Swiss Re Institute

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Gearing up for the electric vehicles ecosystem

Risks along the value chain – Part I

Contents

Key takeaways

The road ahead for electric vehicles (EVs)

1. **Missing the planned electric vehicles trajectory could result in 6 billion tonnes of additional CO_2 emissions by 2030**
   Although sales of electric vehicles (EVs) more than doubled during the COVID-19 pandemic, overall vehicle emissions are still increasing. Vehicle emissions will continue to rise into 2030, even assuming countries meet current climate commitments and adhere to existing policy promises.

2. **While sales of EVs are growing, risks in the value chain must be better understood and mitigated**
   Replacing internal combustion engines (ICEs) changes risk profiles across the entire automotive value chain – encompassing usage profiles, driving behaviour, accidents, repairs, construction, manufacturing, transportation and recycling. Specific changes during the use phase include: adaptation to unique EV features, driving behaviour and usage profiles.

3. **EVs could be up to 15% more expensive to repair than comparable conventional vehicles**
   Lack of expert knowledge can result in greater repair time and costs. EVs are typically heavier than comparable ICEs due to their battery systems. Manufacturers are trying to offset this weight with the use of lightweight body materials. These materials may be more difficult to repair and replace.

4. **Lower noise levels, greater weight, instant torque and variability in deceleration may change EV loss profiles**
   Silent EVs coupled with delayed deceleration may result in more road accidents. Greater claims severity may occur from a growing weight disparity between EVs and ICEs. Altered acceleration could increase claim frequency for new EV drivers, although this may reduce with driving experience.

5. **Risks associated with the EV charging infrastructure need to be acknowledged and addressed**
   New vehicle risks include the installation and operation of charging infrastructure and battery-as-a-service solutions such as battery swapping. Magnified fire and explosion risks associated with an accumulation of vehicles particularly increase the chances of both property and liability related losses.

6. **Insurers can play a key role in risk assessment and holistic risk management within the EV ecosystem**
   Insurers can participate early on by offering risk-based premiums and promote the adaption of safer EVs. They can partner with battery research labs to better understand links between battery performance, degradation and its external environment. They can also develop EV risk-scoring models based on telematics data.

Impetus for electric vehicle adoption: cleaner environment

Mobility currently accounts for almost a fifth of global carbon dioxide (CO_2) emissions.[1] Reducing vehicular emissions with new fuels and electricity are therefore important means in reaching overall CO_2 reduction goals. Momentum is building in the transition from internal combustion engine cars (ICEs) to electric vehicles (EVs). While the COVID-19 pandemic dampened ICE sales, global sales of EVs more than doubled from 3.1 million in 2020 to 6.6 million in 2021; and have surpassed 10 million in 2022.[2]

When will EV adoption make a significant dent to overall vehicular emissions? The International Energy Agency (IEA) uses three EV sales projection scenarios to assess the difference in lifetime emissions of cars by 2030: i) Net Zero (NZE); ii) Announced Policies (APS); and iii) Stated Policies (STEPS).[3] The results show a significant decline in lifetime CO_2 emissions only under the NZE scenario as shown in Figure 1.[4] Unfortunately, based on the other two scenarios, emissions from all vehicles will rise by 2030, even assuming countries meet existing government climate commitments. A STEPS scenario could cause an additional 6 billion tonnes of unwanted emissions by 2030 compared to the NZE scenario.

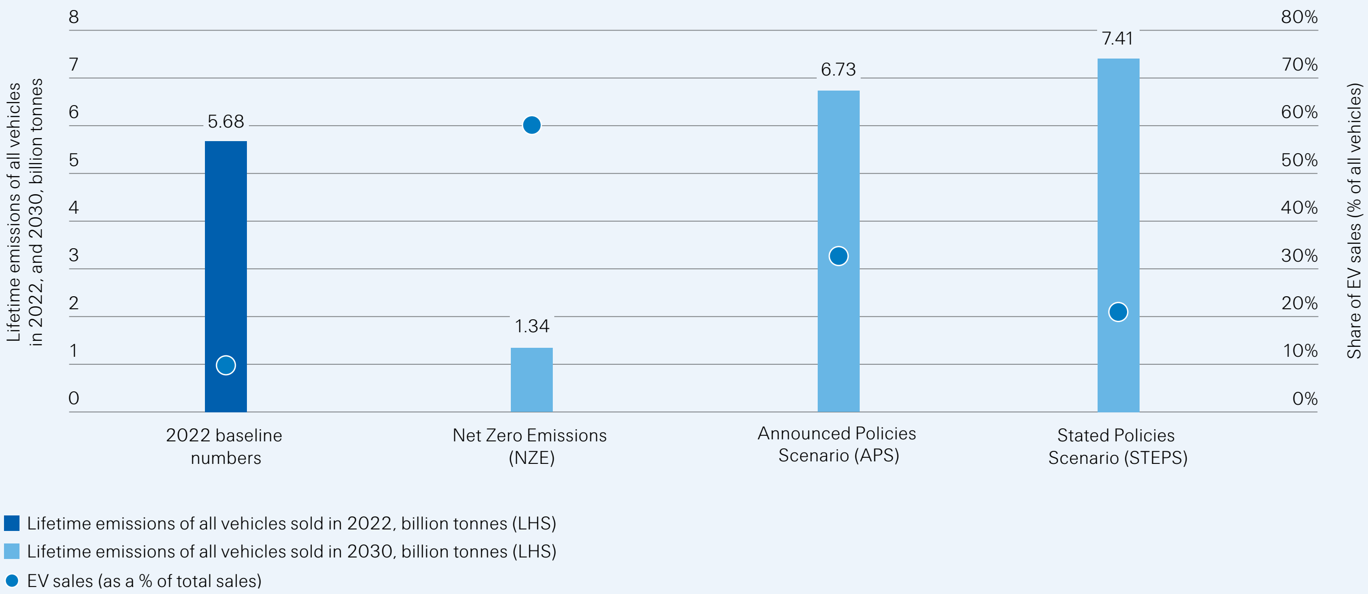
This suggests EV sales have to increase significantly to achieve a meaningful reduction in total emissions. The current stock of EVs represents only 1.4% of the total global vehicle fleet. IEA predicts that EVs will make up more than 30% of global new sales of cars, buses and trucks by 2030 (much nearer a STEPS than a NZE scenario). Legislative initiatives, such as the ban on ICE sales in California by 2035[5], may add impetus to global EV sales. This rapid shift poses new challenges to insurers in ascertaining how EVs will affect risks along the value chain, including motor, liability and property risks.

