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Powering the future

Commercial opportunities and legal developments across the EV batteries lifecycle

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Contents

Introduction

The advent of electric vehicles (**EVs**) is one of the most revolutionary changes to take place in the history of transport. The take-up of electric vehicles will transform not only driving habits and energy usage, but also supply chains, industries and physical infrastructure across the world.

This report, which concentrates on market and regulatory developments relating to electric vehicle batteries, is the third in a series of Linklaters reports covering the future of the car. Previous reports in this series have covered the impact of autonomous vehicles on infrastructure investment opportunities, and the implications of data laws on the use of "shadow mode" in autonomous vehicles. [1]

Why are we focusing on EV batteries in this report?

The strategic importance of the batteries inside electric vehicles was underscored at the recent Financial Times Future of the Car summit, which took place in London in May 2019. This summit, which was co-sponsored by Linklaters, brought together more than 600 experts from the automotive and technology sectors across the world. Electrification was one of the four key trends identified at the summit (the others being autonomy, connectivity and ridesharing) [2] and much of the discussion around the market uptake of EVs revolved around batteries. For example:

> Advancements in battery power density will allow for greater ranges, which is key for customer take-up. Recent research in the UK, for example, suggests that "a range of 320 km (200 miles) [is] needed for 50% of participants to consider owning a fully electric car. Increasing the range to 480 km (300 miles) [means] 90% would consider electric." [3]

> Advancements in battery power density will allow for heavier cars, taller cars, and so on. This would allow an ever-widening range of products to come onto the market, allowing more segments of the market to consider purchasing an EV.

> Much of the discussion of demand for EVs related to the importance of cost parity between EVs and ICE (**internal combustion engine**) vehicles. The battery is a significant driver of total EV cost: analyst research suggests that "for a midsize US car in 2015, the battery made up more than 57 percent of the total cost. This year [2019], it's 33 percent. By 2025, the battery will be only 20 percent of total vehicle cost." [4]

The strategic importance of EV batteries was underscored by the announcement that Volvo made at the summit: a multibillion-dollar deal to buy electric car batteries from China's CATL and South Korea's LG Chem, to supply the company until 2028. According to Hakan Samuelsson, CEO of Volvo, the capacity of batteries ordered by Volvo was "more or less the same amount of batteries as the whole of the global supply last year". [5] The announcement follows significant deals entered into by several other car makers including Volkswagen's €40 billion of battery-purchasing contracts announced in May 2018, [6] and Daimler's announcement that it is aiming to spend €20 billion on EV batteries in the next 10 years. [7]

What insights are we bringing to the table?

This report is an examination of the **whole** EV battery lifecycle: from the sourcing of raw materials, through to their manufacture, installation in EVs, recharging and eventual recycling. There are significant commercial opportunities, and legal considerations, in every part of this lifecycle – and often the legal developments will have a significant impact on the nature, location and size of these commercial opportunities. This report therefore offers a combination of commercial and legal commentary to help dealmakers, inhouse lawyers, and other industry participants understand the risks and opportunities that they should bear in mind in relation to the EV battery lifecycle.

How is this report structured?

The main report is an overview on the commercial opportunities emerging in the EV battery lifecycle as well as the legal developments in the EU, US, China and Australia that will unlock them. The Appendix to this report provides more detail on the legal developments that will drive the EV battery value chain.

The report is subdivided to reflect the five stages of the EV battery lifecycle shown in the diagram overleaf, which also summarises some of the key commercial and legal takeaways from this report.

1 For more details, please see here and here.
2 For a summary of the key takeaways from the summit, please see here.
3 Source: BBC, 21 May 2019
4 Source: Bloomberg, 12 April 2019
5 Source: Financial Times, 15 May 2019
6 Source: Fortune, 3 May 2018
7 Source: Financial Times, 11 December 2018

Powering the Future

Key insights from our report on **commercial opportunities and legal developments across the lifecycle of batteries used in electric vehicles ("EVs")**

Stage of lifecycle

1. SOURCING RAW MATERIALS

Commercial opportunities

- **A significant amount – potentially up to US$30-45bn – may need to be invested in mining capacity by 2025 to help satisfy demand for EVs.**
- Mix of metals demanded will also depend on the types of batteries produced in future (e.g. the development and take-up of solid state solutions).
- The prices of key metals used to create EV batteries (lithium, nickel and cobalt) have been highly volatile.
- There is potential for trade tensions between the US and China to impact the supply of these minerals and others used in EVs and associated technologies.

Legal / regulatory developments by region

- **EU:** Responsible sourcing is required from 2021 for conflict minerals. The European Commission is developing a common set of principles for a socially and environmentally sustainable mining sector in Europe and will map the availability of raw materials within the EU. It is also exploring sustainable mining benchmarks.
- **China:** No relevant provisions.
- **US:** Few specific regulations pertaining to sourcing of raw materials for battery production; certain disclosure requirements. American Mineral Security Act – which aims to foster domestic production of minerals considered critical to US – under consideration.

2. BATTERY MANUFACTURING

Commercial opportunities

- **China already accounts for >60% of the world's battery plant capacity. Relatively concentrated industry.**
- European Battery Alliance established by European Commission in Oct 2017 to facilitate access to funding to develop new battery manufacturing capacity in Europe. Potential for M&A and joint ventures.

Legal / regulatory developments by region

- **EU:** Strategic Action Plan aims to support a sustainable EU battery cell manufacturing base with the lowest environmental footprint possible.
- **China:** Foreign investment restrictions on EV battery manufacturing lifted in 2017.
- **US:** Adopted safety-related amendments to existing standards for batteries for electric vehicles.

3. INCORPORATION INTO, AND SALE OF, EVs

Commercial opportunities

- **EV sales will overtake traditional vehicle sales as early as 2033, assuming:**
  - the price of EVs continues to fall;
  - charging infrastructure increases significantly; and
  - the mileage range of EVs increases.
- Government subsidies, incentives and new regulations will drive manufacturers to increase EV sales as a percentage of their total, particularly in the EU.

Legal / regulatory developments by region

- **EU:** Proposed regulation requiring CO_2 emissions from new cars to fall 37.5% over 2021-2030. Varying EV subsidy levels across EU. Big push to improve air quality. Ban on new internal combustion engine vehicles in many cities falling between 2030 – 2040.
- **China:** EV subsidies scheduled to end in 2020. However, "China VI" emissions standards (seen as building on comparable European and US requirements) to be implemented in 2023.
- **US:** Up to $7,500 federal tax credit per EV under threat of elimination in 2020 budget.

4. RECHARGING OF EVs

Commercial opportunities

- **US$80bn investment potentially required to develop ultra-fast EV infrastructure globally by 2025.**
- The length of time required to charge an EV battery will change consumers habits on refuelling and could provide opportunities for new market entrants including those offering services during charging.

Legal / regulatory developments by region

- **EU:** EU Directive 2014/94 requires Member States to set targets for public recharging points which would allow EVs to operate in urban and suburban areas by end of 2020 (potential extension to 2025).
- **China:** Guidance anticipates 4.3 million private charging points and 500k public charging points by 2020.
- **US:** No federal incentives for installation of EV charging systems (state level incentives vary by state).

5. BATTERY RECYCLING

Commercial opportunities

- **The significant power storage capacity of batteries will result in a secondary market potentially worth US$24bn by 2030.**
- After their in-car life, EV batteries will still have substantial power storage capacity.
- Alternate uses include recycling for raw materials or reuse in other contexts.

Legal / regulatory developments by region

- **EU:** Policy initiatives on battery recovery, reuse and recycling anticipated by Autumn 2019. Batteries Directive to be revised to take EV batteries into account.
- **China:** Measures introduced in 2018 require automobile manufacturers to establish battery recycling channels and recycling service outlets.
- **US:** Recent federal proposal to facilitate re-use of EV batteries.

Section 01

Sourcing raw materials

Lithium, nickel and cobalt are the key metals used to make EV batteries. Analysts believe there is a potential shortfall in the global mining capacity required to extract the minerals needed to manufacture sufficient batteries to meet projected EV demand.

US$30-45BN

UP TO US$30-45BN ADDITIONAL MINING CAPACITY REQUIRED BY 2025

This shortfall may arise due to factors including:

> Price volatility (for example, lithium rose from $182 per tonne in May 2016 to $296 in May 2018, before falling to $200 as at May 2019);[8]

> Uncertainty over future battery compositions: for example, while lithium-ion batteries are at present "the reigning replacement for the internal combustion engine",[9] the next generation of solid state batteries may result in a relative decrease in nickel and cobalt demand and a relative increase in lithium demand;[10] and

> The potential for trade tensions between the US and China to impact the supply of these minerals and others used in EVs and associated technologies (such as rare earths).

Analyst estimates suggest that a significant amount – potentially up to **US$30-45 billion** – may need to be invested in mining capacity by 2025 in order to meet the demand for EVs and their batteries.

One of the success factors for the significant commercial opportunity provided by this increase in mining capacity will relate to risk management and legal compliance. National and international sanction regimes will be influential in the development of sourcing strategies, with certain automotive sector manufacturers facing pressure for imports from sanctioned territories.

Another success factor for such projects is arranging appropriate financing. Projects supporting "new energy" such as EV batteries face challenges such as funder concerns on price volatility, and the infancy of this sector meaning that funders are working out what sort of offtake commitments they need and want from particular projects. There will also be structuring risks – for example, in relation to "project on project risk" where mining projects link to manufacturing projects.

There is also currently a lack of contract standardisation for the supply of these raw materials. It is anticipated that this will come in due course; however, at the moment, negotiations on key terms can be time consuming.

Any increase in mining capacity will need to be accompanied by a comprehensive risk management programme that considers issues such as conflict minerals, child labour, human rights and supply chain due diligence and management.

To date there is very little specific legislation governing the sourcing of raw materials, but we expect this to change as the market grows. Indeed, the EU has already started to develop a common set of principles for a socially and environmentally sustainable mining sector in Europe and the Conflict Minerals Regulation will require responsible sourcing of certain minerals from 2021.

The OECD Guidelines for Multinational Enterprises and the OECD Due Diligence Guidance for Responsible Mineral Supply Chains are currently the main sources of reference for EU companies or those selling into the EU. The UK, Germany, Belgium and the Netherlands encourage companies to implement the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High Risk Areas, with the UK London Metal Exchange currently consulting on its new responsible sourcing proposals. The French *devoir de vigilance* requires companies to source raw materials in a socially and environmentally sustainable way. The US and Australia have their own specific rules, but the broad principle is that these too relate to conflict minerals and modern slavery.

The American Mineral Security Act (S.1317) was introduced in the Senate last month, for the purpose of fostering domestic production of minerals considered critical to the US. The act would require an inventory of metal reserves in the US and seek to streamline permitting for the Electric Vehicle sector. The US currently has limited mining capacity for minerals crucial to lithium-ion batteries, including lithium, cobalt, graphite and nickel. S.1317 is still in the process of consideration by the Senate Committee on Energy and Natural Resources.

8 Source: Bloomberg
9 Source: Bloomberg, 6 January 2019
10 Source: Materials Risk, 15 January 2019

Section 02

Battery manufacturing

In order to meet projected demand for EVs, batteries will need to be manufactured in much larger quantities. Higher production levels will help economies of scale to be realised, ultimately reducing the price and hence driving the take-up of EVs.

There is significant opportunity for corporates and financial investors to invest in the development of EV battery plants all over the world, supported not just by projected demand, but also by policy and regulatory activity to support such investment.

At present, China accounts for over 60% of the world's battery capacity. [11] Chinese companies such as CATL, Funeng Technology, BYD and Tianjin Lishen have invested heavily in "megafactories" (i.e., battery manufacturing plants with outputs of at least 20 GWh) – and Korean companies LG Chem and Samsung have also opened megafactories in China.

Moreover, analysts predict that China will continue to host the greater proportion of battery manufacturing over the next 10 years. Analysts also predict that Europe will overtake the US in battery manufacturing capacity over the next 10 years, due to the activities of companies such as Sweden's Northvolt (whose first factory in Northern Sweden aims at full capacity to produce 32 GWh of capacity per year). [12] By 2028, worldwide production capacity is expected to grow by 400%. [13]

Investment in battery manufacturing capacity will be catalysed by legal and regulatory developments across key jurisdictions: for example, the EU has recognised that battery manufacturing is of strategic importance and it, along with several Member States such the UK, France, Germany, Belgium and the Netherlands, have all declared initiatives to promote the manufacture of batteries. The EU is currently running a consultation, due to close on 8 August 2019, to encourage stakeholders to provide evidence and views on the support for a regulatory intervention, the primary aim of which is to foster the production and placing on the EU market of high-performing, safe, sustainable and durable battery cells, packs and modules, produced with the lowest environmental footprint possible and in a cost-effective manner.

