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THE SILVER INSTITUTE

Market Trend Report

SILVER'S GROWING ROLE IN THE AUTOMOTIVE INDUSTRY

JANUARY 2021

CONDUCTED BY:
METALS FOCUS

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Chapter 1

Summary

- Average silver loadings, in each internal combustion engine (ICE) light vehicle, is estimated at 0.5-0.9 ounces (15-28 grams).
- Growing ICE powertrain electrification has underpinned the increasing use of silver globally in the automotive industry.
- The gradual transition to electric vehicles, and much further ahead, autonomous driving, will each benefit silver automotive offtake.

Introduction & Summary

The use of silver in the automotive industry is an area of demand that has gone almost unnoticed until quite recently. However, silver has played a role in the automotive sector going back many decades. At that time, it was quite restricted (as we explain below), but what comes through in our research is how silver bearing components have become woven into an increasingly diverse range of applications in light vehicles. This in turn reflects two key characteristics of silver, its unique properties of having the highest thermal and electrical conductivity of any metal and its widespread availability.

Another key factor behind silver's growing use in this segment lies in the relatively modest amounts of silver used in each car. While highly variable across different vehicle types and markets, our research suggests a range of 0.5 to 0.9 ounces (15-28 grams) is consumed in one internal combustion engine (ICE) vehicle, with higher loadings estimated for hybrid and then electric cars. Even so this may sound extremely modest, but it is worth noting that in 2021 global light vehicle (LV) production is expected to be around 85m units (source: LMC Automotive). (While this report focuses on LVs, it is important to acknowledge the use of silver components in both motorcycles and heavy duty vehicles, although in each segment silver loadings will be far lower than in LVs.) This in turn suggests that silver auto demand this year will be in the region of 61Moz (1,900t). To offer some perspective, this compares with the forecast 98Moz (3,000t) of silver that Metals Focus expects to be consumed in the photovoltaic industry in 2021.

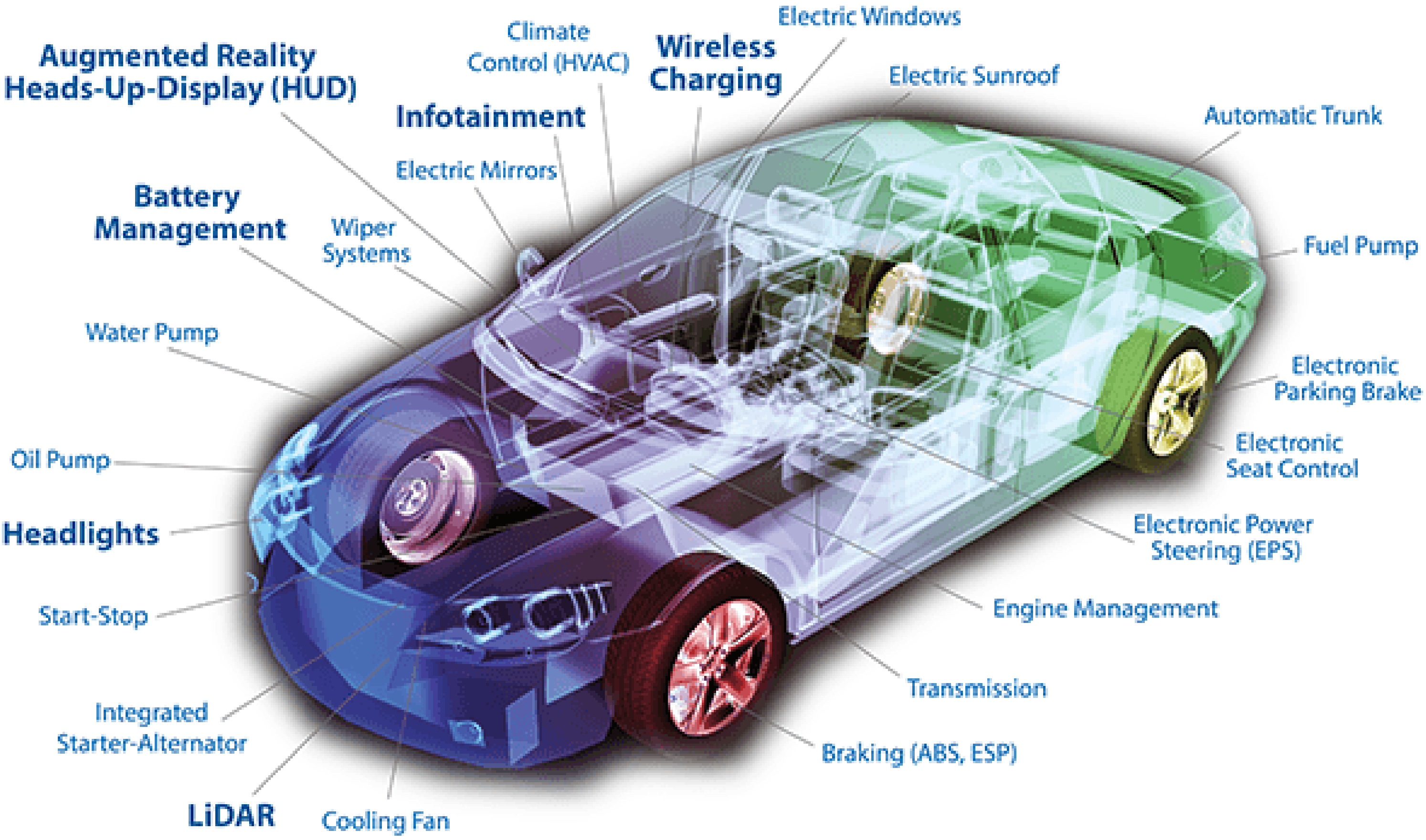
It is important to note that these figures are estimates. This is highlighted by the wide range of suggested loadings per vehicle offered by our contacts in industrial silver. This, in the main, flows through from the fact that industrial fabricators producing a silver bearing component may not know the final end-use for that device as there are typically several tiers of companies between them and the final automotive original equipment manufacturer (OEM). As such, the above forecast total of 61Moz (1,900t) for 2021 may be a conservative total. Looking further ahead, this total could approach 88Moz (2,700t) by 2025. Furthermore, Metals Focus will continue to research this market segment and so it is quite likely that our views on average silver loadings and our estimates for global automotive silver demand total will be revised going forward.