Bumps in the road: Risks of EV roll-out

The risk landscape around the EV value chain is complex. Replacing ICEs with EVs affects the entire automotive cradle-to-cradle value chain. The transition to EVs precedes changes in driving behaviour and usage profile (eg, range anxiety, concerns about battery health and lifetime). New and unknown risks could arise during EV construction, distribution and ultimately disposal, including: i) the rushed

Figure 1

Lifetime CO_2 emissions from cars sold in 2030 under different energy scenarios

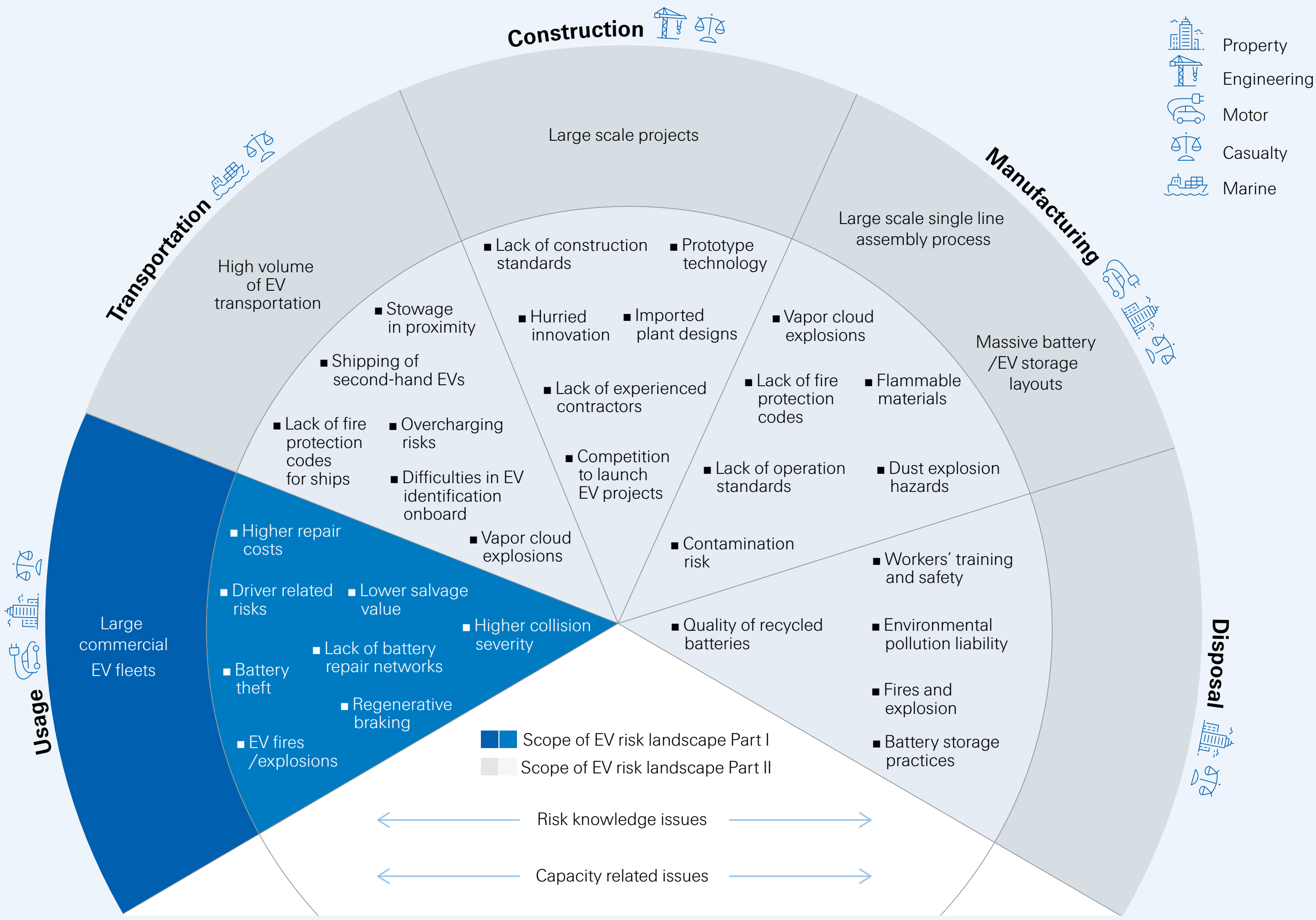


Source: Swiss Re Institute, International Energy Agency

[1] *EMIT database, Sustainability Insights*, McKinsey, September 2021.
[2] *Global EV Outlook 2022*, International Energy Agency. May 2022.
[3] The NZE scenario sets out a narrow pathway to achieve net zero CO_2 emissions by 2050. The APS scenario assumes that all climate commitments made by governments are met. The STEPS scenario reflects current policy settings based on a sector-by-sector assessment of specific policies that are in place; Please see "Understanding WEO Scenarios",*iea.org*, 2021.
[4] Please refer Appendix I for detailed methodology
[5] D. Anguiano, "California bans sales of new gasoline-powered vehicles by 2035 in milestone step", *The Guardian*, 25 August 2022.

construction of manufacturing facilities to meet growth ambitions; ii) assembly, transportation and usage of vehicles; and iii) disposal and recycling of old batteries. Each activity carries distinct risk vulnerabilities and insurers will need to develop a deeper understanding of processes to underwrite these effectively. In terms of usage, telematics driving data from connected EVs is enabling the creation of new insurance tools. Figure 2 illustrates this complexity across insurance lines of business and the EV value chain. As expected sales ramp up, it is essential for insurers to take a first-mover approach and set new standards in assessing the risks of EVs.

Figure 2
EV risk radar across production value chain



Source: Swiss Re Institute
Note: The diagram is purely illustrative. Placement of risk drivers in different phases does not necessarily indicate their relative importance.