CHINA ACCOUNTS FOR >60% OF WORLD'S BATTERY MANUFACTURING CAPACITY

11 Source: Benchmark Mineral Intelligence, cited on Visualcapitalist.com, 19 October 2018
12 Source: Northvolt website, as at 25 June 2019
13 Source: Benchmark Mineral Intelligence, cited on Visualcapitalist.com, 19 October 2018

The European Commission set up a European Battery Alliance in late 2017 to encourage cooperation between key industrial stakeholders, interested Member States and the European Investment Bank. Its aims are to facilitate access to various types of funding for battery manufacturers, including allowing EU Member States to give state-aid to cross-border battery research projects considered to be Important Projects of Common European Interest. Pursuant to that Alliance, a battery-making consortium backed by France and Germany has announced a project with an investment requirement of €5bn to €6bn, "including €4 billion from the private sector and up to €1.2 billion of state subsidies that will have to be approved by Brussels". [14] Participants in this project that have been announced so far "include carmakers PSA of France, Opel of Germany, and Saft, a battery subsidiary of the French oil major Total". [15]

There are no longer foreign investment restrictions on EV battery manufacturing in the PRC, with such restrictions being lifted in July 2017. Accordingly, non-Chinese companies can now establish a presence in the PRC to manufacture EV batteries without having to enter into a JV with a Chinese entity.

More broadly, we expect to see more joint ventures and other combinations and forms of collaboration in this space as mining enterprises, battery manufacturers and car manufacturers that seek to source batteries come together. This opens a whole host of new opportunities and challenges.

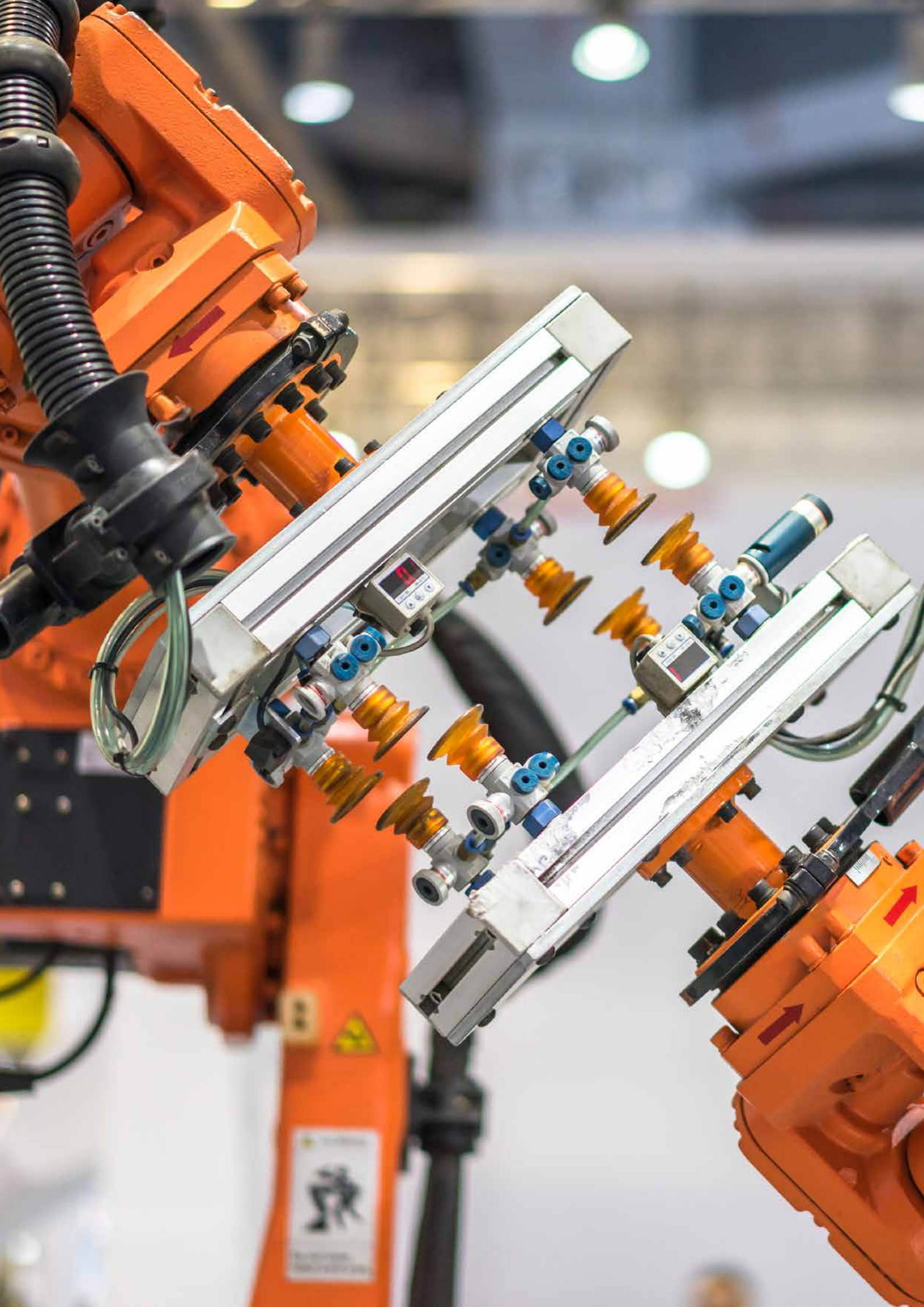
The key challenge for such JVs relates to conflicts around decision-making and governance, especially if members have differing expectations about roles, strategies and responsibilities (see pages 14–15 for more discussion of the pros and cons of JVs and other forms of combination). Legal advice is particularly useful in helping to anticipate these complexities and ensure that they are reflected in the JV's governance and contractual arrangements.

In terms of law and regulation, to date this has focussed, as one would expect, on product standards to ensure compatibility and safety, with China, the EU and the US issuing new standards in addition to the ISO standards. Future regulatory requirements and standards, certainly at an EU level, are likely to address safety, connectivity, performance, durability, bi-directionality, re-usability, recyclability, resource efficiency and the lowering of the carbon footprint.

What will be interesting to monitor is the potential for clashes between standardisation of battery production, eg for safety, sustainability or interoperability purposes and IP rights providing exclusive rights on new technology (the so-called "standard essential patents"). We have seen similar challenges arise in relation to telecommunication technologies. The Court of Justice of the EU issued a decision on a negotiation scheme for licences between the patent holders and those implementing standardised technology. Many questions will remain unanswered for a little while, however, such as the appropriate royalty rates and the availability of licences along the manufacturing chain. In Australia, changes to antitrust law due to commence in September 2019 will mean that patent licensing arrangements will no longer be exempt from scrutiny.

CHINA HAS RELAXED RULES ON FOREIGN COMPANIES ESTABLISHING A PRESENCE IN ITS JURISDICTION BY REMOVING FOREIGN INVESTMENT RESTRICTIONS ON EV BATTERY MANUFACTURING.

14 Source: Financial Times, 2 May 2019
15 Source: Financial Times, ibid



Joint ventures and other forms of technology partnerships for corporates

There are many models for engaging in innovation and entering into new tech ventures for large corporates. Companies may go down the JV route for several reasons, including risk-sharing, limiting their financial exposure, enabling knowledge exchange in a safe environment, and creating industry-wide buy-in to new, disruptive technologies and solutions such as those relating to EVs and their batteries.

From a legal perspective, there are several key issues that may become particularly important when JVs or other forms of partnership or combination are considered:

Antitrust issues

Antitrust regulators can be cautious about joint ventures, particularly because of the information-sharing that takes place within them and because of the potential for such arrangements to dictate industry behaviour and standards (and hence competition) where they involve a large number of major participants. GCs and legal counsel can add significant value to consortia by mitigating against this risk – for example, ensuring adequate barriers and firewalls are implemented in order to block or channel information flows, or preventing breaches of cartel regulations.

Data issues (especially GDPR)

Privacy is an increasingly important issue from a political, regulatory and customer perspective. The importance of managing this issue can be seen from the recent introduction of the GDPR in Europe, under which fines can go up to 4% of global turnover. This may be a particular risk if the partnership includes large companies (with the resources to have implemented appropriate measures to ensure GDPR compliance) working with young or start-up tech companies (who may not have the institutional knowledge, or the resources, to have adequately prepared for the GDPR implications of the arrangement).

Other regulatory issues

Consortia, JVs and other forms of partnership and combination may well transcend any one particular industry sub-sector. For example, a JV in the field of electric vehicles may comprise automotive companies, tech companies, energy businesses, and so on. This multi-sector participation may be a risk given that across the arrangement there will be varying levels of understanding of the regulatory risks and requirements that relate to the product(s) being developed, manufactured and sold. It is imperative that these risks are understood across all the participating businesses to minimise the risk of any member breaching these regulations.

A comparison of the major routes, including JVs, is given in the table below.

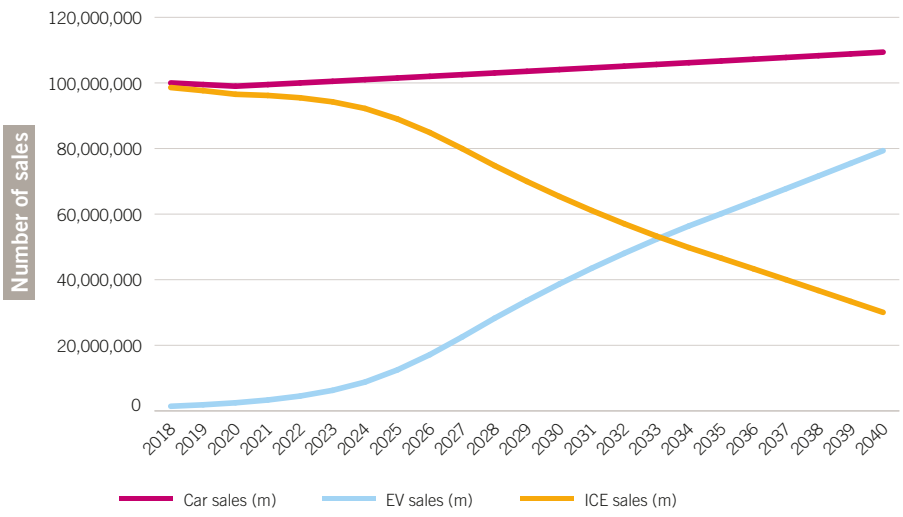
	Incubation	Acceleration	Commercial co-operation	JVs	Acquisition
What is it?	> Ideas generated inside the business are developed by an internal entity that enjoys autonomy from the rest of the business	> A group of start-ups are selected to participate in a time-limited programme run by the company and then returned to the outside economy (or are acquired by the company)	> An established company and a start-up cooperate on the basis of a commercial contract	> A group of peer corporates/ investors work together through an unincorporated or incorporated entity	> Corporation acquires a majority (or minority) interest in a venture
When would you consider this?	> The technology under development is not mature enough to be integrated into the business as a whole – an incubator allows the ideas to be developed on a standalone basis, even while the entity itself remains part of the corporate group	> The instigating company is not ready to invest and wishes to explore different options before a potential future investment	> The company wishes to access technology without making an investment or exposing itself to the risk that the start-up fails	> Benefits of risk-sharing, limiting financial exposure, enabling knowledge exchange in a safe environment, and developing buy-in across JV partners and their stakeholders for new technologies and solutions	> The technology already exists and is mature enough to be incorporated into the business, allowing access to a technology, service or product that has not been developed internally
Pros	> Autonomy from internal processes > Full control of assets of innovation > Safe way to introduce new modes of thinking inside a business while maintaining stability of wider operations	> Access to new talent > Limited financial investment > Limited duration > Broad focus on different ideas	> Limited financial investment or risk > Getting to know the team, product and/or service	> Sharing knowledge > Risk sharing and cost savings > Limiting financial exposure > Developing buy-in for new technologies and solutions across JV partners and their stakeholders > Potentially easier to finance than other routes	> More control over innovation > More due diligence, so more certainty on what the company is getting and understanding the risks > Technology may be ready to integrate into business > Potentially easier to finance than other routes
Cons	> Similar to R&D expense if not ultimately integrated or sold > Potentially culturally difficult to implement in large firms > Long-term timeline to ROI > No access to external talent or knowhow	> Limited control over assets of innovation and direction of travel of start-up > Start-up can eventually sell out to competitors	> No route to control through equity ownership > Needs a certain level of organisational maturity at the start-up > Potential for contracted products and services being offered to competitors, too	> Potential complexity of establishment and decision making > Delicate implementation (e.g. potentially competing visions, determining exit strategies) > Potential antitrust considerations to be tackled before implementation	> Costs and uncertainties of participating in an auction process > Potentially complex valuation and pricing structure > Governance of ongoing relationship with founders

Section 03

Incorporation into, and sale of, EVs

Our analysis suggests that EV sales may overtake ICE sales globally as early as 2033, though this will depend on EV battery costs, battery power density, the provision of sufficient charging infrastructure, and the legal requirements and incentives that will drive investment, manufacturer and customer decisions.

Comparison of EV and ICE sales



Source: Linklaters projections

The development of EV sales in comparison to ICE sales is dependent on an enormous number of factors. At the recent Financial Times Future of the Car Summit (which took place in May 2019 in London and was sponsored by Linklaters), four key drivers for EV sales were highlighted.

