avoided (particularly if the procuring party is a member of the WTO’s Government Procurement Agreement). According to Herve and Luff (2012), the Government Procurement Agreement provides for flexibility for procuring sustainable energy goods and services (including electric vehicles), driven by technical specifications and based on international standards (where they exist) as well as through allowing the concept of “most economically advantageous” tender (rather than lowest cost tender). If discrimination is still found, according to Herve and Luff, justification could probably be sought under the General Exceptions to the Government Procurement Agreement. Given that positive discrimination in favour of electric vehicles is likely to be based on “end use” environmental benefit rather than process and production methods, government procurement rules under the WTO, as well as under free trade agreements, will likely not act as a barrier to positive discrimination in favour of electric vehicles. From an environmental, quality and performance perspective of course it may be also important to consider if procurement practices for EVs give undue emphasis to one attribute (such as cost) while possibly sacrificing others such as quality, safety and performance.

3.6 Technology Access and Diffusion

Access to technologies and technology diffusion will certainly be an important concern and consideration for governments as well as companies involved in sustainable transport. For instance, a Harvard Kennedy School report (Howell, et al.2014) noted the lack of success among Chinese firms in getting access to foreign EV technology despite inducements provided through joint ventures. At the same time, the report notes that trade barriers and restrictions on producing and selling foreign electric vehicles in China (such as ineligibility for subsidies and stringent intellectual property (IP) requirements) have also contributed to the problem. Particularly in the areas of lithium-ion battery technology, control accuracy, reliability of motor technology, process control and materials treatment some experts have noted the technology gap between China and more advanced international producers. These experts have also called for greater R&D collaboration between Chinese and foreign firms as well as for the establishment of technology platforms supported by governments to speed up commercialisation of various EV technologies (Xunmin and Xiliang 2012).

Presently, no one country or company has a clear monopoly on EV-related technology, although the patent landscape in the electric vehicle industry (including hybrid-electrics) is dominated by US companies, with Ford and General Motors in the lead followed by the Japanese companies—Honda Motors and Toyota Motors (Brachmann 2015). Different companies may choose to follow different approaches to patents and licensing of its technology. Tesla for instance has adopted an “open-source” model, famously declaring that its patents belonged to everyone in the interests of electric vehicle development and that the company would not initiate patent lawsuits against anyone who, in good faith, wanted to use Tesla's technology (Musk 2014). However, such a strategy may, according to some experts, also help Tesla and expand EV deployment by further building and expanding markets and, importantly, through establishing standards. The exact role of IP in the transfer of climate-related technologies is unclear and further research may be needed. Options for the post-Paris Agreement scenario may also involve looking at financing elements for technology and the treatment of publicly funded technologies. Prices for climate-related innovation and institutional arrangements for open or collaborative innovation will also matter (ICTSD 2008). While IP protection can encourage innovation, it may also discourage more rapid dissemination of technologies if it increases costs. There may be a need to further explore governance models in IP that could help in EV deployment as part of a bigger "trade and technology governance ecosystem" that may involve a number of factors including trade and investment policies as well as the development of human capital.

An earlier ICTSD survey of firms on clean energy licensing found that IP protection in host countries was not the only factor in influencing the decision by foreign firms to enter into licensing agreements with firms in developing countries. Overall, respondents attached slightly more weight to factors such as scientific infrastructure, human capital, favourable market conditions and investment climates. However, licensing-intensive respondents attached somewhat greater importance to IP protection than to these other factors. At the same time, 70 percent of respondents said they were prepared to offer more flexible terms when licensing to developing countries with limited financial capacity (UNEP, EPO and ICTSD 2010).