We have structured the risks along the EV value chain into two broad sections. This report focuses on the major risks faced on the demand side of the equation – the usage and repair of EVs. A subsequent publication will discuss the risks faced along the EV supply chain, including construction, manufacturing, transportation and disposal phases of EVs.

Unique risks to EVs during usage and repair

Key takeaway: EVs have many distinct properties from ICEs. Features such as greater curb weight, lower noise, instant torque and use of rare materials can all complicate insurance claims. Collision severity (own as well as third party) could be higher in EV accidents compared to ICEs, particularly because of weight disparity. Installation and operational risks accompany EV infrastructure (such as charging points).

EVs have a different consumer risk profile to ICEs. Some distinct EV risks will be transitional and dissipate with experience and technological progress. Others will prove more persistent and require new assessment and mitigation. A range of EV usage and repair risks can be condensed within three categories, as shown in Figure 3.

Figure 3
EV usage and repair risks

Vehicle risks
- Lower noise
- Greater curb weight
- Regenerative breaking
- Abrupt acceleration
- Fire risk
- Battery theft
- High repair costs

Driving risks
- Driver demographics
- Usage profiles

Infrastructure risks
- Installation risks
- Operational risks
- Battery swapping risks
- Cyber risks

Role of insurers
- Risk modelling of electric vehicles
- Supporting decentralized repair networks
- Offer adequate risk covers
- Better risk assessment with telematics data
- Preventive measures- monitoring and supervision
- Mitigation measures- minimizing losses
- Cyber covers and warranties
- Insurance solutions for battery swapping

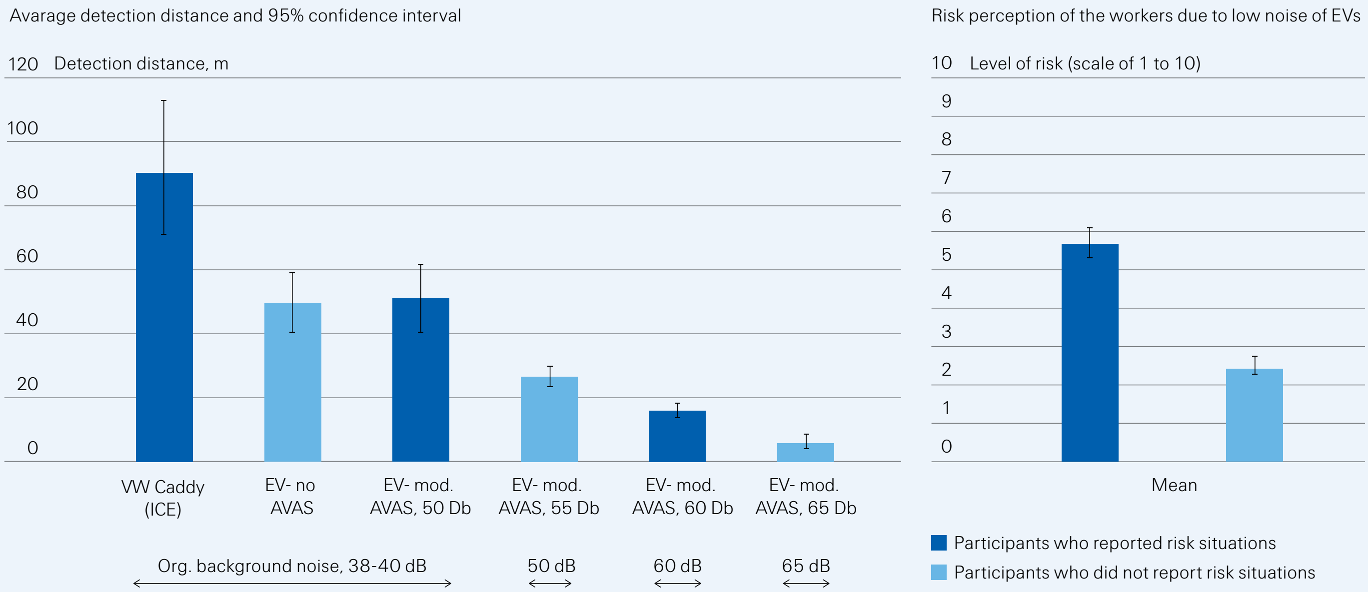
Source: Swiss Re Institute

Vehicle risks

Lower noise level poses new risks to vulnerable road users
Significant noise reduction in EVs may result in driver speed perception being lower than driving an ICE. Pedestrians may not hear an approaching EV. Regulations in some countries now mandate the installation and use of an Acoustic Vehicle Alert System (AVAS) in EVs that alerts pedestrians of low speed EVs. However, AVAS is currently not mandatory in all countries and can be turned off manually in many vehicles. A study found (Figure 4) that even the presence of AVAS may not be a sufficient safety warning in highly congested urban areas where background noise is relatively high (greater than 65 dB).[6] Using an ICE as a control, the study found that the conventional vehicle could be heard and detected when it was at a distance of 90 metres away.[7]

[6] *Adaptive acoustic, vehicle alerting sound, AVAS, for electric vehicles*, SINTEF, 20 February 2019.
[7] In non-congested areas with low background noise

Figure 4
Risk perception by pedestrians and ICE vehicle drivers due to low noise of electric vehicles



Source: "New Risk Situations Related to Low Noise from Electric Vehicles: Perception of Workers as Pedestrians and Other Vehicle Drivers." International journal of environmental research and public health, Sep 2020; Adaptive acoustic vehicle alerting sound, AVAS, for electric vehicles, SINTEF, Feb 2019

Greater curb weight
A 100 kWh battery can add 400–500 kg to an EV, with longer ranges demanding a larger battery. To carry this weight, EV framework and suspension has to scale accordingly. Heavier vehicles have some advantages. A lower centre of gravity may render EVs more stable and less likely to roll in a serious accident. EV passengers will be subsequently better protected during a collision. However, greater weight means higher impact force in collision with other road users. A rising number of casualties and increased claim severity may result from this growing disparity of vehicle weight. Pedestrian fatalities in US accidents were already estimated at a 40 year high in 2021 by the Governors Highway Safety Association, in part because of the greater weight of ICEs in recent decades, with more sports utility vehicles (SUVs) on the road.[8]