Firstly, the price of EVs needs to fall so that parity is achieved with ICE vehicles. In particular, the scaling up of EV battery production will be key to achieving the economies of scale necessary to reduce the price of batteries. The battery is a significant driver of total EV cost: analyst research suggests that "for a midsize US car in 2015, the battery made up more than 57 percent of the total cost. This year [2019], it's 33 percent. By 2025, the battery will be only 20 percent of total vehicle cost." [16]

Secondly, battery power density needs to be improved. Improving the power levels of EV batteries will also mean longer journeys, which is a vital component of driving demand: recent research in the UK, for example, suggests that "a range of 320 km (200 miles) was needed for 50% of participants to consider owning a fully electric car. Increasing the range to 480 km (300 miles) meant 90% would consider electric." [17] Advancements in battery power density will also allow for heavier cars, taller cars, and so on. This would allow an ever-widening range of products to come onto the market, allowing more segments of the market to consider purchasing an EV.

Thirdly, sufficient charging infrastructure needs to be built in order to mitigate customer anxiety about their ability to recharge their cars wherever required – primarily at home and within cities. The visual presence of charging infrastructure will also help to drive demand by improving customer familiarity with EVs and their usage.

Finally, laws and regulations such as subsidies, incentives, emissions targets and performance requirements will be key catalysts for driving EV sales. Many countries are introducing new regulatory measures tightening emissions performance requirements, enhancing air quality and offering subsidies to incentivise the purchase of EVs. The role of subsidies in incentivising the purchase of EVs may diminish in the medium to long term.

LAWS AND REGULATIONS SUCH AS SUBSIDIES, INCENTIVES, EMISSIONS TARGETS AND PERFORMANCE REQUIREMENTS WILL BE KEY CATALYSTS FOR DRIVING EV SALES.

16 Source: Bloomberg, 12 April 2019

17 Source: BBC, 21 May 2019

The EU leads on stringency of global emissions performance standards. However, China is set to implement its China VI Standards which will both combine and add to best practice from both European and US regulatory requirements. The US Corporate Average Fuel Economy (or CAFÉ) standards are in the process of being challenged by the Trump Administration, and litigation has begun with respect to the ability of the State of California to set its own emission performance limits. The Trump administration's proposed "Safer Affordable Fuel-Efficient Vehicles Rule" would freeze fuel economy standards at 2020 levels through 2026, and reverse the increases scheduled in 2012 under President Obama.

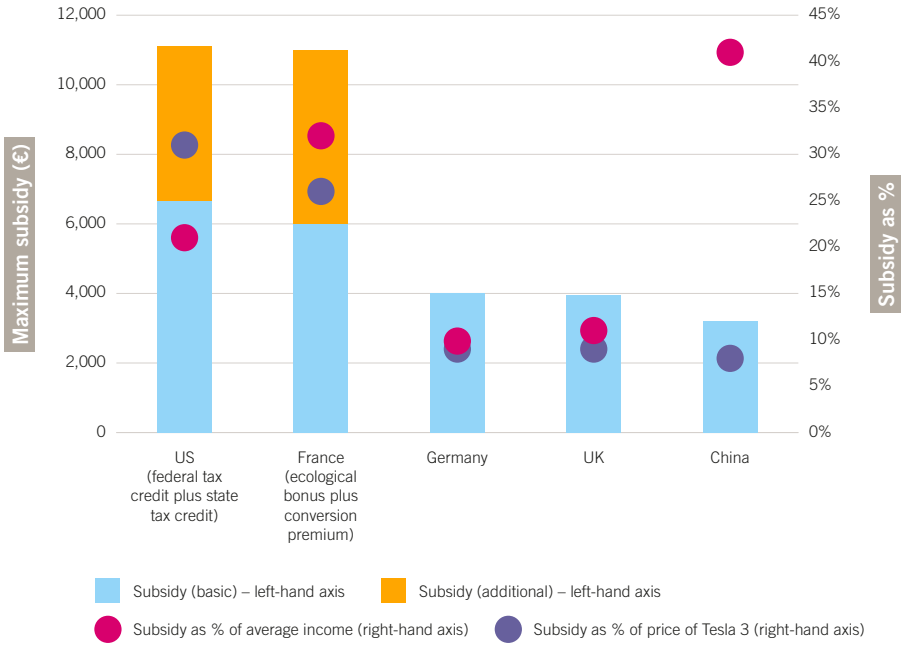
Across EU Member States, targets for the reduction of carbon emissions are underpinned by policy initiatives seeking to reduce those emissions associated with the use of vehicles including the creation of aspirational longstop dates for the sale (and eventually use) of only those vehicles which emit low or zero emissions. Various countries are deploying low emission zones in their cities to enhance air quality (London, Paris, Amsterdam, Brussels) and we expect to see the expansion of such zones in the years to come. Some countries, like France, have set targets for electric vehicle volumes. There are significant financial incentives to meet the emission reduction targets, as car manufacturers failing to meet CO_2 targets from 2020 will be faced with a fine of €95 per gram of CO_2 they are above the limit, multiplied by the number of cars they have registered in the EU in the given year.

On subsidies, whilst China has poured billions of dollars into the EV industry since 2012 as part of its efforts to combat air pollution, it has begun to phase out subsidies and expects subsidies to be completely phased out by 2020. Subsidies are available across the EU and in certain states of the US, and can vary significantly from one country to another both in absolute terms and in relative terms, as shown in the chart on the right:

Comparison of emissions standards and targets in selected regions

Region	Regulation	Fleet wide CO_2 emissions limit
China	> China VI Standards (due to be fully implemented by July 2023. While China VI (a) standards have been implemented for certain vehicles from July 2019)	> China VI Standards provide emission standards for a variety of pollutants (e.g. CO, N_2O), but no standard for CO_2 in the current regulation (CO_2 emission limits for certain types of vehicles will be released at a later stage).
Europe	> Regulation 2019/631 (by 2030)	> 95g/km
US	> CAFE	> 222g/mile (CO_2 equivalent)
Australia	> Euro 5	> No standard

Maximum subsidy available for EV purchase in selected jurisdictions (along with comparison of subsidy to average income and price of a higher-end EV) [18]



18 France subsidy comprises "ecological bonus" of up to €6,000 plus a "conversion premium" of up to €5,000 when an old diesel vehicle is removed from the road.

US subsidy is federal tax credit granted to manufacturers is $7,500 per new battery electric vehicle plus state tax credit of $5,000 in Colorado and Connecticut, converted at exchange rate of $1=€0.89.

Germany subsidy of €4,000 applies to "plug-in hybrid" and electric vehicles, and is available until 2019 or until funds run out.

UK subsidy offsets 35% of the purchase price (up to a maximum of £3,500) for cars that have CO_2 emissions below 50g/km and can travel at least 112km (70 miles) without any emissions, converted at exchange rate of £1=€1.13.

China maximum subsidy of up to RMB 25k is available for pure EVs with range above 400km, converted at exchange rate of RMB1=€0.128.

The magenta circles show the level of maximum subsidy as a % of average income in US$, taken from www.worlddata.info as at 6 June 2019, and using an exchange rate of $1 = €0.89.

The indigo circles show the level of maximum subsidy as a % of the price of a Tesla 3 (used for consistency of comparison purposes), with prices taken from Tesla website as at 7 June 2019.

Section 04

Recharging of EVs

$80 billion of investment is required in order to support demand for charging infrastructure by 2025.[19] This is a significant commercial opportunity: not just for providers to provide a "petrol station"-like experience, but also more premium retail and leisure experiences depending on location and charging time. This range of commercial opportunity is reflected by the range of businesses currently involved in providing charging infrastructure.

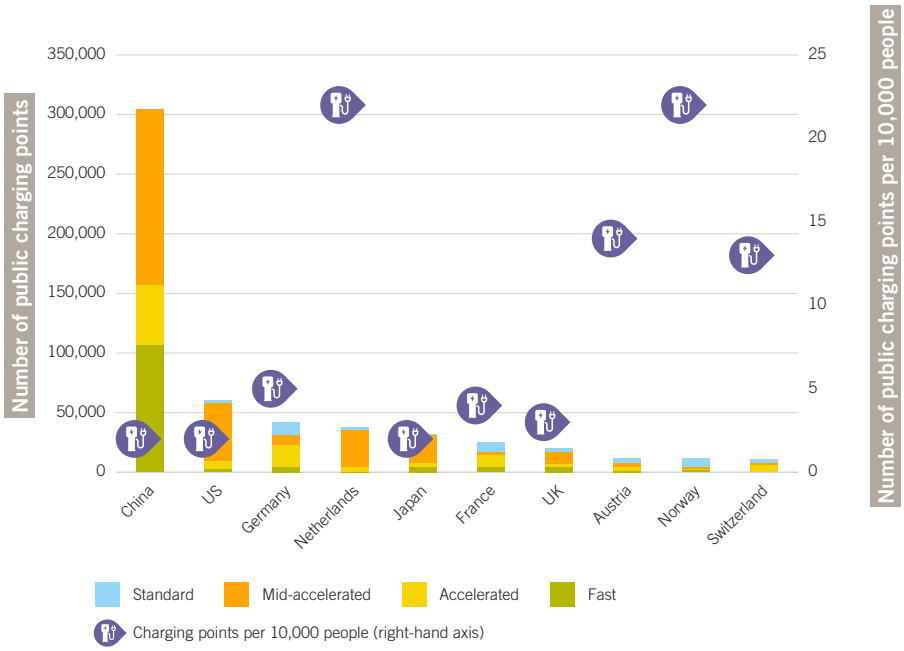
The International Energy Agency has projected that between 14 million and 30 million public chargers need to be deployed globally to serve regular passenger vehicles.[20] This compares to about 632,000 public EV charging points today:[21] clearly a significant commercial opportunity. Solving the recharging problem for EVs will require not only a large amount of investment, but will also require the consideration of a wide variety of issues and opportunities, including:

> Charging speed: while a normal wall socket can replenish an EV battery overnight, this is not a universal solution for EV owners and users. While rapid-charging stations can allow 100 miles of range to be added in 35 minutes of recharging, this is still a much longer time to recharge cars than the time taken to refuel an ICE vehicle in a petrol station. However, this is changing: for example, Tesla recently unveiled its "V3 Supercharger", which aims to add 75 miles of range in 5 minutes.[22] Similarly, BMW and Porsche have unveiled a charging station which can provide 100km of range in 3 minutes, or a full charge in 15 minutes.[23] Rapid recharging will be key to increasing the perceived convenience of using EVs and hence driving demand.

> Charging standards or "interoperability": at present, these can vary significantly. For example, Tesla's proprietary network of "Superchargers" does not work with other car models. Even if a car can be recharged at a particular point, charging processes at different points may require a different set of adaptors, plugs, apps and subscriptions. Getting to scale quickly – or forming alliances – will be vital to simplifying the customer experience.

> Density and location: while China has the most public charging points, the figure only represents 2 charging points per 10,000 people: this is on par with the per-capita penetration level in the US, and is significantly below the per-capita penetration in several European countries, as shown on the chart below.[24] Achieving density – especially in metropolitan areas to start with – will be key to driving EV demand.

EV public charging points by location and population density



19 Source: Navigant Research, 2017

20 Source: Bloomberg, 14 February 2019
21 Source: Bloomberg, 14 February 2019
22 Source: Tesla, 6 March 2019
23 Source: autoblog.com, 13 December 2018

24 Source: Bloomberg, 14 February 2019 and World Bank population statistics

> Customer experience: differences in the location and charging speed of charging points will lend themselves to different customer experiences, and hence different forms of marketing, pricing and ancillary products. For example, fast-charging points offered by traditional fuel providers in existing petrol stations may (once charging speeds improve) allow for a 10 minute "petrol station-like" experience. By contrast, charging points in alternative locations – such as shopping centres or areas with leisure and entertainment opportunities – may allow for, and encourage, a longer experience away from the car and correspondingly increased footfall and ancillary revenue. The advent of autonomous vehicles and associated infrastructure may also change customer experiences significantly: for example, charging may become part of the package offered by car parking operators for self-parking EVs. [25]

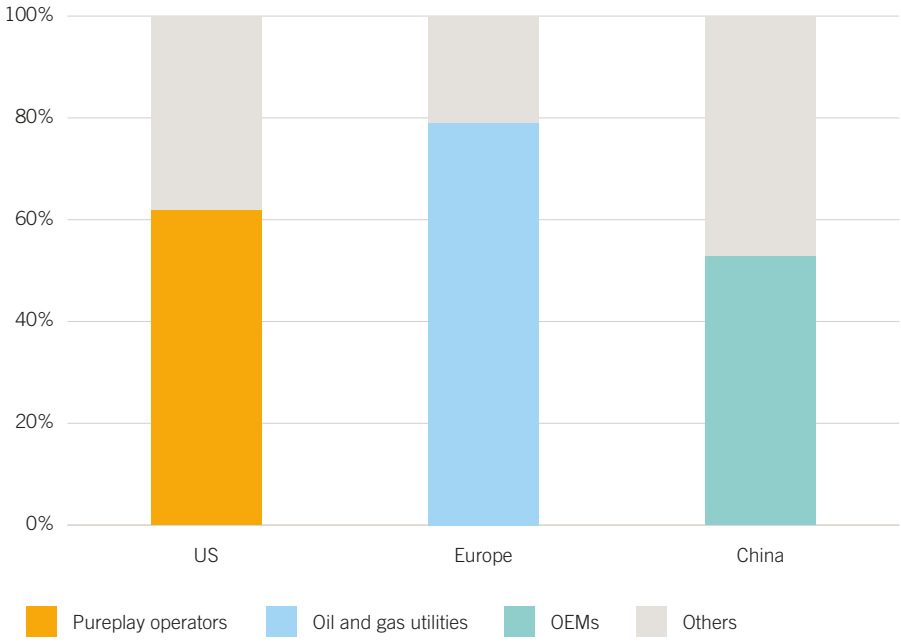
> Power grid management: there are concerns that the recharging of EVs at unpredictable times – particularly peak times – may create levels of demand for electricity that might, in the worst case, lead to power shortages. Updating power transmission and distribution systems to cope with this new demand pattern will require investment by utilities companies, as well as potentially new pricing models. Developments such as smart charging (whereby EVs' systems direct them to recharge at off-peak times when prices and demand are low), or even EV batteries which discharge power back into the grid at times of high demand when the EV is not in use, will also help. [26]

The variety of potential approaches to recharging is also reflected in the variety of operators involved in recharging, which varies significantly by region, [27] as shown on the chart below.