Silver's unique properties make it essential and hard to replace across a wide and growing array of automotive applications, many of those being critical in terms of safety and ever increasing environmental pressures. Performance therefore, is absolutely key. Furthermore, unlike platinum group metals (PGMs), OEMs rarely focus on silver because it is abundantly available and its use is not concentrated in a single, legally required component like a catalytic converter. However, that does not mean that cost pressures do not exist. Suppliers of electronics to auto OEMs will face this constantly and will push back along the supply chain. And in the search for economies, silver will eventually come under scrutiny along with all other metals, even though silver is unlikely to ever be a specific target of OEMs.

As a result, the focus tends to be on ensuring that an appropriate amount of silver is used to deliver the required performance of each electrical or electronic component. In our view, therefore silver's properties, and its ability to perform in critical applications, is the first of four key elements, which is important in helping to boost silver auto demand. The second key element relates to the growing use of automotive applications that require silver (such as reversing cameras or more precise engine and fuel management) and, related to this, the fact that many of these end-uses can be found in mass market, rather than just luxury, models. This helps explain why we frequently see the growth in silver auto demand outpace gains in vehicle production.

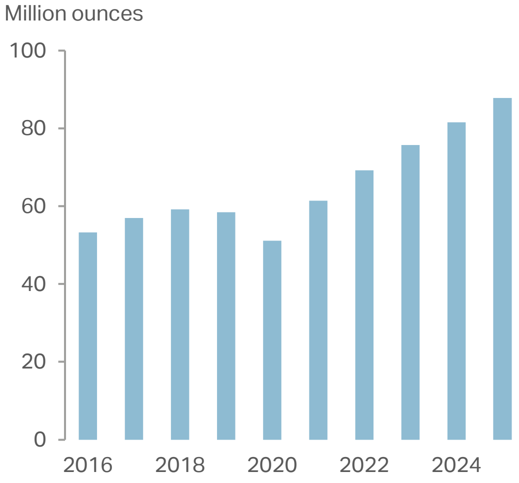
The third point relates to the changing nature of the vehicle fleet as the drive towards vehicle electrification, in the face of the climate crisis and the urgent need to cut CO_2 emissions. For example, at least 15 countries

Selected Automotive Electrical & Electronic Components & Applications



Source: WTWH Media, www.eeworldonline.com/components-corner-gas-or-gauss/

Silver Automotive Demand



Source: Metals Focus

have announced timelines to ban new ICE sales. Furthermore, while the VW emissions scandal in 2015 (which began in the US) may have kick-started the drive to electrification, further impetus is likely to come from the world's post-COVID recovery measures and the US returning to the Paris Agreement (a legally binding international treaty on climate change) which is again set to play a role in the war against climate change.

Hybrid and EVs sales are symptomatic of this impetus. Last year, hybrid vehicle sales accounted for an estimated 8% of global light vehicle production, compared with barely 1% in 2010. The next stage (in the context of the vehicle fleet) relates to the growth in battery electric vehicles (BEVs). As we explain below, these accounted for less than 3% in 2020 of total production, but the increasing commitment of countries to promoting BEVs will have a net positive effect on silver demand, taking into account the expected drop in internal combustion engine (ICE) sales. By 2025, global BEV output could account for around 9% of global light vehicle production. Beyond this, there is the prospect of autonomous driving. This should be net positive for silver offtake.

The final element, concerns the growth in ancillary silver demand. This covers a range of supporting infrastructure, such as roadside and domestic charging stations, additional electrical power generation and distribution and induction charging. To put this into perspective, according to IDTechEx (a consultancy that specializes in emerging technology), by 2029, there will be 10m public charges and 50m private charging points. Looking further ahead, the infrastructure needed for artificial intelligence (AI) and the internet-of-things (IoT) will also be supportive of higher silver industrial demand.

Against this backdrop, the Silver Institute commissioned Metals Focus to assess more closely where silver is used across the automotive industry as part of their Silver Market Trends series. The following therefore first looks at some of the key trends and the outlook for global vehicle production. We then describe how the use of silver in the auto sector has developed and the main applications that consume silver. The analysis focuses on ICE models, given their ongoing dominance of global auto output, but consideration is also given for BEVs as they gain in popularity. Related to this, we also draw attention to the BEV initiatives being introduced in key jurisdictions, which should help accelerate their take-up. Finally, as touched on above, we detail the importance to silver industrial demand of various ancillary uses, particularly in the context of growing BEV production, and also as AI technologies are gradually developed.

Chapter 2

– Global vehicle production is set to rise from a pandemic affected 74m units in 2020 to almost 100m by 2025.

– Internal combustion engine (ICE) powertrains will see their market share drop from around 90% last year to around 70% in five years' time.

– Battery electric vehicles (BEVs) will enjoy strong gains, albeit from a very low base as an increasing number of governments introduce supportive polices and incentives.