What may be required is a balanced market-friendly approach that incentivises global companies to invest in and enter new markets and enable technology diffusion through greater trade and increased foreign direct investments. Research into successful examples of EV policy that encourage technology collaboration and investments through resolving trade-related barriers could inform policy makers around the world in terms of crafting sound well-informed policies aimed at encouraging technology access and diffusion. The role of the UNFCCC's Technology Mechanism and Green Climate Fund in providing a supportive framework could also be explored. The Technology Mechanism consists of two bodies: the Technology Executive Committee (TEC) and the Climate Technology Centre and Network (CTCN). The TEC is the Technology Mechanism's policy body, responsible for analysing issues and providing policy recommendations that support countries' efforts to enhance climate technology development and transfer. It is made up of 20 technology experts representing both developed and developing countries and meets several times a year, also holding climate technology events that support efforts to address key policy issues. The CTCN is the implementation body of the Technology Mechanism and facilitates the transfer of technologies through three core activities, namely:

(i) providing technical assistance to developing countries upon request, to accelerate the transfer of climate technologies;

(ii) creating access to information and knowledge on climate technologies, particularly through its knowledge management system; and

(iii) fostering collaboration among climate technology stakeholders via its network of regional and sectoral experts.

The CTCN is hosted by the United Nations Environment Programme in collaboration with the United Nations Industrial Development Organization and is supported by 11 partner institutions. The Centre also facilitates a network of national, regional, sectoral and international technology centres, networks, organisations and private sector entities.

Developing countries can send a request to the CTCN through their nationally selected focal point, called a national designated entity.[3]

One of the focus areas of the TEC is to develop technology roadmaps for countries following submission of their technology needs assessments (TNAs) identifying their priority needs. Since 2001, more than 90 countries have submitted their TNAs and 41 percent of energy sector TNAs related to climate change mitigation have included transport. Over 25 percent of parties have prioritised technologies related to fuel-switching such as electric or liquefied natural gas vehicles, in addition to transport modal shifts such as mass rapid rail or road systems (Nhlengethwa-Masina 2016). The CTCN is already involved with sustainable transport and urban mobility-related technical assistance requests from Bhutan and Panama (CTCN n.d.). There is scope for further identifying needs that may be specific to EV roll-outs in developing countries and for policy makers to explore, in consultation with interested developing countries, how the CTCN may be able to help and how such efforts could be supported by the countries' own trade policies on EVs. Relevant findings from research studies, as well as important technology policy messages emerging from dialogue between governments and electric vehicle firms, should also be channelled to the TEC as well as to climate and trade policy makers. In addition, according to Gehl Sampath et al. (2012), research—i.e. the development of new technologies to be transferred—will require significantly different arrangements than sectoral and project funding approaches. This is likely to be true for electric vehicles R&D as well.

There will be a multiplicity of channels in addition to the UNFCCC's Technology Mechanism through which technology diffusion takes place including bilateral and regional mechanisms and most importantly through private sector-led trade and investment efforts (Gehl Sampath et al. 2012). A better understanding of these various mechanisms in the EV context, through specific case studies, will be useful for policy makers and also serve to clarify and refine the role that the TEC can play.

3.7 Electric Vehicle Supply Equipment Charging Standards

The development of standards around electric vehicle supply equipment is critical to enabling smooth functioning of electric vehicles, interoperability with regard to EVs and charging points, as well as facilitating international trade and economies of scale in EV production lines. Given that power requirements for charging electric cars clearly exceed those for smaller vehicles such as bikes, they are also likely to require the deployment of novel components of electricity generation, transmission and distribution infrastructure. Charging EVs involves the use of cables, communicators and protocols between the EVs and Electric Vehicle Supply Equipment (EVSE). EVSEs suitable for electric cars have three main characteristics:

- **Level:** describing the power output of an EV charger;
- **Type:** referring to the socket and connector used for charging; and
- **Mode:** describing the communication protocol.

Standards, including those set by international standardisation bodies, may focus on just one of these characteristics or all of them. The major standardisation entities involved in the development of these standards include the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), the Society of Automotive Engineers (SAE) of the US and the Standardization Administration of China (SAC), which issues Chinese national standards (GuoBiao codes, or GB).