As ever, legal requirements will be a significant driver of the size and growth of commercial opportunities. For example, in Europe, the EU's Directive 2014/94 (the "Alternative Fuel Infrastructure Directive" or "**AIFD**") requires Member States to set targets for public recharging points which would allow EVs to operate in urban and suburban areas by the end of 2020. In China, it is anticipated that 4.3 million private charging points and 500,000 public charging points will be built by 2020. In the US, there are no federal targets for the installation of EV charging stations and state level incentives vary.

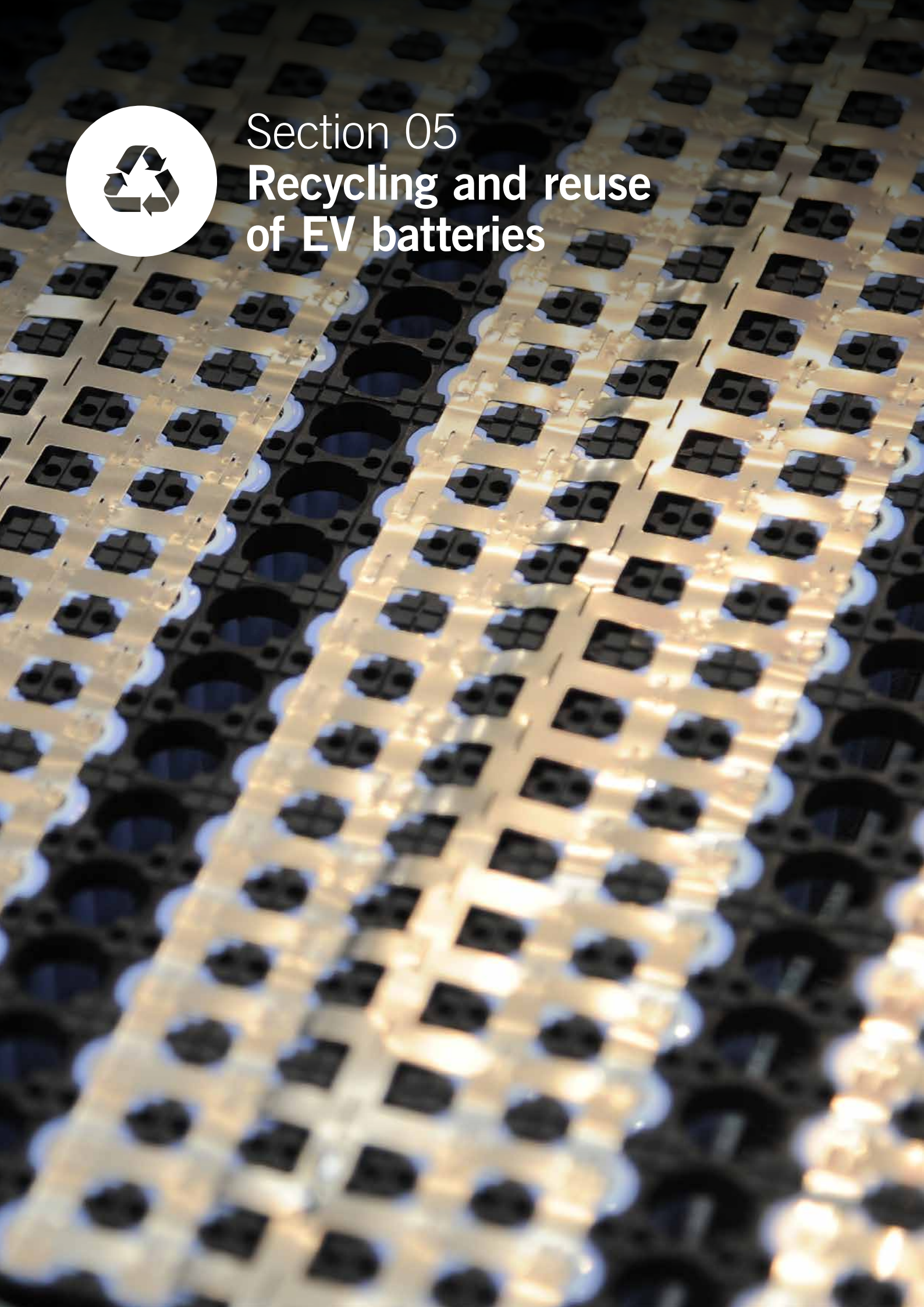
Various EU Member States have (i) legislated in different ways to meet their obligations under the AIFD, (ii) set targets for the construction of charging stations and (iii) rolled out different types of incentive schemes to enable the installation of charging infrastructure (public/private funds, reduced administrative burdens, mandatorily reduced grid connection pricing). Whilst EU and Member State regulators look to industry to take the lead on developing infrastructure, "back-up" provisions have been (or in some cases, will be) enacted to ensure access to charging stations should the market not respond appropriately. Guidance of legislation from a number of EU Member States underlines the importance of "smart" and "interoperable" technology.

This legislation is helping to drive activity at a national level. For example, in Germany, political leaders and industry representatives met on 24 June to agree a "master plan" for charging infrastructure for electric vehicles in order to "expand Germany's charging station network to enable up to ten and a half million electric vehicles to be on German roads by 2030". [28]



CHINA IS TARGETING 4.3 MILLION PRIVATE CHARGING POINTS AND 500,000 PUBLIC CHARGING POINTS BY 2020.

25 For more on this subject, see our recent report here
26 Source: Wired, 3 February 2018
27 Source: Bloomberg, 14 February 2019
28 Source: Xinhua, 25 June 2019



Section 05

Recycling and reuse of EV batteries

Depending on the manufacturer and the battery's usage, after 7-10 years an EV battery will have around 70% of its original capacity remaining.

At this point, it would no longer be suitable for powering an EV but the battery would still be suitable for being recycled into a plethora of "secondary" uses – broadly, either being re-used in a different context (such as for energy storage, powering fixed infrastructure such as street lights or lifts), or the materials within the batteries being recycled. As EV batteries become more powerful, their secondary uses will expand and likely include grid management, home power storage, and so on.

This represents a significant residual value opportunity and, coupled with new regulatory developments on the reuse and recycling of EV batteries, has led to the development of an emerging secondary lithium-ion battery recycling market, estimated to be worth **$24 billion** by 2030. [29]

Given the significant and increasing energy storage opportunities available as the number of EV batteries retiring from "in-car" use increases, and as the power of these batteries increases, the ideas above are only the start of a potential fundamental transformation in the way batteries are used.

Many companies in China are concentrating more on the material recycling opportunity rather than the re-use opportunity. This is driven by factors including a desire to reduce dependence on imported lithium (lithium imports being recently estimated to supply 85% of China's total demand), as well as regulatory developments driving recycling activity. Research suggests that the volume of used batteries in China will "total between 120,000 tons and 200,000 tons in 2018-2020" and will "increase to 350,000 tons in 2025": a significant commercial growth opportunity. [30]

Legislation in this area is principally focussed on the 'extended producer responsibility' or "**EPR**" concept: i.e., making the producer responsible for the management of waste generated by batteries until they are scrapped. Whilst the development of legislation around disposal or recycling will be of key importance, we anticipate amendments to such legislation to cater for the 'second life' of EV batteries.

The EU has already identified that the Batteries Directive will need to be revised to include:

(i) criteria to identify harmful substances which are not currently regulated (cobalt; organic electrolytes such as lithium hexafluorophosphate) and management measures prescribed;

(ii) targets for battery collection or provisions for national schemes, EPR, financing, labelling or reporting obligations with respect to industrial batteries (which include EV batteries);

(iii) a mechanism to integrate new battery chemistries into the directive (e.g. solid state);

(iv) targets for the recovery of materials that constitute lithium batteries such as cobalt or lithium;

(v) specific provision around those holding responsibility at the end of the "second life" of batteries (producers currently remain responsible until the battery is eventually scrapped or recycled, independently of the number of intermediate lives it may have had).

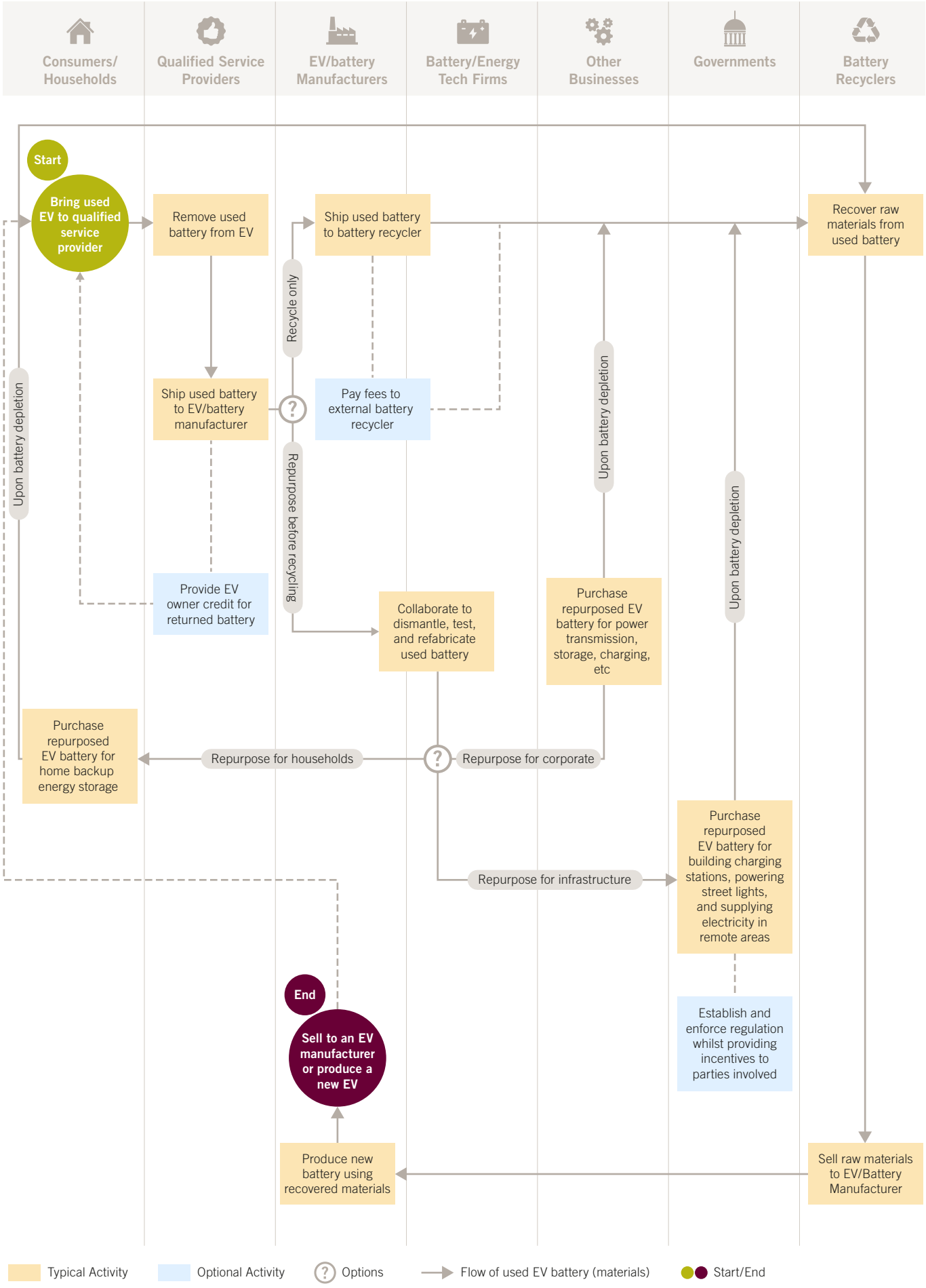
In the EU, policy initiatives on battery recovery, reuse and recycling are anticipated by Autumn 2019. The Batteries Directive is also expected to be revised to take EV batteries into account.

Measures introduced in China in 2018 require automobile manufacturers to establish battery recycling channels and recycling service outlets.

There are ongoing efforts at a federal level in the US to facilitate the reuse of EV batteries. Certain states regulate the disposal and recycling of EV batteries while others have placed the responsibility of waste management on battery producers. Several states, including California, Texas and Wisconsin, have battery disposal and recycling laws on the books, and others, including New York, Florida, New Jersey, and Minnesota, have enacted laws requiring extended producer responsibility shifting the cost of waste management and recycling back to the battery producers.