Automotive Production & BEV Policies

Light duty powertrain electrification – laggard to warp speed

In line with policy commitments made over the past decade the development of the automotive industry embarked on a gradual transition from combustion engine powertrains to electric powertrains. During the first half of the past decade adoption progressed at a glacial pace, with a limited range of electrified powertrains available.

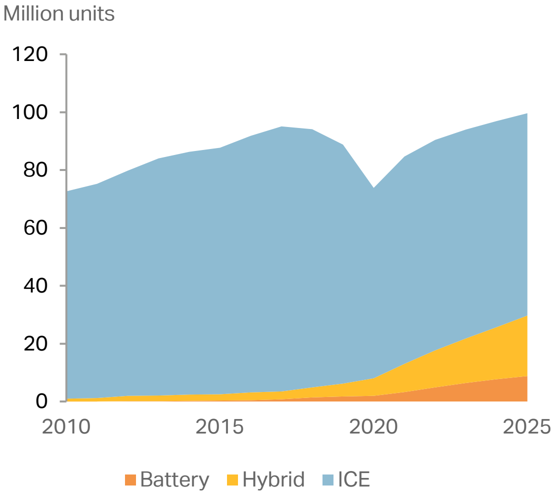
The pace of transformation, however, picked up rapidly mid-decade, with the share of pure battery and hybrid electric vehicle increasing to around 4% in 2017. This followed the VW diesel scandal in 2015, the signing of the Paris Agreement in 2015 and the introduction of new emissions compliance testing and regulation favoring electric vehicles. Despite marked growth, the latter half of the decade was characterized by a limited range of powertrain types and models, as well as unsynchronized regional developments across the globe.

Taking a closer look at specific regional progress, Japan took the early lead in powertrain electrification, with over 80% of global hybrid cars produced in Japan in 2010. Last year, the share of hybrid vehicles in Japan is estimated to have exceeded 20% of the country's light vehicle output, and is forecast to surpass 30% by 2030.

The COVID-19 pandemic appears to be a key trigger for growth in electrified powertrains in Europe and China. In other words, during 2020, authorities in these locations published details of additional government incentives, commitments towards decarbonization, ever tightening emission regulation and the acknowledgment of the need for more sustainable mobility. In other words, without the pandemic, e-vehicle incentives would have been far more modest. Last year, hybrids accounted for some 14% of European light vehicle production, while the share in China was just 3%. Looking ahead five years, these shares should improve, to around 40% and 8% respectively. In addition, both China and Europe will see battery electric vehicle (BEV) production grow from last year's 4% share in each market to 15% and 12% respectively.

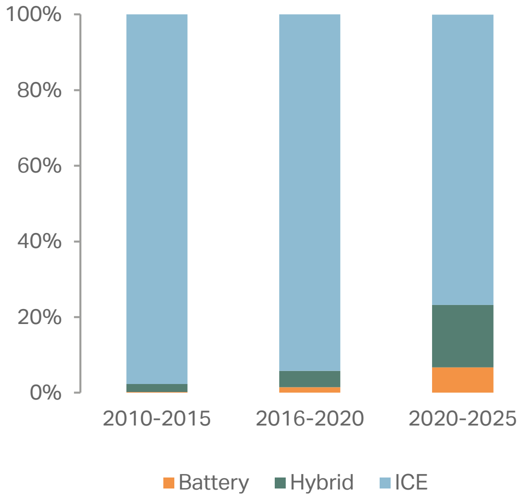
In contrast, the pandemic appeared to have had the opposite effect on the US market. The low fuel costs (due to weak oil prices), the long distances driven by many Americans (which are currently less suited to BEVs), combined with delays in electric vehicle model launches, and the (now seemingly temporary) withdrawal of the US in 2017 from the Paris Agreement (effective in November 2020) will see the adoption of hybrid and electric vehicles in the US continue to underperform other markets initially, especially in respect of pure battery vehicles which is forecast to comprise only 8% of US vehicle production by 2025. Interestingly, hybrids' share of US output will rise from around 6% last year to a forecast 18% in five years'

Powertrain* Transition



Source: LMC Automotive Ltd
* based on where the powertrain is manufactured, rather than where the unit is finally sold; includes FCEV, although not visible in the chart.

Powertrain Transition



Source: LMC Automotive Ltd
Includes FCEV although not visible in the chart

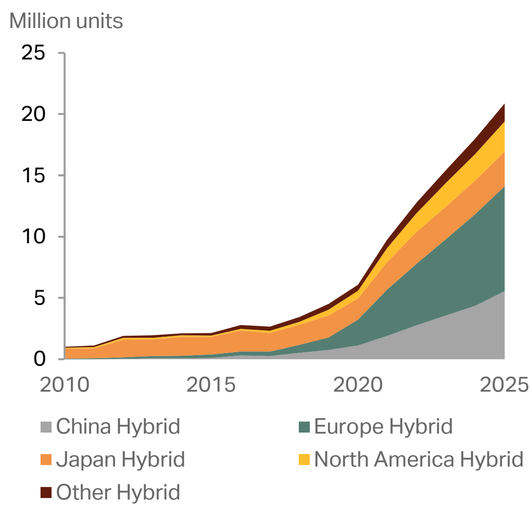
time. Despite the internal combustion engine (ICE) remaining the dominant powertrain over the forecast period, its share will drop by 20% compared to the start of the previous decade.

During the first half of the previous decade, the range of electrified vehicles were limited and dominated by battery electric vehicles (BEV), Full Hybrid Electric Vehicles (FHEV) and Mild Hybrid Electric Vehicles (MHEV). However, since 2018 with the introduction of the MHEV (48V) and wider adoption of Plug in Hybrid Electric Vehicles, the range and mix of electric vehicles have increased significantly as have the selection of brands, especially the MHEV (48 Volt) category which will dominate the electric powertrain landscape over the forecast period. As such, there has been a sea change in the desirability of BEVs. Initially, availability was restricted to small cars, but Tesla made them desirable and, in some ways, better than ICE equivalents.