The Open Charge Alliance (OCA) is an industry alliance comprising EV charging hardware and software vendors, charging network operators

3 See http://unfccc.int/ttclear/support/technologymechanism.html.

and service providers. Its mission is to foster global development, adoption and compliance of the Open Charge Point Protocol (OCPP) and related standards through collaboration, education and testing.[4]

Other organisations active in the area of standardisation include CHAdeMO, an association of vehicle manufacturers and utilities involved, since 2009, in the development of various quick charging standards that enable charging up to 150kw and in future up to 350kw. Several mass-produced electric cars have been equipped with connecting devices enabling the use of CHAdeMO chargers, and adapters are available for most models using different connectors. The Charging Interface Initiative (CharIN) is another organisation set up in 2015 with a broader scope in terms of membership and representation across the automotive sector. It was established with the aim of promoting a global charging standard (CharIN 2015) and promotes the combined charging system (CCS) and combo connectors used in Europe and the US, thereby suggesting a vision for future developments. The approach enables faster charging at 200kw and the target is to develop even faster charging options at 350kw. (IEA,2017).

In 2016, Tesla joined CharIN as a member. Tesla has also been using its own standard to support all levels and modes of charging through the same connector type, with the exception of Europe where Tesla needs to comply with the EU Standardisation Mandate concerning interoperability to use specific standards for sockets and connectors for normal (Level 2) and high-power (Level 3) recharging points (European Commission 2010). Table 5 provides an overview of the level (power output) and type (socket and connector) of EVSEs used in China, Europe, Japan and the US.

Table 5. Overview of the level (power output) and type (socket and connector) of EVSE used in China, Europe, Japan and North America

Classi-fication in use here	Level	Current	Power	Type			
				China	Europe	Japan	North American
	Level 1	AC	≤3.7 kW	Devices installed in private households, the primary purpose of which is not recharging electric vehicles			SAE J1772 Type 1
Slow chargers	Level 2	AC	>3.7 kW and <2.2 kW	GB/T 20234 AC	IEC 62196 Type 2	SAE J1772 Type 1	SAE J1772 Type 1
	Level 2	AC	< 2.2 kW	Tesla connector			
Fast chargers	Level 3	AC, triphase	> 2.2 kW and ≤ 43.5 kW		IEC 62196 Type 2		SAE J3068 (under development)
	Level 3	DC	Currently <200 kW	GB/T 20234 DC	CCS Combo 2 Connectors (IEC 62196 Type 2 & DC)	CHAdeMO	CCS Combo 1 Connectors (IEC J1772 Type 1 & DC)
	Level 3	DC	Currently <150 kW	Tesla and CHAdeMO connectors			

Source: IEA (2017)

4 See www.openchargealliance.org.

A key point to be emphasised is that, while various sockets and connectors are in use across the global regions, two main combined charging systems for both level 2 and level 3 were developed to standardise the connections and represent the current standards in Europe and the US. These, along with the HomePlug Green PHY communication protocol and the global standard for communication between charging stations and electric cars, are emerging as the most significant recent developments towards a global charging solution. So far, due to these initiatives, standards have not arisen as a major problem in the scale-up of production and trade of electric vehicles. On the other hand, there are only a few standardised protocols for EVSE grid communications, but more initiatives are now underway. The Dutch EV charging network operator Elaad's open smart charging protocol is an interesting initiative in this regard (IEA 2017, NITI Aayog and Rocky Mountain Institute 2017a).

This chapter outlined some of the major trade policy-related issues and challenges in EVs. It is clear that understanding the geography and nature of EV supply chains and relevant barriers could help in the design of trade policies that can give a positive incentive for EVs relative to ICE vehicles. For example, while applied import tariffs may be the same for both EVs and ICEs in many cases (or tariff differences negligible), even a small reduction or elimination of tariffs for EVs and their components would tilt the playing field in terms of cost, even if slightly, towards EVs. Similarly, investment measures and incentives, government procurement, standards and technology-related policies could be designed in a way that could have trade-restrictive impacts or might stifle competition, quality, performance and innovation. Alternatively, they could be tailored so as to ensure the widest possible dissemination of EVs while balancing cost, competition, quality, performance and innovation promotion considerations and also enabling greater participation of developing countries in EV value chains. Further research into how such policies have been designed, how they have operated and what impacts they have had on cost and EV deployment could all help in the design of better EV-related regulatory and trade policies that are mutually supportive and coherent. In addition, such policies could be integrated within existing institutional mechanisms for trade and climate policy, whether the WTO, regional trade agreements or the UNFCCC. How such institutions could be effective frameworks for well-designed EV policies and whether their rules and ways of functioning could be further improved in this regard would also merit further consideration.