Abrupt and rapid acceleration
EVs are capable of very abrupt acceleration from a stationary position compared to ICEs due to instant torque. Hitting the accelerator pedal makes an EV shift from zero revolutions per minute to maximum torque and power instantaneously. These properties may challenge new inexperienced EV drivers. According to an unpublished Swiss Re user survey across new EV owners in the United Kingdom, two thirds of the interviewees claimed that they had to adapt their driving habits when switching to their EV.[9] This increases probability of accidents[10] and collisions resulting in own damage for EVs.[11] It also challenges equipment manufacturers to adapt to new driving styles.[12]

Regenerative braking
Kinetic energy recovery or regenerative braking technology is used in most EVs. When kinetic energy recovery is on, a noticeable drag is reported when the driver releases the accelerator pedal or lightly presses the brake pedal.[13] The intensity of the regenerative brake differs from one EV to another and under different road conditions. As a result, new EV drivers may not have full confidence in the effectiveness of braking. This is particularly true in cases of emergency braking. The deceleration effect of regenerative braking is often insufficient; and drivers tend to ignore or delay pressing the brake pedal due to changes in habits. Data driven evidence in this area is yet to surface, but Swiss Re analysed telematics data of four different EV brands in China and found the highest reported loss ratio associated with the EV brand that had the maximum standard deviation of deceleration (See Box on The Chinese EV experience).[14]

[8] *New Projection: U.S. Pedestrian Fatalities Reach Highest Level in 40 Years*, Governors Highway Safety Association, 19 May 2022.
[9] Swiss Re, Internal Swiss Re mobility survey United Kingdom, 2022.
[10] "Electric cars involved in more accidents than regular vehicles, study shows", *The Brussels Times*, 11 September 2022.
[11] G. Kuntzman, " Crash Test: Electric cars are more dangerous than conventional cars, says global insurance company", Streetsblog NYC, 9 September 2022.
[12] B. Robertson, "EV Drivers Love That Quick Acceleration – And That's Forcing Companies Like Pirelli To Rethink Tire Design", *Forbes*, 27 July 2022.
[13] Based on internal expert opinion
[14] Richard Gu, Mobing Zhuang, *"A comprehensive analysis of New Energy Vehicle risk characteristics"*, Swiss Re, 20 May 2022.

Different fire behaviour for vehicle fires caused by battery malfunctions
There is a perception that EVs may have an increased combustion risk, although early data suggests rather the opposite trend. The National Transportation Safety Board (NTSB) in the US studied the likelihood of vehicles catching fire due to a fatal collision and found a slightly reduced fire risk for battery electric vehicles compared to ICE although the sample size was too small to be statistically significant.[15] According to Thatcham Research in the UK, reports on thermal runaway events in electric vehicles are not increasing, despite the rapidly rising number of EVs on the road.[16]

In addition to the recent progress in battery technology, EV vehicle design now most commonly places the battery pack at the bottom of the vehicle, sealed and cushioned to avoid any battery damage in case of an accident. When a crash is detected, the battery should be disconnected from the power supply. This disconnection should ensure there is no risk of high voltage shocks should the driver have to be rescued.

If an EV does catch fire, the temperature levels and fire intensity are similar to ICE fires. However, extinguishing an EV fire can be more challenging, as the battery may re-ignite over an extended period of time. Moreover, an EV fire can be greater in toxicity. As the majority of EVs are still relatively new and fires involving EVs generally rare, emergency services still lack incident management experience. Whilst guidelines are often in place, first responders struggle with the lack of necessary emergency response information from manufacturers.

Different and potentially more expensive repair and maintenance technologies
Although EVs may require less maintenance compared to ICEs, repairing them could be more expensive. Reasons for this include higher labour costs, not necessarily more hours but more costly labour hours. Repairing EVs needs more scanning and calibration than ICEs, as well as higher utilisation of original equipment parts. A recent study in the U.S. revealed that the average total cost of repair for an EV was 26.6% higher than that of an ICE.[17] Although EV interiors are less complex, their reliance on embedded software and sophisticated advanced driver assistance systems (ADAS) requires more time for fault diagnostics and calibrations. Manufacturers may try to offset battery weight with the use of lightweight materials such as aluminium, ultra-high-strength steel (UHSS), composites and carbon fibre. However, these materials are frequently harder to repair. Four out of five components were more likely to be replaced than repaired for EVs as compared to ICEs in a survey by repair consultancy Mitchell.[18] Many repairs are still directly handled by the original equipment manufacturers (OEMs) instead of independent repair shops. This may change as experience of EV repairs becomes more widespread.