MHEV technology offers greater efficiency and lower running costs compared to ICE. In addition to the increased variety of electric and hybrid vehicles there is also a variance in global vehicle size of vehicles when compared to that of internal combustion engines. Only 1-2% of hybrid vehicles are entry level models, while 5-8% of all ICE cars produced will be entry level vehicles.

In conclusion, while in the previous decade, the focus was on the relatively slow development and adaptation of hybrid and electric vehicles to accommodate the wide range of consumer preferences and regulatory requirements, the next decade will see their rapid deployment and large scale adoption.

Hybridization*



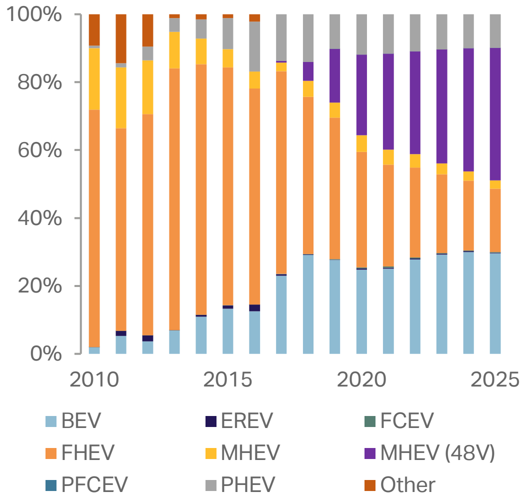
* based on where the powertrain is manufactured, rather than where the unit is finally sold.
Source: LMC Automotive Ltd

Transportation policies paving the road to electrification

For the past decade the importance of shifting from a carbon fueled global economy towards an alternatively powered society has made gradual progress driven by a handful of policy makers and attracting moderate interest. The COVID-19 pandemic may have been a tipping point towards accelerating a transition away from a fossil fuel based existence. The transport industry has been severely impacted by the pandemic, leading to large scale revenue and job losses. The pandemic has also underlined the importance of mobility of people and goods for economic health and global prosperity. To this end, many countries, with economies both large and small, have reviewed and revised transformational policies in a bid to address climate change and revive economic health. In this section though, we focus on Europe, China, Japan and the US.

Looking at **Europe** first, the EU member states' journey towards transport electrification was formalized with the release of the white paper "Roadmap to a Single European Transport Area" in 2011. However, as touched on above, the VW emissions scandal had a massive bearing on the move towards electrification (far more so than the 2011 roadmap). The fall-out from the VW debacle had a palpable effect on the European diesel market (and

Composition of xEV* Sales



*combining hybrid and electric vehicles
Source: LMC Automotive Ltd

elsewhere), which until then had been central to the CO_2 and fuel economy plans of OEMs in the EU. Faced with massive penalties looming for CO_2 emissions and diesel no longer part of the solution, the industry started to become more receptive towards electrification. Over the past decade there have been incremental shifts towards vehicle electrification, but the approval on January 15th, 2020 of "The European Green Deal", a set of policy initiatives towards carbon neutrality, has set the course for fundamental transformation. Emanating from the European Green Deal was the "Sustainable and Smart Mobility Strategy" action plan which was released on December 9th 2020. This expresses the vision to have at least 30m zero-emission vehicles in operation on European roads by 2030, relative to 313m light vehicles on the road in the EU as of 2019.

Similarly, during late 2020 **China's** State Council released and updated several documents outlining their commitment towards the production and deployment of new energy vehicles at scale. These included: the 14th Five-Year Plan; the "2021-2035 New Energy Vehicle Industry Development Plan" and, finally, the "Technology Roadmap 2.0". These were all released in quick succession, building on each in increasing detail and decisive targets. That said, it is worth noting that China is already the world's largest producer of BEVs, a position it is forecast to build on in the coming years. The Technology Roadmap 2.0 indicates that by 2025 new energy vehicles will make up 20% of sales and 50% by 2035. Within this category it envisages that electric vehicles will account for 95% of the total, with fuel cell and hybrid vehicles making up the difference. Digitalization and autonomous vehicles will also receive a strong focus during this time.

After the 2015 Paris Agreement to work towards net zero carbon emissions by 2050, **Japan** began a series of consultations which led to the creation of a new body called the "Council for Promoting Society Utilization of Electrified Vehicles" to advance dissemination of hybrid and electric vehicles (xEVs). The body is a collaboration between vehicle manufacturers, energy companies and national and local governments to promote the acquisition and use of xEVs. The targets captured in the Next Generation Automobile Strategy of 2010, compiled by the Industrial Society for Next Generation Vehicles, has remained unchanged. The targets outlined for xEVs comprise 30-40% HEVs, 20-30% BEVs and up to 3% FCEVs by 2030.

In the **US**, the electrification roadmap was started by former President Obama in the 2011 State of the Union address. He called for one million plug-in electric vehicles to be on the road by 2015, and in March 2012 when he set a target for the US to become the first country to build plug-in electric vehicles affordable for the average US family by 2022. However, the Trump administration was less convinced of the value and benefits of transport electrification and federal incentives for electric passenger vehicles have remained largely unchanged over the past decade. Expectations are that under a Biden administration the transition will gain new momentum. Many state governments, such as California, have already adopted and articulated electrification targets and adopted regulations relating to new energy passenger vehicles.