The following chapter lists important research areas where bridging specific knowledge gaps could contribute to a more effective, co-ordinated and holistic trade policy response.

4. TRADE POLICY, RESEARCH GAPS AND FURTHER ISSUES FOR CONSIDERATION

At present, there is no co-ordinated international policy framework on electric vehicles. While manufacturing of EVs as well as production and supply of raw materials, parts and components are concentrated in a few countries around the world, there is a need to ensure that supplies of both EVs as well as their inputs are available globally on a cost-competitive basis. This will ensure a rapid and cost-effective scale-up and deployment of EVs, assuming that supportive EV domestic policies and incentives are also in place. Effective deployment of EVs and its positive climate change impact will also depend on close coordination with policies that affect other sectors such as electricity supply and information and communication technologies that are vital for V2G connections and interface (NITI Aayog and Rocky Mountain Institute 2017a).

Trade policy can play a supportive role for climate action and the reduction of air pollution by enabling not only greater diffusion and deployment of EVs, but also through the decarbonisation of electricity supply and diffusion of relevant information and communication technologies and services. In addition to environmental benefits it can open up potential development opportunities through exports and green jobs, thereby also helping in the realisation of other SDGs. Further, international trade is an important transmission channel for harmonisation efforts globally, including for standards governing safety, quality, reliability and interoperability. A holistic vision is therefore necessary to ensure coherence and synergy between various policies on electric vehicles, clean energy generation and information and communication technologies on one hand and international trade rules on the other, as part of a larger global governance framework to support EVs.

With the overall objective of ensuring that trade policy is supportive of both decarbonisation of the transport sector though greater deployment of electric vehicles and of the sustainable development goals, research gaps and relevant issues for further consideration under the following broad headings may be identified.

4.1 Trade Policy Measures Shaping Electric Vehicle Value Chains and Trade Flows

From a climate mitigation perspective, regions that are the three largest GHG emitters—China, the US and the EU (Friedrich et al. 2017)—are already involved in deployment policies for EVs as well as manufacturing activity in major segments of the EV value chain, especially batteries.

First and more broadly, the role of trade policies in shaping EV value chains and their geographical dispersion will need to be better mapped and understood. Particularly in a future scenario, where some countries push ahead towards ambitious EV targets and deployment while others lag behind, global automobile production and supply chains may witness a major transformation and restructuring with parallel production lines possibly emerging to cater to EV and non-EV segments. A better understanding of the value chain not only for electric cars, but also for other electric vehicle segments such as bikes, buses, trucks and even boats and maritime vessels and of the role that trade policy can play in shaping these value chains is important. Such understanding will help governments to better overcome trade policy-related challenges such as tariffs and non-tariff measures and help them to better design trade agreements, including outcomes of plurilateral initiatives such as the EGA and regional and bilateral trade agreements.

Secondly, from a sustainable development perspective, it would also be important to map the extent to which developing countries (including those other than middle-income developing countries like China, Korea or Malaysia,) may participate in value chain segments and benefit from increased production and trade of EVs. The lower technology intensity of electric two-wheelers, for instance, may offer potential for greater participation in EV value chains for lower-income developing countries. In many cases, of course, it may be difficult to fully correlate production of trade in raw materials such as lithium carbonate and other intermediates that may have multiple end uses with their final end-use within EV value chains.