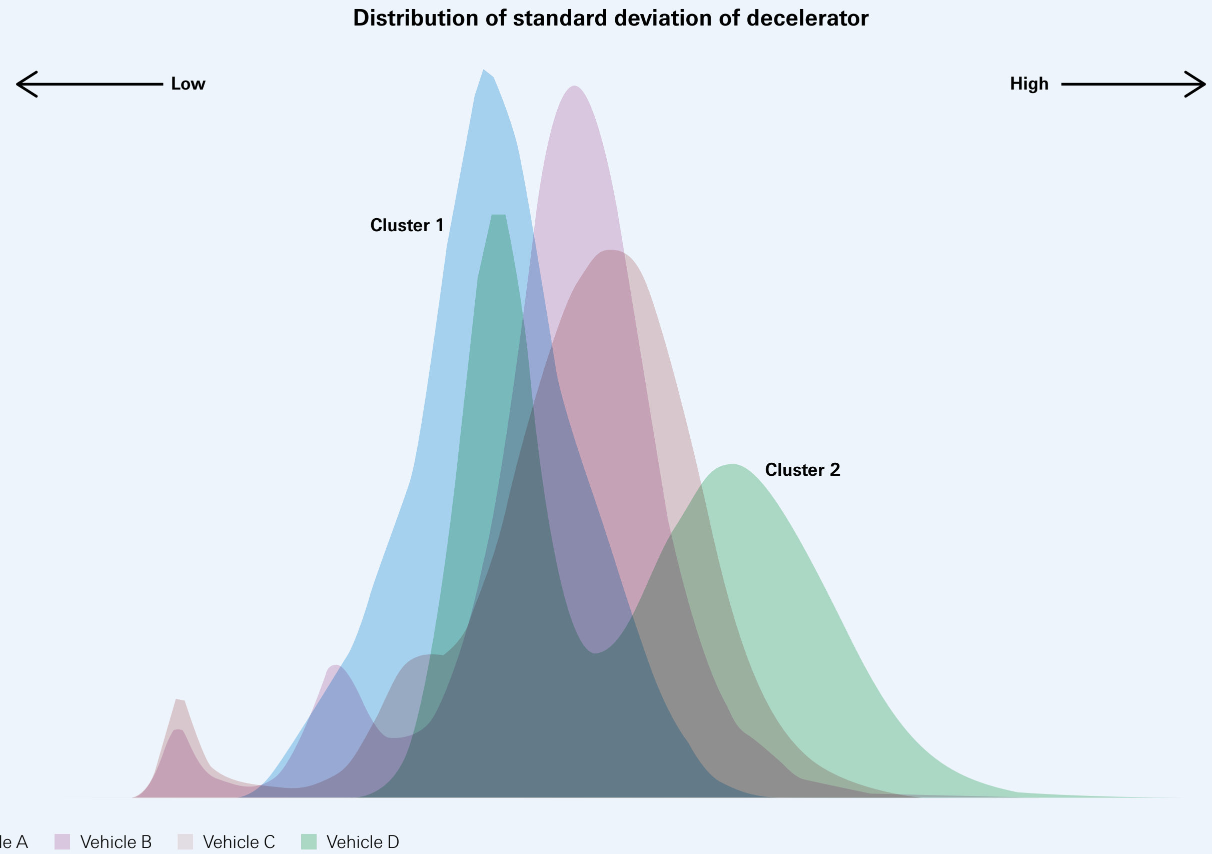
Greater chances of battery theft in two and three wheelers
Markets with a higher prevalence of two and three-wheeler EVs are at greater risk of battery theft. According to reports, around 700 battery packs were stolen in Italy between 2020–21, mostly from electric scooters. The cost of each battery is roughly 1000 Euro.[19] Similarly, consumers are worried about battery theft in two and three-wheelers in India.[20]

[15] *Safety Risks to Emergency Responders from Lithium-Ion Battery Fires in Electric Vehicles,* National Transportation Safety Board, 2020.
[16] N. Winton, "Electric Car Fire Risks Look Exaggerated, But More Data Required For Definitive Verdict", *Forbes,* 2 March 2022.
[17] CCCIS, Electric vs ICE Vehicles: Unpacking Repair Cost Impacts, July 2022. Electric vs ICE Vehicles: Unpacking Repair Cost Impacts | CCC Intelligent Solutions (cccis.com).
[18] Mitchell, EV vs. ICE: The Impact on Collision Repair, 2020. EV vs. ICE: The Impact on Collision Repair | Mitchell.
[19] Hindustan Times, Electric scooters facing battery theft in this country, May 2022. Electric scooters facing battery theft in this country | Electric Vehicles News (hindustantimes.com).
[20] As per internal expert interviews

Higher repair and replacement costs: The Chinese EV experience
To help better understand key trends in EV performance, Swiss Re's Automotive & Mobility Solutions team in China analysed data to investigate the root causes of different vehicle behaviour.[21]

Swiss Re China analysed telematics data of four different EV brands and estimated the instantaneous deceleration of the vehicle in the kinetic energy recovery mode based on the instantaneous power of the drive motor. Figure 5 shows the distribution of standard deviation of estimated deceleration. The order of magnitude is Vehicle A <B <C <D. The analysis revealed that Vehicle D (a popular private passenger EV model) had the widest distribution of standard deviation of deceleration; and also experienced greater loss ratios.[22]

Figure 5
Standard distribution of estimated deceleration for specific vehicles



Source: Swiss Re

The study goes on to examine the cost of motor own damage for different price ranges of EVs in China. The analysis revealed that the average cost of labour in China is about 14% higher for EVs compared to ICE models in the same price range.

Alongside higher labour, repair and replacement costs, EV Unique Components (EUC) are more expensive than comparable ICE requirements.[23] EUCs comprise of power battery, charging and motor systems.

[21] *A comprehensive analysis of New Energy Vehicle risk characteristics*, Swiss Re, May 2022.
[22] Presence of a single major peak for vehicles A, B, and C indicate that drivers of these vehicles have a more clustered breaking pattern, while two major peaks for vehicle D (labelled Cluster 1 and 2) indicate higher variance in breaking, which could hint at aggressive driving behaviour.
[23] EUCs are similar to engines and transmissions in ICE vehicles

Driver risks

Varying usage profiles
EVs are used both in an individual as well as commercial context, each profile with its own set of challenges.

Thanks to government incentives, a large number of EVs are commercial vehicles used as taxis, for ride-hailing or for last-mile deliveries in urban areas. Reports suggest that the commercial EV market is likely to grow at a Compound Annual Growth Rate (CAGR) of 30–35% by 2030.[24] Commercial EVs can travel for around 150–200 miles on a single charge,[25] leading to higher average risk exposures.