Chapter 3

- Use of silver bearing components is set to continue rising, across ICE, BEV and, eventually, autonomous driving vehicles.
- The relatively low cost of silver, together with focus on performance and safety, means there is little incentive to substitute or thrift.
- Silver automotive demand is forecast to rise from an estimated 51Moz (1,600t) last year to 88Moz (2,700t) in five years' time.

Silver Automotive Demand

Profile of Silver Automotive Demand

Silver is used extensively in electrical contacts throughout a vehicle's electronic systems, which in turn are mainly used in switches, relays, connectors, breakers and fuses. Silver's widespread use reflects its superior electrical properties, as well as its excellent oxide resistance and durability under harsh operating environments.

- **Switches** provide an on-off mechanism in devices and while copper is also widely used it is quite typical for these to contain silver. Normally, demand is proportional to the required level of electronics functionality. However, the innovation of multi-functional switches, such as those that control indicators, lights and windscreen wipers has reduced demand for switches. Furthermore, the growing preference for touch screen control panels and the possible wider adoption of gesture recognition systems are likely to dampen demand as numerous functions can increasingly be integrated into a central console.

- A **relay** is similar to a switch and is used to control an electronic circuit, by adjusting the current within the operational range. This is a critical component that is used to activate different electronic devices from one central power source.

- Silver **conductive pastes**, or silver-ceramic lines, for automotive glass are designed to defog and defrost vehicle windows. Normally, a silver content of around 60-80% is used in these conductive lines. This is one of the longest established uses of silver in the automotive sector and is understood to be the largest single application using silver in this sector.

- **Circuit-breakers** and **fuses** are components that are used to protect against short circuits, in which the silver is typically plated on the terminal for superior conductivity. Each component is designed to protect circuits in different ways. A fuse will melt when exposed to too much current, while a breaker will be disconnected when the circuit overloads.

- Silver **brazing alloys** are used in welding applications, including in laser brazing to join steel and aluminum to build high-strength and lightweight vehicle bodies. Typically, the brazing filler metals will feature a silver content of around 15%. However, the recent high silver price has encouraged fabricators to introduce alloys with a lower silver content. In the auto market this is a clear, but rare, example of price-driven thrifting.

- The trend towards electrification and digitalization, and therefore higher-end electronics, has a direct impact on electronic control unit (ECU) demand. This in turn has created a challenge to prevent signals generated by internal or external sources, from impacting other electronic devices. As such, electromagnetic interference (EMI) **shielding** is widely used as a barrier to block electromagnetic or radio frequency from interfering with sensitive electronics. Silver is frequently coated on the shielding surface due to the corrosion resistance it exhibits under severe conditions.

- Low-emissivity **glass** is also commonly used in vehicles, where several layers, including that of silver, are coated onto the glass to diminish the transmission of infra-red light. This helps to reduce the need for air-conditioning, as well as lower fuel consumption and carbon emissions.

Application-driven growth for silver in light vehicles

In the initial decades of automotive production, silver's use was relatively limited, being primarily used as connectors for power linkage in batteries, generators and alternators. Silver was also used in switches to control basic electric devices, such as headlights, windshield wipers, heating controls and early electronic systems, chiefly radios. From around the 1960s to the 1980s, vehicle sophistication rose considerably, with the widespread adoption of silver-bearing devices such as air-conditioning units.

Fast forward to the present time, and the rapid development of semi-conductor technologies has revolutionized the industry, with more complex electronics modules being rapidly introduced. The adoption of new technologies toward a safer, and ultimately more enjoyable, driving experience have triggered the implementation of more advanced electronic components and control units in each car.

The increasing use of ECUs in particular is of pivotal importance to silver automotive demand. These are effectively micro-computers, which analyze data, control parameters and operate designated functions in a vehicle. With the rising complexity of control systems, and the increased need for device connectivity, an increasing number of ECUs are now used to control a wide variety of features.

These devices require various contacts, switches, relays and breakers and so underpin much of the growth in automotive silver demand. In addition, the importance of contacts in these devices explains why we believe silver-bearing contacts are the most significant components in a car in the context of silver demand. Although it is extremely difficult to be precise, we believe that, today, a mass market light vehicle may contain around 150-250 electrical contacts. It is important to note that some of these will feature base metals. However, we understand that the majority will be silver-based.

In the following analysis, we have highlighted some of the key ECUs in ICE, BEV and, finally, autonomous driving vehicles. What emerges from this analysis is that, as the industry embraces new technologies and powertrains, silver remains of pivotal importance.

a. For **ICE and hybrid** powertrain control modules, silver membrane switches are used in the engine ignition, while silver bearing contacts are used in various control systems to help the engine operate efficiently.