4.2 Trade Rules and Faster Scale-Up and Diffusion of Electric Vehicles

Identifying ways in which trade can play an enabling role for EV deployment entails not only a review of existing trade rules and disciplines, but also of how they can be further improved or amended to provide positive support to the EV industry (even at the possible cost of disincentivising fossil fuel vehicles). In addition, provisions in relevant investment agreements (including bilateral investment treaties) should be reviewed, as should competition policy measures in case certain forms of vertical or horizontal integration, mergers or acquisitions may lower competition in the EV industry. The role of any successful domestic industrial policy measures to promote EV manufacturing would need closer study, including whether such policies can and should be replicated globally and to what extent they can be designed in a manner that is non-discriminatory and least disruptive to trade.

4.3 Domestic and Trade Policy Measures to Support Electric Vehicles and Renewable Energy: Ensuring Synergy and Coherence

Policies designed to promote EVs may not accelerate decarbonisation of the transport sector unless supported by policies that aim at rapid decarbonisation of the electricity grid. In such cases, potential trade agreements like the EGA and other sustainable energy trade initiatives can play an important role by ensuring that barriers to goods as well as services relevant to both clean energy as well as electric vehicles are eliminated and that innovative policies are designed to support scale-up in both sectors. In addition, some form of policy space for positive support for both clean energy scale-up (relative to fossil fuels) as well as EVs (relative to fossil fuel vehicles) will need to be maintained. It may be worth exploring innovative ways in which trade agreements can enable such policy space without countries finding themselves in violation of WTO rules.

4.4 Trade and Related Capacity Building Initiatives and Technology Diffusion in Electric Vehicles

Technology development and transfer is an important building block for climate action. As a tool in the context of sustainable development, it is also enshrined in Article 4.5 of the 1992 UNFCCC founding document. To this end, a Technology Mechanism was established in 2010 at COP16 with the task of enhancing climate technology development and transfer. However, as is well documented, such technology development and transfer can prove difficult to harness in practice due to a range of challenges, including access to finance, institutional and innovation-related constraints. Trade policy can play a supportive role in keeping markets open for final and intermediate products required for technology development.

In addition, the role of IPRs and licensing practices may need to be examined further and this is also true for the EV sector. A better understanding of technology and innovation drivers in the EV sector, the major players involved in technology development and innovation, the role of IPRs and licensing and their link with trade and investment policies will all help in the crafting of better governance frameworks that enable technology diffusion. Furthermore, ways of harnessing financial assistance and capacity building mechanisms such as the UNFCCC's Green Climate Fund as well as the WTO's Aid for Trade initiative should also be explored.

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ANNEX

Table A 1: MFN applied tariffs for selected countries and vehicle categories reported based on HS 12 and HS 17 nomenclatures

Country	Reporting Year	HS Version	HS Code*/**	No: of Tariff Lines	Minimum MFN applied Ad-valorem duty	Maximum MFN applied Ad-valorem duty	Average of MFN applied AV duties	Duty-free Tariff Lines (percent)
Brazil	2016	HS12	870210	1	35	35	35	0.0
			870290	2	35	35	35	0.0
			870310	1	35	35	35	0.0
			870321	1	35	35	35	0.0
			870322	2	35	35	35	0.0
			870323	2	35	35	35	0.0
			870324	2	35	35	35	0.0
			870331	2	35	35	35	0.0
			870332	2	35	35	35	0.0
			870333	2	35	35	35	0.0
			870390	1	35	35	35	0.0
			871110	1	20	20	20	0.0
			871120	3	20	20	20	0.0
			871130	1	20	20	20	0.0
			871140	1	20	20	20	0.0
			871150	1	20	20	20	0.0
			871190	1	20	20	20	0.0
China	2015	HS12	870210	4	4	25	19.8	0.0
			870290	3	25	25	25	0.0
			870310	3	25	25	25	0.0
			870321	4	25	25	25	0.0
			870322	4	25	25	25	0.0
			870323	12	25	25	25	0.0
			870324	8	25	25	25	0.0
			870331	6	25	25	25	0.0
			870332	8	25	25	25	0.0
			870333	12	25	25	25	0.0
			870390	1	25	25	25	0.0
			871110	1	45	45	45	0.0
			871120	5	45	45	45	0.0
			871130	2	45	45	45	0.0
			871140	1	40	40	40	0.0
			871150	1	30	30	30	0.0
			871190	2	45	45	45	0.0
India	2016	HS12	870210	6	20	20	20	0.0
			870290	8	10	20	18.8	0.0
			870310	2	60	60	60	0.0
			870321	5	60	60	60	0.0
			870322	5	60	60	60	0.0
			870323	5	60	60	60	0.0
			870324	5	60	60	60	0.0