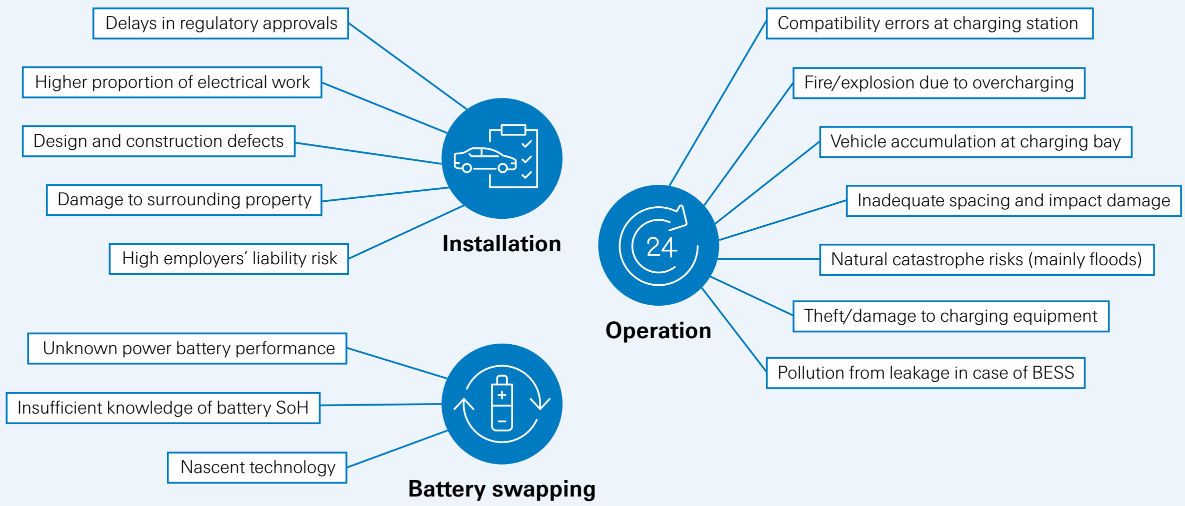
In an individual, non-commercial context, risks associated with EVs are more complex. On one hand, EVs are often used as a second car and/or for daily commutes, resulting in lower mileage compared to ICE vehicles. A research study conducted in the United Kingdom indicates that range anxiety among EV drivers makes them drive more cautiously and reduces the probability of an accident, at least partially.[26,27] On the other hand, EV adoption rates are still higher in urban and suburban areas, with large traffic volumes. As discussed earlier, there are specific risks associated with low noise levels in EVs as compared to ICEs, especially in high traffic scenarios. These may increase the probability of traffic related accidents.

Different driver demographics
The higher cost of EVs could lead to a higher mix of wealthier households among EV owners. This suggests the average driver age will be slightly higher compared to the average ICE driver – although there are exceptions. In China, the average age of EV drivers is younger due to a larger emerging middle class.[28] With falling EV prices and new EV models being made available in all vehicle segments, the mix of EV owners is expected to diversify in the future. In particular, gender disparity in EV ownership is currently disproportionately tilted in favour of men; studies reveal that three of four EV buyers in California, America's biggest EV market, are male.[29]

Charging infrastructure risks

Installation risks of charging infrastructure
EV charging points comprise of multiple non-battery subsystems that include the AC/DC converter, transformers and cooling units. The charging mechanism itself can be of three types- wired, wireless and battery-swaps. Wired charging methods are by far the most common. EV charging infrastructure poses unique risks, especially for commercial fleets where operators may have to construct mass charging points

Figure 6
EV charging infrastructure related risk landscape



Source: Swiss Re Institute[30]

[24] *Electric Commercial Vehicle Market Size*, Strategic Market Research, August 2022.
[25] *Electric Commercial Vehicle Market*, Markets and Markets, May 2022.
[26] N. Hellen, "Range anxiety' drives down e-car accident rates", *The Times*, 19 September 2021.
[27] Vehicle safety could also be technology driven- for example, Bosch's pedal-travel sensor (PDS) records the driver's desired level of breaking and then implements the same electrically or hydraulically.
[28] *A comprehensive analysis of New Energy Vehicle risk characteristics*, Swiss Re, 2022.
[29] M. Meaker, A. Marshall, "EV Makers Think They've Figured Out What Women Want", *Wired*, 26 July 2022.
[30] Note: BESS or Battery Energy Storage System is a type of energy storage device that uses batteries as its underlying storage technology.

at their home site. The presence of charging points may change the nature of risks for parking lots in offices, residential buildings and commercial/retail premises. Moreover, an accumulation of vehicles charging at the same time or waiting in a queue represents substantial fire and explosion risk. These hazards need risk prevention and management measures for both property and liability related losses.

A further pain point around EV charging infrastructure is the lack of standardisation. A wide variety of plugs and plug-in positions limit the accessibility to charging infrastructure.[31] Increasing standardisation could reduce the costs of infrastructure installation. Equipment and cybersecurity certifications could also improve the reliability of public charging infrastructure. Establishing charging networks and guaranteed interoperability across different providers and countries would enable the collection of meaningful data around charging behaviour while improving the user experience through better interoperability.

Operational risks
Third party property damage and bodily injury may be an exposure during the operation of charging stations, where fire/explosion in batteries may also damage surrounding assets, especially in densely populated urban areas. Site selection is extremely important. The presence of combustible materials or critical infrastructure near charging stations should be minimised. Combustibility ratings of walls should be adequate and passive structural barriers should be installed to increase fire resistance to at least an hour.

Battery-swapping
Battery-as-a-service solutions, though nascent, are gaining popularity because they offer convenience and save time. Once the battery charge is nearly exhausted, users can go to swap stations and replace empty batteries with a fully charged battery within a short period of time. Swapping solutions providers, however, face a number of challenges. The performance of the swapped battery is not known to the exchanging party. Insurers can potentially help by splitting the power battery from the whole vehicle and provide battery own damage insurance. State of Health (SoH) can be one of the determining factors for considering battery warranties. Reliable empirical data on SoH and its determinants are scarce, but simulations suggest SoH to be above 80% up till 2 000–2 500 charging cycles. This drops to 60% within 300 charging cycles following the expiration of their designed lifecycle.[32]

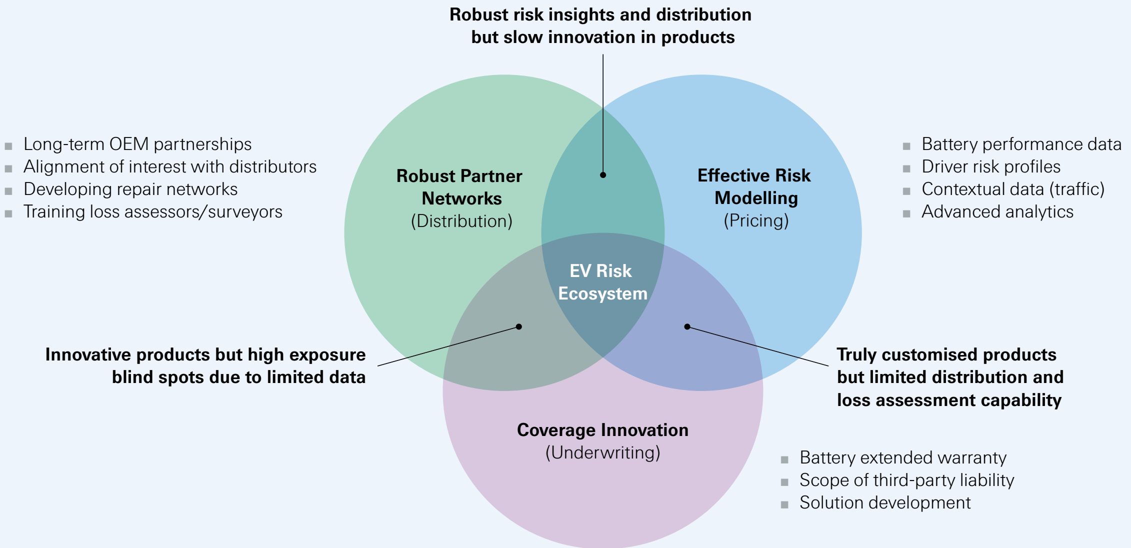
	Swiss Re has developed a number of consumer-end EV solutions to support insurers and mobility players:
	The Swiss Re EV Risk Score supports insurers in pricing EVs and their technical specificities more easily and accurately.
	Swiss Re provides Extended Warranty Insurance (EWI) for batteries and EV equipment (for specific markets).
	Swiss Re EV consultancy helps identify immediate and prospective portfolio risks due to increased electrification.