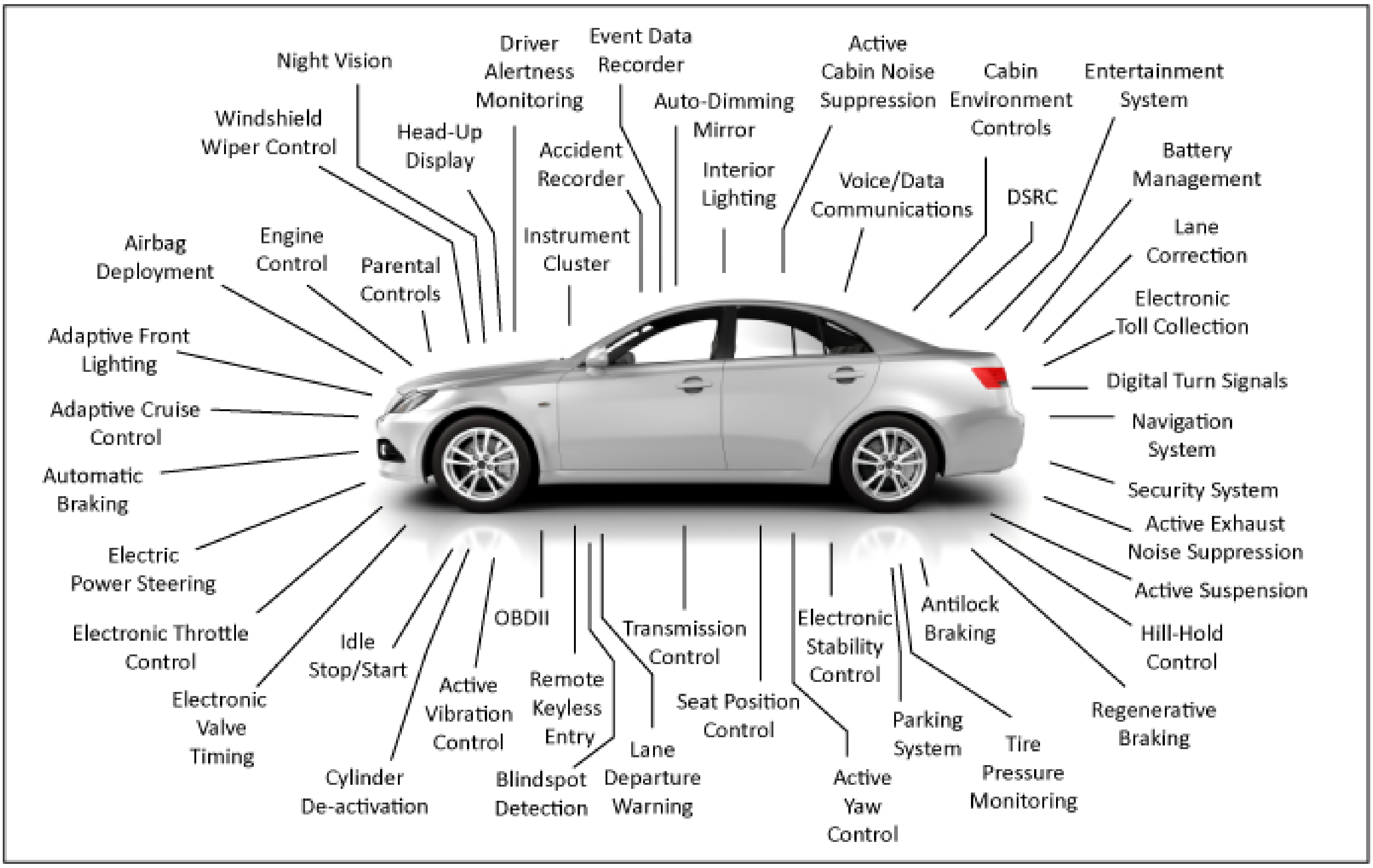
These include EFI (electronic fuel injection), ECU (engine control unit), TCU (transmission control unit), KCS (knock control system), cruise control and cooling systems.

b. As vehicles have developed, so has the focus on safety features, chassis and active/passive safety modules. In this context, each control unit manages a variety of safety functions, including ABS (anti-lock braking systems), TCS (traction control system), airbags and PA (parking assistance). New ECU modules are also becoming more prevalent, such as VSC (vehicle stability control), EBD (electronic brake distribution) to secure the amount of braking power to each wheel and radar/camera warning systems.

c. Staying with ICE and hybrid models, many electronic auxiliary systems are managed by ECUs which are installed to help meet increasingly strict emission regulations. These include exhaust gas recirculation (EGR), diesel exhaust fluid (DEF), and evaporative emission control (EVAP) systems.

d. ECUs are also integral to **BEVs** where the motor is powered by battery packs and a battery management system (BMS), the latter being an example

Selected Automotive Electrical & Electronic Components



Source: The Clemson University Vehicular Electronics Laboratory of an ECU. Silver is largely consumed in the energy management system as the main electrical contact material in the battery packs and in the surrounding control modules.

It is worth noting that the BEV market is seeing automakers consolidate multiple ECUs into a single domain control unit. This saves cost and space, as well as reducing vehicle weight to the benefit of energy consumption. Although this will result in far less demand for multiple ECUs, ever increasing vehicle electrification should see demand for electrical contacts surge to meet the requirement for a broad range of sensors, micro-controllers, and other components across the various control units and subsystems.

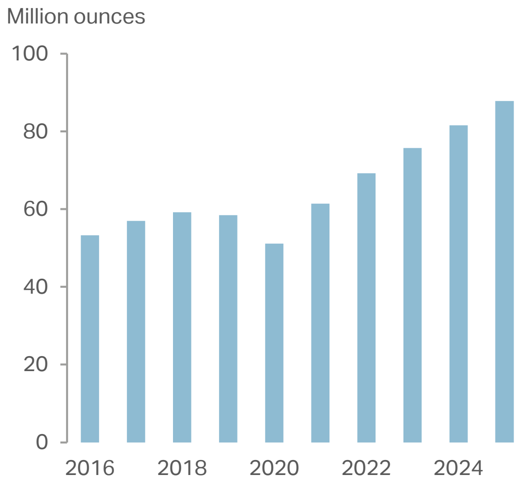
e. **Autonomous driving** is becoming an increasingly exciting area for silver demand. There are six levels of AD, from 0 to 5 (defined by the Society of Automotive Engineers). As we describe below, the development of this technology over the past few years has boosted demand for ECUs and related silver-bearing components.