Table A 1. *Continued*

Country	Reporting Year	HS Version	HS Code*/**	No: of Tariff Lines	Minimum MFN applied Ad-valorem duty	Maximum MFN applied Ad-valorem duty	Average of MFN applied AV duties	Duty-free Tariff Lines (percent)
			870331	5	60	60	60	0.0
			870332	5	60	60	60	0.0
			870333	5	60	60	60	0.0
			870390	2	60	60	60	0.0
			871110	3	100	100	100	0.0
			871120	8	100	100	100	0.0
			871130	3	100	100	100	0.0
			871140	2	100	100	100	0.0
			871150	1	100	100	100	0.0
			871190	3	100	100	100	0.0
Mexico	2017	HS12	870210	5	20	50	26	0.0
			870290	6	15	50	24.2	0.0
			870310	3	15	15	15	0.0
			870321	3	15	50	28.3	0.0
			870322	2	20	50	35	0.0
			870323	2	20	50	35	0.0
			870324	2	20	50	35	0.0
			870331	2	20	50	35	0.0
			870332	2	20	50	35	0.0
			870333	2	20	50	35	0.0
			870390	3	15	50	28.3	0.0
			871110	3	15	15	15	0.0
			871120	4	15	15	15	0.0
			871130	4	15	15	15	0.0
			871140	4	0	15	7.5	50
			871150	3	0	0	0	100
			871190	2	0	15	7.5	50
EU	2017	HS17	870210	4	10	16	13	0.0
			870220	2	10	16	13	0.0
			870230	2	10	16	13	0.0
			870240	1	10	10	10	0.0
			870290	5	10	16	12.4	0.0
			870310	2	5	10	7.5	0.0
			870321	2	10	10	10	0.0
			870322	2	10	10	10	0.0
			870323	3	10	10	10	0.0
			870324	2	10	10	10	0.0
			870331	2	10	10	10	0.0
			870332	3	10	10	10	0.0
			870333	3	10	10	10	0.0
			870360	2	10	10	10	0.0
			870370	1	10	10	10	0.0
			870380	2	10	10	10	0.0
			871110	1	8	8	8	0.0

Table A 1. *Continued*

Country	Reporting Year	HS Version	HS Code*/**	No: of Tariff Lines	Minimum MFN applied Ad-valorem duty	Maximum MFN applied Ad-valorem duty	Average of MFN applied AV duties	Duty-free Tariff Lines (percent)
			871120	3	8	8	8	0.0
			871130	2	6	6	6	0.0
			871140	1	6	6	6	0.0
			871150	1	6	6	6	0.0
			871160	2	6	6	6	0.0
Japan	2016	HS12	870210	1	0	0	0	100
			870290	1	0	0	0	100
			870310	1	0	0	0	100
			870321	1	0	0	0	100
			870322	1	0	0	0	100
			870323	1	0	0	0	100
			870324	1	0	0	0	100
			870331	1	0	0	0	100
			870332	1	0	0	0	100
			870333	1	0	0	0	100
			870390	1	0	0	0	100
			871110	1	0	0	0	100
			871120	1	0	0	0	100
			871130	1	0	0	0	100
			871140	1	0	0	0	100
			871150	1	0	0	0	100
			871190	1	0	0	0	100
Korea	2017	HS17	870210	1	10	10	10	0.0
			870220	1	10	10	10	0.0
			870230	1	10	10	10	0.0
			870240	1	10	10	10	0.0
			870290	1	10	10	10	0.0
			870310	1	8	8	8	0.0
			870321	1	8	8	8	0.0
			870322	1	8	8	8	0.0
			870323	1	8	8	8	0.0
			870324	1	8	8	8	0.0
			870331	1	8	8	8	0.0
			870332	1	8	8	8	0.0
			870333	1	8	8	8	0.0
			870360	1	8	8	8	0.0
			870370	1	8	8	8	0.0
			870380	1	8	8	8	0.0
			871110	3	8	8	8	0.0
			871120	2	8	8	8	0.0
			871130	2	8	8	8	0.0
			871140	2	8	8	8	0.0