There is no overarching framework regulating the end of life of lithium-ion batteries in Australia, although various environmental and OH&S measures do apply to their storage, transfer, transport and recycling.

29 Source: Marketsandmarkets.com, December 2017
30 Source: Nikkei Asian Review, 4 April 2019



Note: The diagram is a typical used EV battery ecosystem inferred from information gathered from the following sources as of April 2019: Bloomberg; The Guardian; The Telegraph; Yole Développment; Green Car Journal; Medium


STATE LAW
FINES OF
SUSPENDED
AFTER TWO
WORK ZONE
SPEEDING
TICKETS

Appendix: further detail on developments in policy, law and regulation across the EV battery lifecycle

Stage 1: Sourcing raw materials

Key insights:

> In the EU, responsible sourcing will be required from 2021 for conflict minerals. The European Commission is developing a common set of principles for a socially and environmentally sustainable mining sector in Europe and will map the availability of raw materials within the EU. The Commission is also exploring sustainable mining benchmarks.

> The US has few specific regulations pertaining to the sourcing of raw materials for battery production. Some public companies may be required to make "conflict materials" disclosures.

> In China there are no compulsory laws or regulations on responsible sourcing for conflict minerals, although there are rules put forward by industry institutions and the chamber of commerce which are self-regulated.

EU

Responsible sourcing of the elements mined for lithium-ion batteries is not currently regulated by EU law. The European Commission's "Strategic Action Plan" (or "**SAP**"), adopted in May 2018, [1] has various aims to strengthen the battery manufacturing base in Europe which includes securing access to raw materials. In its communication, "*Europe on the Move – Sustainable Mobility for Europe: safe, connected and clean*", the Commission commits to, amongst other things, building on the EU List of Critical Raw Materials by mapping the availability of current and future primary raw materials for batteries, assessing the potential **within the EU** for sourcing further primary and secondary raw materials and putting forward recommendations aimed at achieving this.

As part of the SAP, the EU has established that there is EU-based processing capacity for cobalt and nickel but not for lithium compounds or graphite, [2] despite there being reserves of lithium in Portugal, the Czech Republic and in the Nordic countries. [3]

The Commission states it will:

i. *"work to develop a common set of principles for a socially and environmentally sustainable mining sector in Europe"; and*

ii. *"also explore options for including existing sustainable mining benchmarks in the Sustainable Finance taxonomy to guide investors towards mining projects which comply with high sustainability standards".* [4]

Reference has also been made to a "*sustainability code of governance*" for European battery manufacturers which commits to compliance with the OECD Guidelines for Multinational Enterprises and the OECD Due Diligence Guidance for Responsible Mineral Supply Chains, in partnership with the OECD. Work may also include "*a model contract clause*" for suppliers in clean battery value chains which promotes similar commitments along the battery value chain. The Commission will also look at options for including sustainable sourcing elements in the Non-Financing Reporting Directive.

1 COM(2018) 293 final of 17 May 2018.

2 Report from the Commission on the Implementation of the Strategic Action Plan on Batteries: Building a Strategic Battery Value Chain in Europe, 9 April 2019, COM(2019) 176 final.

3 https://www.euractiv.com/section/circular-economy/news/race-for-lithium-illustrates-eu-drive-for-strategic-raw-materials/.

4 At page 12 of the aforementioned Report from the Commission on the Implementation of the Strategic Action Plan on Batteries: Building a Strategic Battery Value Chain in Europe.

UK, Germany, Belgium and the Netherlands

Similarly, responsible sourcing of the elements mined for lithium-ion batteries is not currently regulated by UK, German, Belgian or Dutch law. However, these jurisdictions encourage companies to implement the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High Risk Areas. The guidance is primarily focused on 3TG (tin, tantalum, tungsten and gold) minerals but is broad enough to encompass, for example, the mining of cobalt. The London Metal Exchange is currently consulting on its proposals for responsible sourcing, which include requiring audits and risk assessments and have the potential to impact market access for important raw materials, with the consultation due to close at the end of June 2019.

Furthermore, the UK Modern Slavery Act 2015 requires commercial organisations carrying on business, or part of a business, in the UK, which have an annual turnover exceeding £36 million to publish an annual statement on the steps they are taking to combat the risk of modern slavery and human trafficking in their business and supply chain. A similar regime in Germany requires companies with over 500 employees and an annual turnover over €40 million or annual balance sheet total above €20 million to disclose the impact of their business on the environment.

France

There is no specific provision in France in relation to the sourcing of raw materials for the manufacturing of batteries. However, the French law on the corporate duty of care, [5] which is applicable to organisations with more than 5,000 employees in France or 10,000 employees in France and abroad, requires businesses to source those raw materials away from zones of conflicts and without human rights violations or serious environmental damage whether resulting directly or indirectly from the operations of the company, the companies it controls, subcontractors or suppliers.

US

There are few specific regulations or restrictions in the United States pertaining to the sourcing of raw materials for battery production. Depending on which raw materials are sourced and their country of origin, public companies in the US may be required to make certain "conflict materials" disclosures. In addition, the trade policies of the United States are in flux and consideration of all applicable tariff requirements and import/export laws needs to be undertaken with respect to any imported raw materials.

The American Mineral Security Act (S.1317) was introduced in the Senate in May 2019, for the purpose of fostering domestic production of minerals considered critical to the US. The act would require an inventory of metal reserves in the US and seek to streamline permitting for the electric vehicles sector. The US currently has limited mining capacity for minerals crucial to lithium-ion batteries, including lithium, cobalt, graphite and nickel. S.1317 is still in the process of consideration by the Senate Committee on Energy and Natural Resources.

Australia

The lithium-ion battery value chain has been identified as a strategic growth industry by the Australian government. [6] Australia has access to all of the essential mineral element inputs required in the lithium-ion battery supply chain. [7] It is the largest producer of lithium in the world and has the world's third largest reserves of lithium, and is ranked in the top five for reserves and production of cobalt and manganese. [8]

Responsible sourcing of the elements mined for lithium-ion batteries is not currently regulated by Australian law, although Australian entities, or entities carrying on business in Australia, with at least $100 million global consolidated revenue are required to submit a statement on risks of modern slavery in their operations and supply chains under the *Modern Slavery Act 2018* (Cth), reflecting similar obligations in other jurisdictions such as the UK.

5 Law no. 2017-399 dated 27 March 2017

6 Commonwealth of Australia. 2019. Australia's Critical Minerals Strategy 2019. Viewed 24 April 2019: https://www.industry.gov.au/sites/default/files/2019-03/australias-critical-minerals-strategy-2019.pdf.

7 Commonwealth of Australia, Australian Trade and Investment Commission. 2018. The Lithium-Ion Battery Value Chain: New Economic Opportunities for Australia. Viewed 24 April 2019: https://www.austrade.gov.au/local-sites/singapore/news/investment-opportunities-in-australias-lithium-ion-battery-value-chain.

8 Geoscience Australia. 2019. Australia's Identified Mineral Resources 2018. Australian Government, Canberra.

Stage 2: Battery Manufacturing

Key insights:

> The EU's Strategic Action Plan aims to support a sustainable EU battery cell manufacturing base with the lowest environmental footprint possible.

> Various EU Member States have developed policy initiatives highlighting the importance of developing intra-country battery manufacturing capacity.

> In China, foreign investment restrictions on EV battery manufacturing were lifted in July 2017. It also plans to implement mandatory national safety standards for battery development.

> The US has adopted safety-related amendments to existing standards for batteries for EVs.

China

Establishing a presence in China

There are no longer foreign investment restrictions on EV battery manufacturing in the PRC, with the requirement to enter into a JV with a Chinese entity for the manufacturing of EV batteries being lifted in July 2017.

Product standards

Currently, there are eight (non-binding) recommended national standards with respect to EV battery manufacturing in China, including standards relating to safety, electrical performance and test methods for lithium-ion EV battery packs. The Ministry of Industry and Information Technology ("**MIIT**") plans to implement **mandatory** national safety standards for lithium-ion batteries for EVs within the next 2 to 3 years and released a draft of the Safety Requirements for Lithium-ion Traction Batteries for EVs for public consultation on 24 January 2018.

EU

Strategic importance

Batteries have been identified by the Commission as a strategic value chain where the "*EU must step up investment and innovation in the context of a strengthened industrial policy strategy aimed at building a globally integrated, sustainable and competitive industrial base*". [9] This is the aim of the European Battery Alliance (the "**Alliance**"), which was established by the European Commission in October 2017 as a platform for cooperation between key industrial stakeholders, interested Member States and the European Investment Bank to facilitate access to various types of funding for battery manufacturers by, amongst other things, allowing EU Member States to give state-aid to cross-border battery research projects considered to be Important Projects of Common European Interest.

Product standards

The SAP is a key outcome of the work of the Alliance and has various aims to strengthen the battery manufacturing base by supporting the sustainability of the EU battery cell manufacturing industry with the lowest environmental footprint possible. Work on a proposal for a new Eco-Design Regulation is underway which seeks to ensure that the design of batteries promotes their recyclability and sustainability. Future regulatory requirements are likely to address safety, connectivity, performance, durability, bi-directionality, re-usability, recyclability, resource efficiency and the carbon footprint. [10]

The Commission has also started work on minimum performance and sustainability requirements which will be science-based and developed by the Commission and European standardisation bodies (CEN/CENELEC).

9 European Council Conclusions, 21-22 March 2019.

10 Bobba S. et al, Sustainability Assessment of Second Life Application of Automotive Batteries, Final technical report, 2018, JRC112543.

Belgium

The Belgian government strongly supports the aims of the Alliance. It is worth noting that Umicore announced that a new process competence centre will be built in Belgium to develop and scale up high-efficiency production technologies.

France

France is part of the Alliance and has declared, with Germany, its will to implement a joint strategic plan to develop battery manufacturing capacities in Europe. In early January 2019, the Finance Ministry launched a call for expressions of interest by French companies interested in participating in a large-scale project for designing and manufacturing cells and modules for sustainable and environmentally-friendly batteries in Europe. [11] The French President also announced on 13 February 2019 that €700 million will be invested in the Alliance over the next five years. On 2 May 2019, the French and German finance ministers announced their intention to invest €1.2 billion (subject to state aid approval) in a European battery consortium. [12] The consortium, which so far includes PSA, Opel and Saft, will require a further €4 billion from the private sector and intends to open plants in both France and Germany. It is expected that those plants will begin manufacturing liquid vehicle batteries by 2023 and solid-state vehicle batteries by 2026.

Germany

In addition to its joint investment with France, the German Federal Government also seeks to promote battery cell production and will provide up to €1 billion funding for companies working in this field up to 2022. In February 2019, the Federal Ministry for Economic Affairs and Energy issued a call for expressions of interest for this investment. Additionally, the Federal Ministry for Education and Research is planning to invest €500 million in battery technology. [13] The Federal Ministry for Education and Research is also separately funding a "research production battery cell" project, the location of which is subject to a competitive procedure.

The Netherlands

The Dutch government has, together with parties in the private sector, initiated research into the current state of the battery technology value chain and its development in the Netherlands. Specifically, this research aims to assess market opportunities for Dutch companies in the European battery technology industry and put together a corresponding market strategy. The results of this research are expected in the first half of 2019.

UK

The UK Government has set aside £246 million for the design, development and manufacturing of batteries through the Faraday Challenge. As part of the Challenge, a consortium has been awarded £80 million to establish the UK Battery Industrialisation Centre, which will open in 2020. The Centre seeks to provide industry with open access to manufacturing knowledge and allow OEMs to trial their manufacturing processes.

US

Following nearly a decade of research, the U.S. National Highway Traffic Safety Administration ("**NHTSA**") adopted its initial safety standard related to electric vehicles in 2000. As initially adopted, the purpose of the standard, known as "*Federal Motor Vehicle Safety Standard ("**FMVSS**") 305, Electric-powered vehicles: Electrolyte spillage and electrical shock protection*", was to reduce deaths and injuries from electrical shock during and after a crash event. It requires vehicles with high voltage sources to protect vehicle occupants, rescue workers and others who may contact the vehicle after a crash, specifying that the high voltage sources must be electrically isolated from the vehicle's chassis or their voltage must be at levels considered safe from harmful electric shock.

In 2017, NHTSA adopted significant amendments to the standard. Specifically, the 2017 amendment added a physical barrier compliance option that prevents direct and indirect contact of high voltage sources post-crash by way of "electrical protection barriers" beside the vehicle's battery. The amendment also added vehicle performance requirements for every day (normal) vehicle operations to reduce the risk of electric shock due to direct or indirect contact with high voltage sources including the battery. The amendment also added requirements to address safety during refuelling and to mitigate driver error in vehicle operation. These amendments became effective for vehicles manufactured on or after September 27, 2018. [14]

In addition, all chemical substances used in batteries must be used consistently with the requirements of the Toxic Substances Control Act.

11 Report on technological scenarios to achieve the goal of the end of commercialisation of thermal vehicles in 2040, Huguette Tiegna (deputy) and Stéphane Piednoir (Senator).