Level 2 automation is now standard in many light vehicles. This includes advanced driver assistance systems (ADAS) which is one of the fastest growing fields in automotive electronics. Taking a longer-term view, the eventual transition towards level 3 (and above) is expected to boost demand for ECUs to manage a range of functions and related components, including light detection and ranging (LiDAR), cameras, radars and sensors. This will help maximize the amount of driving information that can be extracted to enhance the driver's sight and situational awareness.

Levels of Autonomous Driving

Level 0	No Driving Automation	Manually controlled.	The driver takes care of all driving tasks.
Level 1	Driver Assistance	The vehicle features a single automated system for driver assistance.	The driver must have hands on the wheel, but can share specific control of vehicle feature, such as speed and steering.
Level 2	Partial Automation	The vehicle can perform steering, acceleration and braking, often referred to as "ADAS".	The driver still monitors all tasks and can intervene at any time, often referred to as a "hands-off" state.
Level 3	Conditional Automation	These vehicles have "environmental detection" capabilities and can make informed decisions under ideal conditions albeit with limitations.	The human override is still required, often referred to as an "eyes-off" state.
Level 4	High Automation	These vehicles can operate in self-driving mode under specific circumstances.	Human override is an option, often referred to as "mind-off" state.
Level 5	Full Automation	The vehicle performs all driving tasks under all conditions.	Zero human attention or interaction is required.

Silver Automotive Demand



Source: Metals Focus

f. Staying with autonomous driving (and still focusing on level 3 and beyond), the rapid development of 5G and related applications is accelerating the development of this technology, and also encouraging a greater focus on human machine interfaces (HMI). The control unit for HMIs is required to help bridge communications between people and machine, to achieve full autonomous driving. The emerging needs of advanced HMI functions is seeing an increasing number of internet-of-things (IoT) devices being installed in each vehicle to improve road safety and solve traffic congestion through communication between vehicles and roadside components. We believe that ECUs will be required to integrate vehicle and on-the-road infrastructure (see below under "Ancillary demand" for more on this).

The growing importance to silver demand of ancillary auto services

With the growing penetration of BEVs, the growth in silver demand in ancillary services is becoming increasingly important in the automotive industry. According to our research, charging stations account for the largest portion of silver demand in this broad segment. A charging module is usually composed of switches, transformers, relays and connectors. As mentioned above, most of the contacts in these apparatus are made by silver. As a guide, the International Energy Association (IEA) has recommended an ambitious roadmap, calling for a ratio of 10 EVs to 1 charging connection, which far exceeds the current situation of 30-40 to 1 in those countries which have promoted the adoption of EVs. With the proliferation of government and automotive OEM incentives and subsidies to promote EV sales and expand the required infrastructure, this suggests that the installation of charging modules, including residential chargers and public charging stations, will ramp-up dramatically in the next few years, to the benefit of silver industrial demand.

At present, plug-in models dominate the overall EV charging station market. However, the development of wireless charging could have a pronounced impact on the entire industry. This technology is based on inductive changing, which transfers electricity through magnetic coils. Ideally, the coils can be installed almost anywhere, for example in parking lots or on the road, so vehicles can be charged when moving. Understandably, this offers several advantages over the more traditional plug-in approach, including:

- convenience and efficiency as there is no need to charge at a specific location using a cable
- less need for charging stations
- smaller battery units due to more charging points
- high utilization for autonomous vehicles, with an effectively endless power supply

However, the wireless technology is still some distance from being commercialized. In particular, significant hurdles remain in terms of addressing the efficiency of energy transfer and the huge investment associated with infrastructure, as well as concerns over the health impact.

Irrespective of the use of plug-in or wireless charging, it is expected that demand will grow for a variety of power devices and connectors required for the infrastructure to meet power generation and distribution networks, much of which will support silver fabrication.

Silver loadings and the outlook for automotive silver demand

As discussed earlier in this chapter, average silver loadings have risen in light vehicles (LV) over the past four to five decades, although the growth in the use of silver has been concentrated over the past two decades or so. The flow chart on page 15 summarizes some of the key developments in ICE and other vehicle types over roughly the past 60 years, much of which has impacted silver demand, either directly or indirectly. A prime example of the latter concerns the use of catalytic converters, which required a considerable number of electrical components, such as engine management and emission detection systems, much of which would require silver. In addition, an increasing emphasis on safety and improving the cabin experience have encouraged a greater take-up of electrical and electronic devices. And more recently, the more widespread use of ECUs has helped drive up average silver loadings.

ECUs have already been discussed at length in this chapter. Here, we focus on one issue that is impacting silver demand, the consolidation of ECUs which is a developing trend, both for ICE and BEV models. However, the move away from several ECUs is not straightforward, as it concerns the integration of hardware and software, and also a series of engineering challenges, such as power loadings, cooling design and maintaining reliability across various systems. As such, automakers tend to first add ECUs to meet a designated function instead of immediately combining them into a single domain controller.

Overall though, even with an in-depth understanding of electrical and electronic auto devices there is still considerable uncertainty, across much of the auto supply chain, as to how much silver is consumed in each light vehicle. That said, from our discussions with a range of key participants some observations can be made. Looking first at the ICE market, we would suggest that (very broadly) around 0.5-0.9oz (15-28g) of silver is contained in each light vehicle. As expected, there is a considerable jump to mild-hybrids, and then again to full hybrids. For the latter, our research suggests that silver loadings will be as much as 20-35% higher compared with a mass market ICE model, which would indicate average silver loadings somewhere in the region of 0.6-1.1oz (18-34g) per light vehicle.