[31] Models such as Tesla, Nissan Leaf and Mitsubishi Outlander don't work with the standard Level 1 and 2 chargers for EVs (CleanTechnica).
[32] Designed lifecycle is significantly impacted by driving behavior and charging behavior – the figures are based on internal calculations.

Role of insurers

Transition from ICEs to EVs will entail changes across the entire value chain. For the insured (both EV manufacturers as well as end users), sound risk management of exposures will be important; as will supply chain mapping to quickly identify critical material bottlenecks. Insurers will have to invest new resources in data collection, risk research and partnership creation (see Figure 7). This will provide insurers with the opportunity to pivot their risk knowledge and deliver effective risk transfer and services.

Figure 7
Insurance opportunities in the EV risk ecosystem



Source: Swiss Re Institute

Effective risk modelling

Limited data hampers risk assessment of driving EVs compared to ICEs. Insurers can already collect and analyse EV data on their portfolios as a first step towards more effective future risk modelling. With the increasing availability of connected data and cross-testing with claims data, initial models can then be refined over time.

Battery performance data: Development of depreciation scales, excess tables and indemnity values depend on battery performance data, especially for partial losses. However, the risks of battery ageing may take some time to be realised and cannot be priced into current coverage programmes. Dedicated testing facilities can help insurers collect risk and pricing data more quickly. Through battery management systems (BMS) attached to individual batteries, EV original equipment manufacturers (OEMs) also collect battery performance, charging and discharging profiles. Early insurer involvement can enable them to benefit from this data. In return, insurers may be able to close the loop by providing loss data to OEMs.

Vehicle data: With claims experience still limited, insurers need a good understanding of observed differences between ICE and EV risk. Differences in the individual risk performance of the growing number of EV manufacturers are becoming more pronounced with time. Data collected for pricing ICE models may currently be insufficient for an accurate assessment of EV risk. For example, engine power is a typical rating parameter for ICEs; more suitable risk data points for EVs may be acceleration capacity or gross weight. Granular vehicle data will enhance basic vehicle information in risk evaluations. Finally, EVs are often equipped with new technologies not used in ICEs and with which experience is limited. EV risks will be reduced with a stronger emphasis on EV-protocol specific vehicle testing.

Driving profiles: Motor insurance is typically priced on a combination of driver data, such as age or historical loss experience; and basic vehicle parameters, such as their price or engine power. A more dynamic risk picture can be gained using telematics data, capturing both driver behaviour and driving context. Transition changes in behaviour by new EV drivers can be monitored and coverages adapted. Telematics applications can incentivise better driving behaviour and coach new EV drivers.

Coverage innovation

Insurers must update traditional vehicle wordings to capture EV risk. Coverage, rate and liability clauses need to be adapted to cover battery safety and degradation. Unlike ICEs, EV after-sales services are not so widespread. Insurers require more specialised EV capabilities in underwriting and loss adjusting practices. New technologies and usage scenarios, such as battery swap programmes and charging stations, have led to an increasing demand in insurance coverages within the overall EV ecosystem. Bespoke clauses are urgently required to cover EV specific design, risk assessment and claims management.

Changes in wording: Policies covering EVs may require changes in wording for the definition of vehicles, endorsements and scope of cover. New wording may need to amend definitions to include vehicles fully or partially driven by new energy, including purely electric, hybrid (plug-in and extended range) and fuel cell vehicles. Scope of cover for own damage will be the vehicle body, battery and energy storage systems, motor and driving systems, other control systems and manufacturer equipped devices. Third party liability may include liability from "fire or burning" but not necessarily "rescue" and "battery degradation". The definition of "usage" may extend to include parking and charging, in addition to driving and working. New wording may also include depreciation scales adapted for EVs. These scales are needed to create insured declared values (IDVs) for total and constructive total loss.

Battery extended warranty: OEMs provide warranties for battery packs for at least 8 years or 100 000 miles (whichever happens earlier). Battery warranties not only cover complete failure of the batteries but also guarantee repair or replacement if the battery experiences serious degradation. Together with the OEMs, insurers can develop extended warranties for specific use cases where the standard warranty is considered insufficient. One example could be commercial fleets with high exposure which quickly run over the mileage limit of standard battery warranties. However, as EVs are still a relatively recent phenomenon, the long time series data required for accurately modelling and predicting degradation and deterioration of battery performance is still limited. Collaborations with OEMs or battery manufacturers and battery researchers can close the gaps in understanding battery performance and reduce uncertainty on the long tail consequences of extended warranty insurance.

Robust Partner Networks

Collaboration models should be built on long-term partnerships based on mutual trust regarding data and revenue sharing, rather than short term tactical considerations. The right partnership approach will gain even more relevance with the entry of new partners, such as battery manufacturers and analytics vendors, focussing on battery research.

Long-term OEM and industry partnerships: EVs do not have established battery performance and depreciation schedules, which account for up to 40% of cost of vehicles. Long-term partnerships with OEMs can help insurers understand the dynamics of EV propulsion technology and create the property, business interruption and marine coverage most suitable for such vehicles. Customisation can apply to multiple OEMs as well as multiple vehicle models offered by a single OEM. Insurers can also be part of projects and initiatives working on finding permanent solutions to extinguishing EV fires (including thermal runaway).