Table A 1. *Continued*

Country	Reporting Year	HS Version	HS Code*/**	No: of Tariff Lines	Minimum MFN applied Ad-valorem duty	Maximum MFN applied Ad-valorem duty	Average of MFN applied AV duties	Duty-free Tariff Lines (percent)
			871150	2	8	8	8	0.0
			871160	2	8	8	8	0.0
US	2017	HS17	870210	2	2	2	2	0.0
			870220	2	2	2	2	0.0
			870230	2	2	2	2	0.0
			870240	2	2	2	2	0.0
			870290	2	2	2	2	0.0
			870310	2	2.5	2.5	2.5	0.0
			870321	1	2.5	2.5	2.5	0.0
			870322	1	2.5	2.5	2.5	0.0
			870323	1	2.5	2.5	2.5	0.0
			870324	1	2.5	2.5	2.5	0.0
			870331	1	2.5	2.5	2.5	0.0
			870332	1	2.5	2.5	2.5	0.0
			870333	1	2.5	2.5	2.5	0.0
			870360	1	2.5	2.5	2.5	0.0
			870370	1	2.5	2.5	2.5	0.0
			870380	1	2.5	2.5	2.5	0.0
			871110	1	0	0	0.0	100
			871120	1	0	0	0.0	100
			871130	1	0	0	0.0	100
			871140	2	0	2.4	1.2	50
			871150	1	2.4	2.4	2.4	0.0
			871160	1	0	0	0.0	100

** HS Code descriptions are provided in the Tables A 2 and A 3.*

*** HS codes highlighted in green contain electric vehicles.*

Note: Tariff data, reported to the World Trade Organization (WTO) by many countries, is based on the previous HS 2012 (HS 12) nomenclature HS870290 ("Other Motor Vehicles for the transport of 10 or more persons including the driver") and HS 870390 ("Other motor-cars and other motor vehicles principally designed for the transport of persons (other than those of heading 87.02) including station wagons and racing cars"); a full list of all relevant HS 12 codes is given in Annex Table A 2. These data reveal a high average of applied tariff rates above 10 percent and often above 20 percent in many developing countries. The illustrative Table A 1 in the Annex shows the minimum and maximum applied rates for NTLs in major WTO member countries, including OECD as well as developing economies, under selected sub-headings covering both electric and non-electric vehicles. The table shows whether these economies have reported such data on the basis of HS 12 or HS 17 nomenclatures. It also shows the average value of applied tariff rates. Rows highlighted in green show HS subheadings that may contain tariff lines pertaining to electric or hybrid-electric vehicles. Under the HS 12 nomenclature, such subheadings may also contain other vehicles that are not necessarily electric or hybrid-electric. Rows highlighted in green for country data based on HS 17 nomenclatures show HS sub-headings that contain plug-in hybrid electric and pure electric vehicles, but exclude those containing non-plug in hybrid electric vehicles.