12 Financial Times, Battery venture seeks EU approval for €1.2bn state aid (2 May 2019).

13 This was announced in the "Battery Forum" in January 2019.

14 The current standards can be found here: https://www.ecfr.gov/cgi-bin/text-idx?SID=02729467eb83e59e4bf192912cb9f7f4&mc=true&node=se49.6.571_1305&rgn=div8

Australia

Strategic importance

To date, there has been no commercial-scale lithium-ion battery manufacturing activities in Australia, with mineral inputs exported abroad for refining and manufacturing. The Australian Government is seeking to attract international investment to develop battery manufacturing and associated downstream processing and manufacturing activities. [15]

Product standards

Australia has adopted the 2009 editions of ISO 6469-1, ISO 6469-2 and ISO 6469-3 as the applicable product safety standards for EV batteries. [16]

Intellectual property challenges

Standard essential patents

Standardisation of EV batteries, either for safety, sustainability or interoperability purposes, although it seems highly advisable, may collide with the IP rights protecting the related technologies. Indeed, while standardisation implies a widespread availability of a technology, IP rights provides exclusive rights on such technology (e.g. the so-called "essential patents").

Similar challenges have arisen with respect to the telecom technologies that have been widely implemented in the automotive sector, leading to much litigation around the world. The interplay between standardisation and IP in the context of "essential patents" is not subject to specific binding rules in Europe but the Court of Justice of the EU provided a negotiation scheme for licences between the patent holders and the implementers of the standardized technology. [17] Many questions however remain unanswered, such as the appropriate royalty rates and the availability of licences all along the manufacturing chain.

In the absence of clear regulations, it may be advisable for all stakeholders to anticipate and reach a global agreement on how and under which conditions the standardized technologies related to EV batteries may be widely used, while providing appropriate compensation to their inventors, in order to avoid the related issues encountered by the Telecommunications sector in the implementation of connectivity features.

Australia

In Australia, those sharing their IP rights will soon need to exercise extra caution in light of pending changes to competition laws. The Competition and Consumer Act prohibits cartel conduct, the making of or giving effect to arrangements that have the purpose, effect or likely effect of substantially lessening competition, and exclusive dealing arrangements that have such purpose, effect or likely effect. Currently, arrangements that relate to IP rights are exempt, but the exemption has been repealed and the repeal will take effect in September 2019. There are currently no plans to introduce the exemptions that apply in many other jurisdictions, such as class exemptions and exemptions for vertical licensing arrangements. This may affect patent licensing arrangements in relation to the electric vehicle industry and similar markets, depending of course on the exact terms of the arrangement.

15 Above, n [38].

16 Standards Australia. 2019. Standards Catalogue – EM-001 : Electric Vehicle Operation. Viewed 24 April 2019: https://www.standards.org.au/standards-catalogue/sa-snz/transportandlogistic/em-001.

17 CJEU, C-170/13, 16 July 2015, Huawei v. ZTE.

Stage 3: Incorporation into, and sale of, EVs

Key insights:

The growth in the market for EVs will be partly driven by emissions performance legislation, air quality targets and subsidies for the purchase of EVs respectively, each of which have evolved to a greater or lesser extent in recent years.

> A new EU regulation requires CO_2 emissions from new cars to fall by 37.5% as against 2021 levels by 2030.

> China VI emissions standards which both combine and add to European and US requirements will be implemented in 2023.

> The US Corporate Average Fuel Economy standards are being challenged by the Trump Administration, and litigation has begun with respect to the ability of the State of California to set its own emission performance limits.

> Subsidies for EVs in the EU vary between and within Member States. Chinese EV subsidies are scheduled to end in 2020 while US federal tax credits of up to $7,500 per EV are under threat of elimination in the 2020 budget. See the overview table at the end of this section for more details.

China

China's emission standards have been developing rapidly over the past 15 years since the introduction of the China Stage I Emission Standard in 2001. According to a report published by the Chinese Ministry of Science, China's carbon intensity (i.e. the quantity of CO_2 emitted per unit of GDP) in 2017 fell by 46% compared to 2005 figures.

The Ministry of Ecology and Environment ("**MEE**") released the China Stage VI Emission Standard for Light-Duty Vehicles and Heavy-Duty Vehicles in 2016 and 2018 respectively ("**China VI Standards**") which are drafted with reference to Euro VI Standards. China VI Standards are due to be implemented by July 2023. The China VI Standards are broadly equivalent to Euro VI, with the former introducing slightly more stringent requirements in terms of, among others, testing requirements, remote emission monitoring system and pollutant emission limits. For example, by 2023, the CO_2 emission limit for passenger vehicles carrying less than 6 passengers and with a gross vehicle weight of no more than 2.5 tonnes will be 500mg/km. In addition, an N_2O limit is applied under China VI Standards. Unlike previous emission standards which largely followed the European model, the China VI Standards combine, and add to, best practice from both European and US regulatory requirements.

EU

Legislation in the EU has consistently tightened the emissions performance standards applicable to light passenger vehicles under a series of regulations which are prescribed requirements in each of the Member States. [18]

The recent adoption of a regulation setting emission performance standards for new passenger cars, [19] coupled with the revised Clean Vehicles Directive (which sets public procurement targets for low and zero-emission fleets) are part of this trend. [20] The regulation requires carbon dioxide (CO_2) emissions from new cars in the European Union to fall by 37.5 per cent. by 2030, based on 2021 levels. To meet the 2030 target, the legislation also calls for a drop of 15 per cent CO_2 emissions against 2019 levels by 2025. The 2030 target will apply to car manufacturers' fleets, meaning that high-emission models would have to be offset with sales of low-emission or zero-emission vehicles, such as battery-run cars. To achieve the new targets, the onus will be on car manufacturers to sell an increased proportion of clean vehicles compared to internal combustion engine vehicles. Financial penalties will apply in cases of non-compliance.

Air quality has also been subject to consistently tightening standards under EU law. The EU revised the National Emission Ceilings Directive in 2016 to further limit emissions of SO_2, NO_x, non-methane VOCs, NH_3 and $PM_{2.5}$. The Directive sets out emission reduction commitments for each Member State and requires them to prepare national air pollution control programmes explaining how those commitments will be met. [21]

Belgium

The collective Belgian commitment is to reduce Belgian greenhouse gas emissions for the non-ETS sectors by 35% by 2030 from 2005 levels. Each Region has developed its own binding and non-binding measures to reduce the impact of greenhouse gas emissions, notably in the transport sector.

On air quality, Belgian federal entities have implemented several instruments, such as traffic bans for certain vehicles or low emission areas in certain cities. The different regional entities focus on a low emission public transport sector and low emission mobility through fostering electric and hybrid cars, but also LNG and hydrogen solutions.

18 See Linklaters Automotive Regulatory Update, "The Regulatory Landscape for Alternative Fuels", April 2018.
19 Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019.
20 Regulation (EC) No 715/2007 (recast) (COM(2017)0676 – C8-0395/2017 – 2017/0293(COD)).
21 Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants.

France

Greenhouse gas emissions should be reduced (i) by 40% between 1990 and 2030 and (ii) by a factor of four between 1990 and 2050. [22] These objectives may be clarified and strengthened by the draft bill for Climate and Energy (dated April 2019) which currently aims for carbon neutrality in 2050 by dividing greenhouse gas emissions by a factor greater than six as between 1990 and 2050 levels. [23]

The French Government has also issued a draft decree for the Multiannual Energy Program on 5 March 2019 (the "**Draft MEP Decree**"), the final form of which is expected at the beginning of the summer. The Draft MEP Decree has two main objectives: (i) reduce fossil fuel consumption and (ii) ensure a clean, fair and sustainable transition for all. It aims to reduce fossil fuel consumption by 19% in 2023 and 35% in 2028 in each case as compared with 2012 levels. The transport sector is one of the main levers for lowering fossil fuel consumption, through the development of clean mobility. The following objectives for electromobility are currently provided for: [24]

Deadline	2023	2028
Electric vehicles	660,000	3,000,000
Rechargeable hybrid private vehicles	500,000	1,800,000

At the end of 2017, the Mayor of Paris publicly announced the goal of achieving 100% electric or hybrid vehicles in Paris by 2030.

Germany

Germany's Climate Protection Plan 2050 seeks to reduce German emissions by at least 80 per cent by 2050 from 1990 levels. The Climate Protection Plan notes that electromobility plays an important role in the envisaged reduction of greenhouse gases, and as such, the German government wants to strengthen this sector. The draft Climate Protection Act, published in February 2019, sets binding annual emission targets for the transport sector. In 2021, only 145 million tonnes of carbon dioxide equivalent will be permitted, with 139 million by 2022, 123 million by 2025 and 95 million by 2030.

The Climate Strategy for Road Transport is currently being discussed and is expected to be adopted soon. It will address emissions from cars, the requisite infrastructure and the interlinking of sectors with respect to electromobility. In a similar vein, the "Climate Cabinet", established in March 2019, aims to prepare legally binding climate protection measures with a special focus on electromobility.

In many German cities, driving bans on older diesel vehicles (i.e. diesel vehicles below Euro V or Euro VI standard, depending on the respective city) are being implemented or discussed as part of air quality plans to avoid exceedance of the limit values set out by the European Union in Directive 2008/50/EC on ambient air quality and cleaner air for Europe. Following lawsuits against local air quality plans, many local courts are ruling that such diesel bans must be implemented and the German Federal Administrative Court has ruled that they are, in principle, permissible.

The Netherlands

The Dutch government seeks a reduction of 95% in carbon emissions in the Netherlands by 2050 as against 1990 levels and a 49% reduction by 2030 as against 1990 levels. These targets are to be met through a five-yearly climate plan and an annual climate budget, as laid down in the Climate Act, which was adopted by the Dutch parliament on 20 December 2018. [25] Specifically in relation to transport, the 2017 Energy Agenda aims to achieve:

> a 60% reduction in carbon emissions in the transport sector by 2050 as against 1990 levels;

> the sale of only emission-free cars by 2035; and

> all cars in circulation being emission free by 2050.

In December 2018, the Dutch government presented further objectives to support the cutting of carbon emissions in the Climate Accord, an agreement reached with key industry players following a series of round-table discussions. These objectives include:

> a reduction of 7.3 megaton in greenhouse gas emissions by 2030;

> the sale of only emission-free cars by 2030 (rather than 2035 as set out in the Energy Agenda);

> subsidies for the purchase of electric cars of up to €6,000 per purchase; and

> a tax increase on the purchase of carbon emitting cars.

In October 2018, the Hague Court of Appeal ruled that the Dutch government has a binding obligation to reduce greenhouse emissions by at least 25% by 2020 from 1990 levels. [26] The Court considered that the Dutch government's envisioned timeframe of a 17% reduction by 2020 as compared to 1990 is insufficient in light of the severity and scope of the risks associated with climate change. The Dutch government has stated that it intends to comply with the binding objective set by the Hague Court of Appeal and will present a set of measures in June 2019.

22 Pursuant to article L. 100-4 of the French energy code as modified by the so-called Energy Transition Law no.2015-992 dated 17 August 2015.
23 Pursuant to article 1 of the draft bill for climate and energy.
24 Pursuant to article 41 of the Energy Transition Law

25 The proposed Climate Act is currently being discussed by the Dutch upper chamber for approval.
26 The Hague Court of Appeal 9 October 2018, ECLI:NL:GHDHA:2018:2610 (Urgenda Foundation). Appeal proceedings before the Dutch Supreme Court are pending.

UK

In May 2019, the UK's Committee on Climate Change issued a report in which it recommended a net zero emissions target by 2050.[27] The proposal would require accelerated adoption of EVs.

The Clean Growth Strategy, published in October 2017, made a commitment to end the sale of new conventional petrol and diesel cars in the UK by 2040. The 2018 Road to Zero Strategy sets the following targets:

> At least 50 per cent, and up to 70 per cent, of new car sales to be ultra-low emission[28] by 2030;

> Almost every car to emit no emissions by 2050.

Enshrined in policy documents, these targets are aspirational and the UK's regulatory position on emissions performance will (excluding consideration of any impacts of Brexit and city-specific regulation) continue to be governed by EU law.

An Ultra-Low Emissions Zone ("**ULEZ**") came into force in central London on 8 April 2019 which permits Euro IV-standard compliant petrol-fuelled cars and Euro VI-standard compliant diesel-fuelled cars to enter (and any vehicle with better emissions performance) without charge. The ULEZ will expand to cover the whole city from 25 October 2021.

The Department for Environment, Food and Rural Affairs has also recently published the National Air Pollution Control Programme ("**NAPCP**"), which implements the National Emissions Ceilings Directive 2006.[29] Significantly, the NAPCP sets out sector-specific emission reduction commitments for the road transport sector with respect to the pollutants covered by the Directive.

US

In October 2012, via a report of the Congressional Research Service, NHTSA and the EPA announced the second (current) phase of CAFÉ (Corporate Average Fuel Economy) and GHG emissions standards affecting model year 2017-2025 light-duty vehicles. These standards were agreed to by the State of California, 13 auto manufacturers, and the United Auto Workers Union. Manufacturers agreed to reduce GHG emissions from most new passenger cars, sport utility vehicles, vans, and pickup trucks by approximately 50% by 2025. NHTSA's fleet-wide CAFÉ standard was set to 49.7 mpg by 2025, while the EPA's GHG-equivalent fuel economy standard was set to 54.5 mpg by 2025 (which became the most commonly used standard in the industry). Different sizes and categories of vehicles have different compliance targets. The 54.5 mpg number was not a requirement for every – or for any specific – vehicle or manufacturer; instead it's an estimate for what the agencies deemed likely to be achieved, on average, by the sales of fleet-wide light-duty vehicles [which are weighted] for the model year 2025 in the US.