Developing repair networks: Not all garages are authorised to undertake EV repairs, as they require specialized professionals. Most EV drivers use an OEM's networked garages for maintenance and repair. Due to the absence of oil, filter or exhaust systems and other ICE-specific engine components, EVs generally require lower maintenance and care. However, with the higher price tags often associated with network garages, EV drivers may seek to avoid their services unless strictly necessary, putting off routine servicing such as changing tyres. Establishing insurance backed independent franchises with capacity for minor repairs and maintenance works of EVs can save costs and avoid delays in servicing.

Training loss assessors/surveyors: Motor surveyors and loss assessors are the eyes of insurers and play an important role in underwriting and claims settlement functions. With the increasing number of EVs, both in-house and out-sourced surveyors may need considerable training to assess EV damages. Historically, automotive technical experts have carried out this task, but the skillset may change with more demand for electronics and electrical experts. Specifically, understanding thermal runaway losses requires deep insight into battery operation and repair dynamics. Insurers will need to work with OEMs and data vendors to develop a curated curriculum for loss assessment.

Conclusion

More than a fifth of total CO_2 emissions currently come from the transport sector. EVs offer an opportunity to significantly lower these emissions. However, there are hurdles to EV adoption. Some of these challenges are customer facing (such as range anxiety, inadequate charging infrastructure, heavier vehicles); while others are production related (availability of materials, quality control, unknowns of battery or vehicle degradation). The question is whether insurers are ready to face these challenges and create EV-specific risk coverage products.

In this publication, we have guided the reader through a forward-looking and holistic view of EV ecosystem risk, focusing on the vehicle use phase. The EV industry is evolving. Traditional vehicle insurance models are no longer enough to accurately capture the overall risk. We need risk models that can focus on the particularities of EVs; of the driving experience of an EV; unique features of an EV; as well as repair and maintenance challenges. Ultimately, it is about finding the sweet spot where environmentally friendly modes of transport (with a low carbon footprint across the value chain of production, use and disposal) meet financial viability for all ecosystem players (OEMs, insurance and service providers). Advancements in technology and the use of data as well as innovative insurance solutions will play a central role in the journey to arriving at the optimum balance.

In Part II of the EV risk radar, we will explore in detail the unique challenges facing EVs in the construction, manufacturing, transportation and disposal phases of the value chain.

Appendix

Calculating lifetime CO_2 emissions from cars sold in 2030 under different WEO scenarios

- The World Energy Outlook (WEO) models different scenarios to examine future energy trends. The Net Zero Emissions by 2050 Scenario (NZE) assumes an emissions trajectory consistent with limiting the global temperature rise to 1.5 °C without a temperature overshoot (with a 50% probability). The Announced Pledges Scenario (APS) and the Stated Policies Scenario (STEPS) are exploratory in nature, defining a set of starting conditions, such as policies and targets
- For each of the three scenarios, IEA calculates what the EV: ICE ratio could look like in 2030. Under NZE, APS and STEPS, 2030 sale of electric cars would constitute 60.9%, 34% and 22% of the total fleet respectively. We use 2022 actual EV sales share data from IEA
- We obtain the break-up of petrol and diesel ICEs (2022 and 2030) from Boston Consulting Group (BCG) analysis[33]
- For each of the four car types used in the analysis- conventional-petrol, conventional-diesel, hybrid electric vehicle and battery electric vehicle, we further break down our analysis to look at car segments within each- compact, medium-sized, SUV and commercial cars
- Transport & Environment has developed a tool to calculate tonnes of CO_2 emitted during the lifetime of a car (battery and vehicle production, use phase and recycling) by car type and segment[34]
- We use this tool and our estimates for cars sold in 2030 (by car type and segment) to arrive at the total lifetime emissions of cars sold in 2030 vs. 2022. Since the number of cars sold in 2030 will be far more as compared to 2022[35], a rise in the share of EVs in total sales alone will not guarantee a reduction of total emissions. Our analysis reveals that countries will have to stay true to the path of NZE by 2050 in order to attain significant overall reductions in emissions from mobility

Segment and type		**Lifetime carbon-dioxide emissions (in billion tonnes)**			
		2022	**2030 (NZE)**	**2030 (APS)**	**2030 (STEPS)**
Conventional petrol	Compact	0.38	0.09	0.40	0.47
	Medium size	0.62	0.14	0.67	0.79
	SUV	2.07	0.48	2.26	2.64
	Commercial	1.87	0.44	2.06	2.42
	Total conventional (petrol)	**4.93**	**1.14**	**5.39**	**6.32**
Conventional diesel	Compact	0.04	0.00	0.03	0.04
	Medium size	0.07	0.00	0.06	0.07
	SUV	0.22	0.01	0.18	0.21
	Commercial	0.20	0.01	0.16	0.19
	Total conventional (diesel)	**0.53**	**0.03**	**0.43**	**0.51**
Total conventional		**5.46**	**1.17**	**5.83**	**6.83**
PHEV	Compact	0.01	0.01	0.03	0.02
	Medium size	0.02	0.01	0.06	0.04
	SUV	0.05	0.04	0.19	0.12
	Commercial	0.05	0.03	0.17	0.11
	Total PHEV	**0.12**	**0.08**	**0.46**	**0.29**
BEV	Compact	0.01	0.01	0.04	0.03
	Medium size	0.01	0.01	0.07	0.04
	SUV	0.04	0.04	0.19	0.12
	Commercial	0.03	0.03	0.14	0.09
	Total BEV	**0.10**	**0.08**	**0.45**	**0.29**
Total electric cars		**0.22**	**0.17**	**0.90**	**0.58**
Total cars		**5.68**	**1.34**	**6.73**	**7.41**

[33] Xavier Mosquet, Aakash Arora, Alex Xie, Matt Renner, *"Who Will Drive Electric Cars to the Tipping Point?"*, BCG, 2 January 2020.
[34] Yoann Gimbert, *"How clean are electric cars?"*, Transport & Environment, 30 May 2022.
[35] According to IEA forecasts.

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