Source: WTO Tariff Download Facility, tariffdata.wto.org

Table A 2: HS Code descriptions based HS 2012 (HS 12) Nomenclatures*

HS Codes	HS Descriptions
8702	Motor vehicles for the transport of ten or more persons, including the driver.
870210	With compression-ignition internal combustion piston engine (diesel or semi-diesel)
870290	Other
8703	Motor cars and other motor vehicles principally designed for the transport of persons (other than those of heading 87.02), including station wagons and racing cars.
870310	Vehicles specially designed for travelling on snow; golf cars and similar vehicles
870321	Of a cylinder capacity not exceeding 1,000 cc
870322	Of a cylinder capacity exceeding 1,000 cc but not exceeding 1,500 cc
870323	Of a cylinder capacity exceeding 1,500 cc but not exceeding 3,000 cc
870324	Of a cylinder capacity exceeding 3,000 cc
870331	Of a cylinder capacity not exceeding 1,500 cc
870332	Of a cylinder capacity exceeding 1,500 cc but not exceeding 2,500 cc
870333	Of a cylinder capacity exceeding 2,500 cc
870390	Other
8711	Motorcycles (including mopeds) and cycles fitted with an auxiliary motor, with or without side-cars; side-cars.
871110	With reciprocating internal combustion piston engine of a cylinder capacity not exceeding 50 cc
871120	With reciprocating internal combustion piston engine of a cylinder capacity exceeding 50 cc but not exceeding 250 cc
871130	With reciprocating internal combustion piston engine of a cylinder capacity exceeding 250 cc but not exceeding 500 cc
871140	With reciprocating internal combustion piston engine of a cylinder capacity exceeding 500 cc but not exceeding 800 cc
871150	With reciprocating internal combustion piston engine of a cylinder capacity exceeding 800 cc
871190	Other

** HS codes highlighted in green contain electric vehicles.*

Table A 3: HS Code descriptions based HS 2017 (HS 17) Nomenclatures*

HS Codes	HS Descriptions
8702	Motor vehicles for the transport of ten or more persons, including the driver.
870210	With only compression-ignition internal combustion piston engine (diesel or semi-diesel)
870220	With both compression-ignition internal combustion piston engine (diesel or semi-diesel) and electric motor as motors for propulsion
870230	With both spark-ignition internal combustion reciprocating piston engine and electric motor as motors for propulsion
870240	With only electric motor for propulsion
870290	Other
8703	Motor cars and other motor vehicles principally designed for the transport of persons (other than those of heading 87.02), including station wagons and racing cars.
870310	Vehicles specially designed for travelling on snow; golf cars and similar vehicles
870321	Of a cylinder capacity not exceeding 1,000 cc
870322	Of a cylinder capacity exceeding 1,000 cc but not exceeding 1,500 cc
870323	Of a cylinder capacity exceeding 1,500 cc but not exceeding 3,000 cc
870324	Of a cylinder capacity exceeding 3,000 cc
870331	Of a cylinder capacity not exceeding 1,500 cc
870332	Of a cylinder capacity exceeding 1,500 cc but not exceeding 2,500 cc
870333	Of a cylinder capacity exceeding 2,500 cc
870360	Other vehicles, with both spark-ignition internal combustion reciprocating piston engine and electric motor as motors for propulsion, capable of being charged by plugging to external source of electric power
870370	Other vehicles, with both compression-ignition internal combustion piston engine (diesel or semi-diesel) and electric motor as motors for propulsion, capable of being charged by plugging to external source of electric power
870380	Other vehicles, with only electric motor for propulsion
8711	Motorcycles (including mopeds) and cycles fitted with an auxiliary motor, with or without side-cars; side-cars.
871110	With reciprocating internal combustion piston engine of a cylinder capacity not exceeding 50 cc
871120	With reciprocating internal combustion piston engine of a cylinder capacity exceeding 50 cc but not exceeding 250 cc
871130	With reciprocating internal combustion piston engine of a cylinder capacity exceeding 250 cc but not exceeding 500 cc
871140	With reciprocating internal combustion piston engine of a cylinder capacity exceeding 500 cc but not exceeding 800 cc
871150	With reciprocating internal combustion piston engine of a cylinder capacity exceeding 800 cc
871160	With electric motor for propulsion

** HS codes highlighted in green contain electric vehicles.*

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