In 2016, a midterm evaluation by the Obama Administration of the 2012 standards found that the model year 2022-2025 standards remained appropriate and that change was not warranted. The 2016 evaluation did however lead to revised references to 50.8 mpg by 2025 for the GHG-equivalent fuel economy standard, and 46.6 mpg by 2025 for the CAFÉ standard. These new numbers were implemented or changed by rulemaking. Both of the original standards (54.5mpg and 49.7 mpg) were based on estimated projections for model year 2025, plans for which were more developed by the mid-term point; final production numbers may impact the standards set by the mid-term review.

In April 2018, the Trump Administration announced its intention to revise the federal standards regulating fuel economy and GHG emissions. The Safer Affordable Fuel-Efficient Vehicles Rule would freeze fuel economy standards at 2020 levels through 2026, and reverse the increases scheduled in 2012 under President Obama. It also proposed to eliminate the waiver that has been in place allowing California to set its own, stricter, emissions standards. The proposed regulation was announced in August 2018, is currently undergoing revisions, and is expected to be finalised in the coming months.

In a case that is still ongoing, California and 16 additional states have sued the EPA in the U.S. Court of Appeals for the District of Columbia, seeking to block the agency from revising the 2012 emissions standards. Last month the California Air Resources Board also filed suit against the EPA and NHTSA in a D.C. federal court, seeking to force the administration to release the data supporting the proposal to roll back Obama-era emissions standards. Automakers have pressured both sides to come to an agreement on a national standard, however negotiations between the executive branch and the California Air Resources Board broke down in February. The opposing sides may now be facing a protracted legal battle that may ultimately have to be decided by the U.S. Supreme Court.

Australia

Australia has committed to reducing its emissions to 26 to 28 percent below 2005 levels by 2030 and transitioning to zero emissions before 2050. Road transport accounted for roughly 16% of Australia's greenhouse gas emissions in 2018 and is projected to increase over coming years.[30]

Emissions standards for new light vehicles in Australia are based on the Euro 5 standard.[31] This standard was introduced for new model vehicles from 1 November 2013 and for existing models from 1 November 2016, and adoption of the more stringent Euro 6 standard is currently under consideration. Australia does not currently have a light vehicle carbon dioxide emissions performance standard in place.

27 Committee on Climate Change, Net Zero – The UK's contribution to stopping global warming (2 May 2019).

28 An ultra-low emission vehicle is one that emits less than 75g of CO_2 per kilometre and is capable of driving at least 10 miles without emissions.

29 DEFRA, Air Quality: National Air Pollution Control Programme, March 2019.

30 Australian Government Department of the Environment and Energy. 2018. Australia's emissions projections 2018.Viewed 18 April 2019: https://www.environment.gov.au/system/files/resources/128ae060-ac07-4874-857e-dced2ca22347/files/australias-emissions-projections-2018.pdf.

31 *Vehicle Standard (Australian Design Rule 79/04 — Emission Control for Light Vehicles) 2011 (Cth); Vehicle Standard*

Stage 4: Recharging of EVs

Key insights:

> EU Directive 2014/94 (the "**Alternative Fuel Infrastructure Directive**" or "**AIFD**") requires Member States to set targets for public recharging points which would allow EVs to operate in urban and suburban areas by the end of 2020. In China, it is anticipated that 4.3 million private charging points and 500,000 public charging points will be built by 2020. In the US, there are no federal incentives for the installation of EV charging stations and state level incentives vary.

> Various EU Member States have legislated to meet their obligations under the AIFD and are also rolling out different types of incentive schemes for the installation of charging infrastructure.

China

China currently has around 800,000 charging points, including around 300,000 public charging points.[32] According to the Guidance on the Development of Charging Infrastructure for Electric Vehicles 2015 – 2020, from 2015 to 2020, it is anticipated that China would build 4.3 million private charging points and 500,000 public charging points.

EU

The Alternative Fuels Infrastructure Directive required Member States to submit policy frameworks on achieving alternative fuels infrastructure by the target deadline of November 2017 (which, in some cases, was not met). It prescribes the following targets and deadlines:

> Member States shall ensure that an "appropriate" number of recharging points accessible to the public are put in place by 31 December 2020; and

> The Commission, if necessary, shall submit a proposal to amend this Directive in order to ensure that a sufficient number of recharging points are accessible to the public in each Member State by 31 December 2025.

Belgium

There are approximately 3,000 public charging stations in Belgium, most of them located in Flanders and the Region of Brussels Capital. Currently, the deployment of charging stations remains one of the biggest challenges in Belgium. However, initiatives are emerging in the three regions to increase numbers. For example, there has been a call for a project for the installation of charging points in the Walloon Region and the Flemish distribution network operator is obliged to ensure that 5,000 public charging points are accessible by 2020. A national Energy Pact provides that sufficient public charging infrastructure will be available in Belgium by 2030, with a ratio of 1 public charging point per 10 EVs to be installed (by preference) along highways and express ways.

i. The Flemish region adopted an Action Plan "Clean Power for Transport" in 2015 to implement Directive 2014/94/EU, which aims to increase the share of EVs, and in particular the charging infrastructure. As a consequence, the distribution network operators ("**DSOs**") were obliged to install the basic charging network.

ii. In the Walloon region, the government has committed to have approximately 680 charging points installed by 2020.

iii. In April 2019, the Brussels Capital region approved a draft mobility plan, which also aims at installing charging infrastructure.

32 Source: Bloomberg, 27 March 2019

France

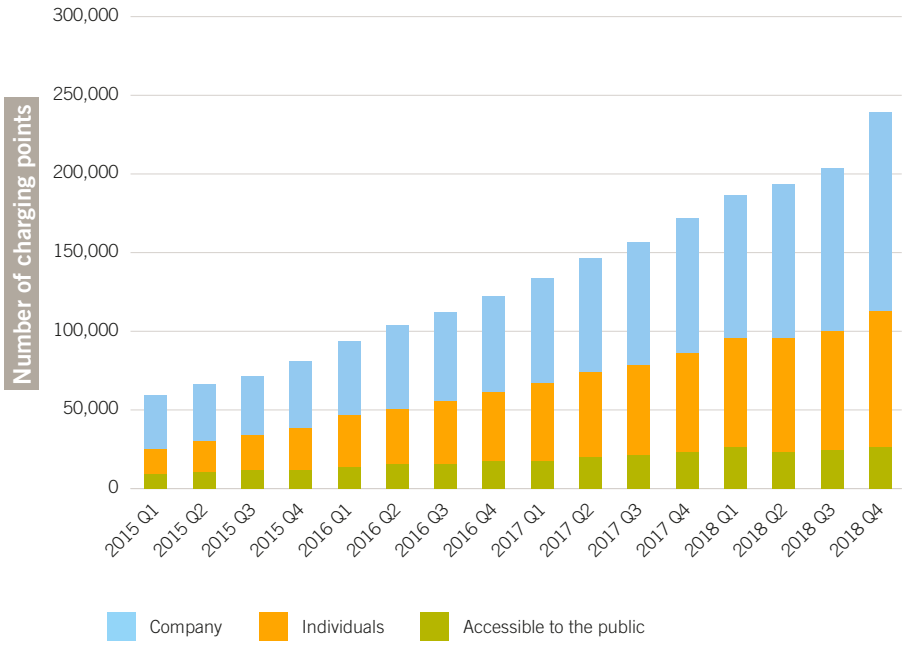
In France, at the end of 2018, the total number of recharging points was c. 238,000, including c. 25,000 points accessible to the public (10%), c. 86,000 accessible by individuals (36%) and c. 127,000 accessible by businesses (53%), with an overall increase of nearly 40% in one year (see graph below).

The French Parliament has been working on the adoption of the law for orientation of mobility ("**LOM**") supporting an accelerated deployment of recharging points since 26 November 2018. The LOM facilitates the deployment of charging stations. Firstly, it clarifies the legal regime applicable to charging station operators: they will not need a permit to supply electricity as they are to be considered to be providers of services and not electricity suppliers. As a result, they will not need an electricity supply permit to enter into an agreement for EV recharging services with an electricity supplier.

Secondly, the LOM increases the costs that public grid transmission or distribution operators are allowed to bear when connecting public electric/hybrid vehicle recharging infrastructure to the public electricity grid from 40% to 75% of the total cost of connection until 31 December 2021. This leaves infrastructure manufacturers or project owners with a reduced burden of 25% of the costs of connecting the recharging infrastructure to the electricity grid. There are also provisions on equipping private parking spaces with recharging points. The amount of cost to be borne is decided by the administrative authority following the opinion of the French regulator for energy (CRE). It depends notably on the characteristics of the recharging infrastructure, in particular its capacity and the level of coverage of the existing recharging infrastructure.

New provisions have also been implemented to facilitate the deployment of recharging points on motorways service areas.[33] The Draft MEP Decree provides for a clear target of 100,000 publicly accessible recharging points by 2023.

Accessibility of charging points – France



33 Order dated 2 January 2019 modifying the order dated 8 August 2016 and fixing the conditions of organisation of the public service on the attached installations to the gird conceded motorways.

Germany

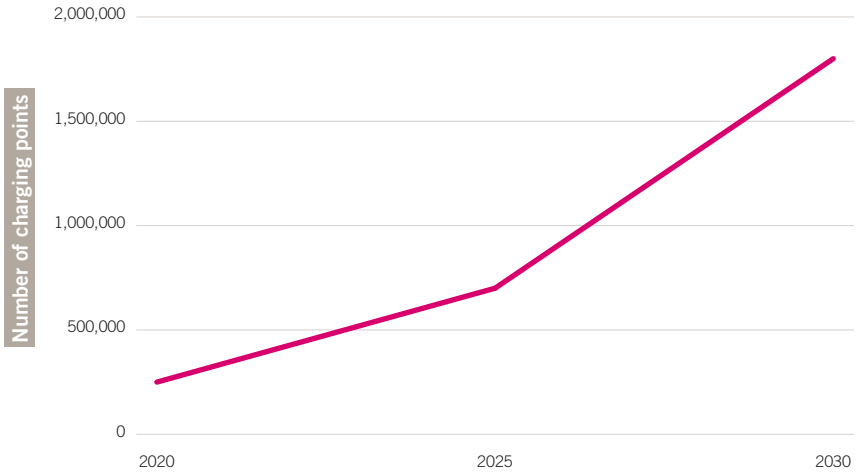
Currently, there are approximately c. 40,000[34] public charging points in Germany. The Climate Strategy for Road Transport will address the need to further support the construction of public and private electricity filling stations. According to the coalition agreement of the federal government from 2018, 100,000 charging points should be constructed by 2020.

A federal fund of €300 million will also subsidise the installation of charging infrastructure until 2020, including both normal (up to 22kW) and quick charging (above 22 kW) stations. A third call for funding was issued in November 2018.

Netherlands

As part of the Energy Accord, the Dutch government proposed a National Charging Infrastructure Agenda in January 2019. According to the agenda, 1.8m charging stations are needed by 2030 to reach the objective of the exclusive sale of emission-free cars by 2030, corresponding to an assumed total of 1.9m cars. In this scenario, the demand for charging stations is predicted to develop as follows:

Increase of charging points (scenario of 1.9m emission-free vehicles in 2030) – The Netherlands [35]



Pursuant to the Charging Infrastructure Agenda, the rollout of charging infrastructure is to be realised with as little government intervention as possible. Instead, the Dutch government has agreed to non-binding commitments by industry players and local governments concerning, amongst other things:

i. updated policy guidelines on charging station placement;

ii. setting a minimum amount of charging stations per business parking lot;

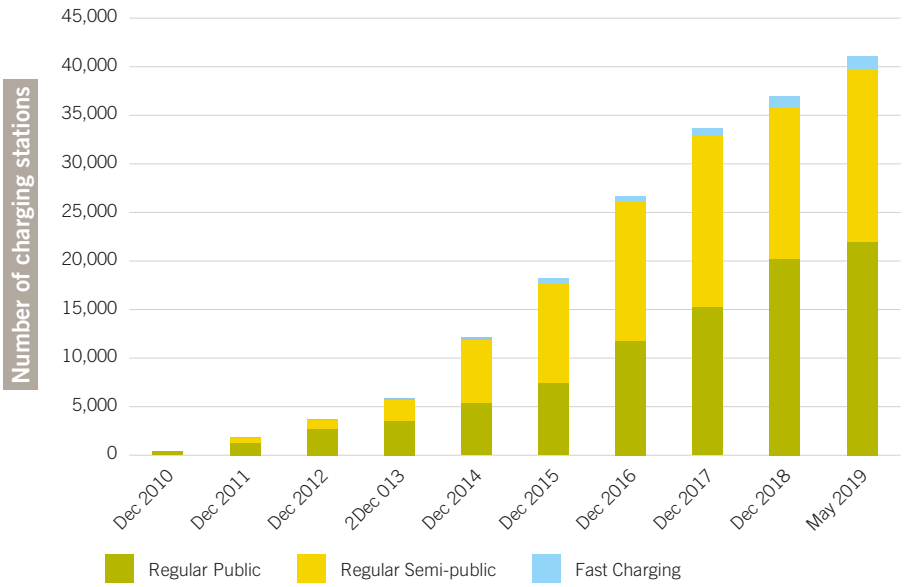
iii. price transparency by charging station operators;

iv. application of 'smart charging' (i.e. adjusting the charging speed around peak usage of the electricity grid to avoid local or momentary over-utilisation of the electricity grid); and

v. application of 'vehicle-to-grid' technology (i.e. bi-directional charging stations that allows the transfer of electricity from the vehicle to the grid in order to meet local or momentary peak demands on the electricity grid).