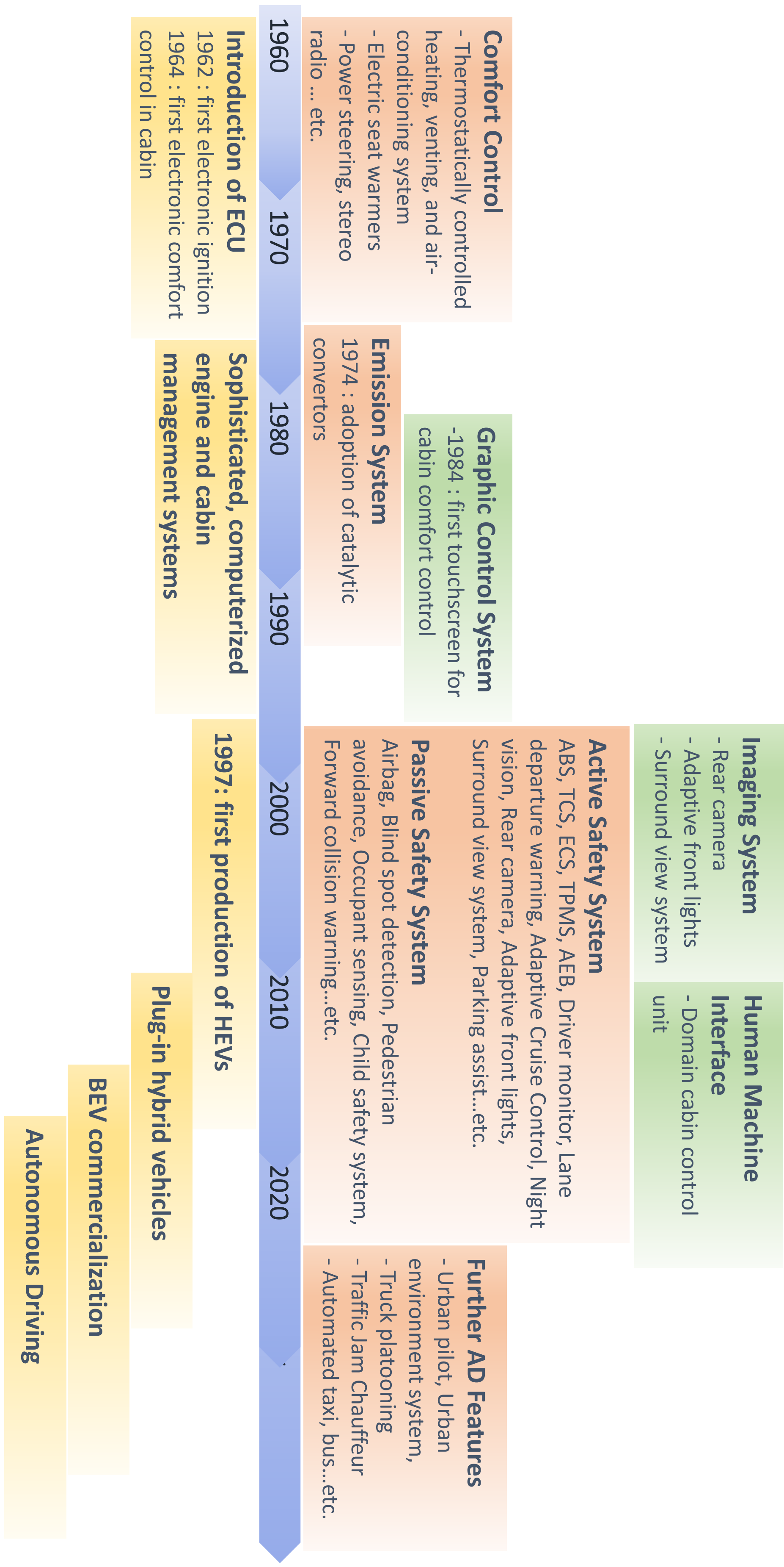
Taking this a stage further, given the electrified nature of BEVs, coupled with the need for extra energy management systems, silver consumption per vehicle is estimated to be 1.6-2.2 times higher compared with ICE vehicles, which suggest loadings in the range of 0.8-1.6oz (25-50g).

Finally, the move to autonomous driving (principally in the context of level 3 described above) will led to a dramatic escalation of system complexity, given the requirement for a greater awareness around the car. We therefore believe that the move from BEVs to AD will be net positive for automotive silver fabrication, especially given the expected jump in demand for control units and IoT devices.

Overall, this all suggests that global silver automotive demand last year was around 50Moz (1,600t), against over 58Moz (1,800t) in 2019 (reflecting short-term COVID damage). It cannot hurt to reiterate that we have received a wide range of estimates of silver loadings per vehicle from our industrial sources and so, to begin with, we have adopted a relatively cautious level for these loadings. As further research is conducted, we may well be obliged to revise these estimates and it would not surprise if they were raised.

Looking ahead, in light of the developments covered in this report, we forecast uninterrupted gains over the next five years, with automotive silver demand by 2025 currently forecast to approach 88Moz (2,500t). Notably, by that time, the use of silver in the automotive industry could match the performance in the PV market. That will be a noteworthy development for global silver industrial demand and, by extension, the global silver market.

Key Developments Driving Automotive Silver Loadings



Source: Metals Focus

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About Metals Focus

Metals Focus is one of the world's leading precious metals consultancies. We specialize in research into the global gold, silver, platinum and palladium markets, producing regular reports, forecasts, proprietary data and bespoke consultancy.

The quality of Metals Focus' work is underpinned by a combination of top-quality desk-based analysis, coupled with an extensive program of travel to generate 'bottom up' research for our forecasting reports and consultancy services. Our analysts regularly travel to the major markets speaking to contacts throughout the value chain from producers to end-users, to obtain first hand and unique information for our reports.

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