Currently, there are around 40,000 public and semi-public electrical charging stations (semi-public stations are accessible to the public even though they are placed on private property) and 1,200 fast charging stations (those with power greater than 22 kWh). The development of charging points has been as follows:

Development in the number of charging stations – The Netherlands [36]



34 Source: Bloomberg, 14 February 2019

35 National Charging Infrastructure Agenda, p. 3. Available at: <https://www.klimaatakkoord.nl/binaries/klimaatakkoord/documenten/publicaties/2019/01/08/achtergrondnotitie-mobiliteit-laadinfrastructuur/Mobiliteit+-+achtergrondnotitie+Nationale+Agenda+Laadinfrastructuur.pdf>.

36 Netherlands Enterprise Agency, June 2019. Available at: <https://www.rvo.nl/sites/default/files/2019/06/Statistics%20Electric%20Vehicles%20and%20Charging%20in%20The%20Netherlands%20up%20to%20and%20including%20May%202019.pdf>.

UK

Passed in the summer of 2018, the Automated and Electric Vehicles Act (the "**AEVB**") provides UK Government with the power to pass regulations governing the payment for, access to, performance of, maintenance and availability of, and means of connection to public charging or refuelling points. It also grants UK Government the power to pass regulations requiring large fuel retailers and service operators to provide public charging points. Secondary legislation has not yet been published under the Act.

Whilst the UK Clean Air Strategy notes that Highways England will ensure that 95% of the network will have a charge point for EVs every 20 miles, there are no mandatory targets for the roll-out of such infrastructure in the UK. However, the UK Government has announced that it intends to legislate to ensure that all newly built homes, where appropriate, have a charging point available. [37]

The Road to Zero Strategy includes measures to increase the number of charging points for electric vehicles, including the establishment of a £400m Charging Infrastructure Investment Fund to accelerate the roll out of charging points (the "**CIIF**"). The CIIF is still in the process of being established.

US

Interconnection with the electric grid is the main challenge to increased availability of public charging stations that can support growth in EV sales. While there are approximately 61,000 EV charging points available to the public in the US, [38] that number is expected to vastly increase as the EV industry grows.

Charging station owners typically need an interconnection agreement with the local electric utility, particularly in states where the utility still has a monopoly on all electric sales. This presents a load growth opportunity for the utility that should be welcomed and expedited. Nonetheless, the utility is also charged with maintaining a safe electric grid, and utilities generally do not yet have enough experience with EV charging stations to make the interconnection process smooth and routine. It can take over six months to have all the necessary tasks completed, but that timeline is likely to shrink as the EV industry grows. This has been the case in other alternative energy innovations, such as rooftop solar installations or other distributed generation technologies.

Currently, in the United States, there are no federal incentives for installation of EV charging systems. Any incentives in the US are at the state level and vary by state.

Australia

In 2018, there were 783 public charging stations in Australia, equating to roughly one charging station for every six EVs in Australia. [39] Given the large geographical area and disperse population of Australia, this lack of charging infrastructure creates a barrier to increased uptake of EVs. [40]

State and municipal governments, as well as organisations and private companies, are investing in public charging infrastructure. For example, the Queensland Government is investing in the Queensland "electric super highway", which stretches from Coolangatta to Cairns and from Brisbane to Toowoomba, with public charging stations at intervals of no more than 200km apart.

37 Department for Transport, The Road to Zero: Next steps towards cleaner road transport and delivering our Industrial Strategy (July 2018) at page 5.

38 Source: Bloomberg, 14 February 2019

39 Senate Report, pp 14-15.

40 Commonwealth of Australia. Report of the Senate Select Committee on Electric Vehicles, pp 40-41. Viewed 17 April 2019: https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Electric_Vehicles/ElectricVehicles/Report.

Stage 5: Battery recycling

Key insights:

> In the EU, policy initiatives on battery recovery, reuse and recycling are anticipated by Autumn 2019. The Batteries Directive is also expected to be revised to take EV batteries into account.

> Measures introduced in China in 2018 require automobile manufacturers to establish battery recycling channels and recycling service outlets.

> There are ongoing efforts at a federal level in the US to facilitate the reuse of EV batteries. Certain states regulate the disposal and recycling of EV batteries while others have placed the responsibility of waste management on battery producers.

China

In China, regulatory consideration of the second life use of batteries after their first life in the EV is becoming more pronounced.

MIIT and six other authorities jointly issued the Interim Measures for the Management of Recycling and Utilisation of Power Batteries of New Energy Vehicles on 26 January 2018 ("**Interim Measures**"), which strengthen the management of recycling and utilisation of new energy vehicle power batteries in order to standardise the development of the second life industry. The Interim Measures require the automobile manufacturers to establish (i) battery recycling channels (as they are responsible for recycling used batteries); and (ii) recycling service outlets which are responsible for collecting used power storage batteries. This mirrors the extended producer responsibility regime in the EU.

EU

The end of life of batteries produced in the EU is governed by the Batteries Directive 2006. It is the only piece of EU legislation dedicated to batteries and seeks to ensure that producers of batteries and products incorporating batteries are responsible for the management of the waste generated ("**extended producer responsibility**" or "**EPR**"). Following a scheduled review which began in 2017, the Commission has identified a need for:

i. criteria to identify harmful substances which are not currently regulated (cobalt; organic electrolytes such as lithium hexafluorophosphate) and management measures prescribed;

ii. targets for battery collection or provisions for national schemes, EPR, financing, labelling or reporting obligations with respect to industrial batteries (which include EV batteries);

iii. a mechanism to integrate new battery chemistries into the directive (e.g. solid state);

iv. targets for the recovery of materials that constitute lithium batteries such as cobalt or lithium; and

v. the directive to address the "second life" of batteries. Producers currently remain responsible until the battery is eventually scrapped or recycled, independently of the number of intermediate lives it may have had.

A separate study recently completed by the European Commission concludes that:

i. *"the waste battery collection within the EU is insufficient; a large amount of batteries end up in municipal waste. Other losses of batteries occur due to the insufficient practice of battery removal from WEEE.*[41] *Improving and increasing collection need to be at the highest priority of the revision of the Batteries Directive."*

ii. recycling targets for waste lithium-ion batteries are too low and not material-specific which is considered necessary to prevent potential supply risks and to support the reduction of environmental impacts.

Policy initiatives on battery recovery, reuse and recycling are anticipated under the European Commissions' current mandate before Autumn 2019.

41 Waste electrical and electronic equipment.

Belgium

Based on the extended producer responsibility, the Flemish region and the Brussels Capital region have entered into specific environmental policy agreements in relation to EV batteries with the sector associations. These agreements appoint Febelauto as (end-of-life) management organisation and contact point in relation to EV batteries. It has been entrusted with the mission of developing solutions to collect, process and recycle EV batteries. No similar arrangement has been implemented in the Walloon Region yet.

France

A national register for manufacturers of batteries was created in 2010. It aims to identify the French manufacturers and collect annual declarations with respect to treatment (including recycling). Indeed, French regulation requires actors in the sector to declare annually the quantity of batteries and accumulators placed on the market, collected and treated in this register.

The Government announced that it aims to invest €2.7 million to finance the so called "UEX2 project", an industrial recycler capable of recycling all types of rechargeable lithium batteries.

US

The Consumer Product Safety Commission has a number of voluntary standards in place for batteries in consumer products. Also, the Department of Transportation has specific rules related to the transport of certain batteries that contain lithium.

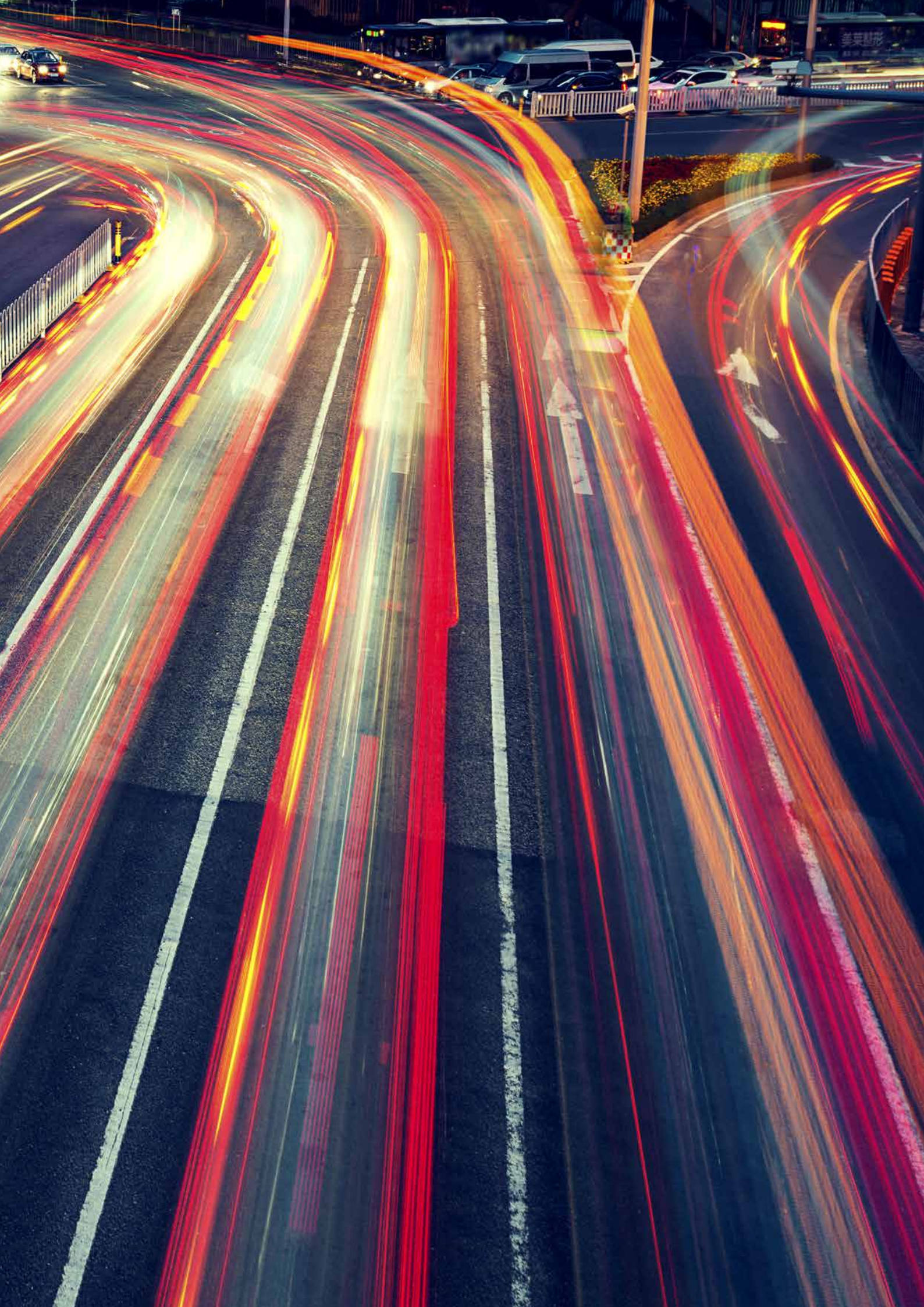
At the end of a battery's useful life, there may be specific disposal obligations, depending on whether the battery would qualify as a universal waste, or a hazardous waste. The majority of batteries can be managed as universal waste, including lithium ion batteries, once the decision is made to dispose of the batteries. A recent federal proposal seeks to facilitate reuse of EV batteries after they are removed from vehicles and before they are discarded as they can still maintain a significant level of charge and be used in various alternative uses. In addition to the reuse efforts, several states, including California, Texas and Wisconsin, have battery disposal and recycling laws on the books, and others, including New York, Florida, New Jersey, and Minnesota, have enacted laws requiring extended producer responsibility shifting the cost of waste management and recycling back to the battery producers.

Australia

There is no overarching framework regulating the end of life of lithium-ion batteries in Australia, although various environmental and OH&S do apply to their storage, transfer, transport and recycling. Only about 3% of lithium-ion batteries currently sold in Australia are returned for reprocessing. [42]

Australia's only lithium battery recycling plant commenced operations in April 2018. [43] Some automotive manufacturers have standard operating procedures for retrieving and recycling waste lithium-ion EV batteries, but these efforts generally rely on sending waste batteries to overseas recycling plants.

42 Senate Report, p 71.
43 Sustainability Victoria. 2018. Australia's first lithium battery recycling plant opens. Viewed 24 April 2019: https://www.sustainability.vic.gov.au/About-Us/Latest-News/2018/04/26/04/57/Australias-first-lithium-battery-recycling-plant-opens.



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