Chenfei Wang
Wire and Cable Analyst

Filippos Papasavvas
Wire and Cable Analyst

What lies ahead for the automotive harness industry?

What makes up an automotive wiring harness?

The automotive wiring harness of a vehicle is defined as the assembly of all the vehicle's wires, including their attached clips and connectors. As a result, it varies across different vehicles, according to their power and communication requirements, as well as technology availability and development. As a general example, the automotive harness for Internal Combustion Engine (ICE) vehicles can generally be separated in four categories, all of which involve wire with a voltage below 60V:

- **The main harness,** which covers the major portion of the vehicle's energy and data distribution needs.
- **The auxiliaries**, which are splits from the main harness, and cover functions surrounding door and roof utilisation, among others.
- **The cockpit harness**, which is mostly linked to entertainment and data-related functionalities.
- **The engine harness**, which includes the combustion engine's sensors and their connection with the engine control unit.

It is also interesting to note the variety of additional harness parts in Hybrid Electric Vehicles (HEVs) and Battery Electric Vehicles (BEVs). Due to their higher reliance on electrical signal, they also require additional wiring than ICE vehicles. These parts can include wiring surrounding the vehicle's external or recuperation charging system, and the e-motor and battery harnesses.

Furthermore, full HEVs and BEVs will include a variety of >60V wiring, due to the power efficiency gains it provides. As a result, given our expectations for faster growth in electric vehicles vs. non-electric ones, we expect the per-vehicle wiring harness volume and value to increase over the coming years.

Who are the main automotive harness exporters?

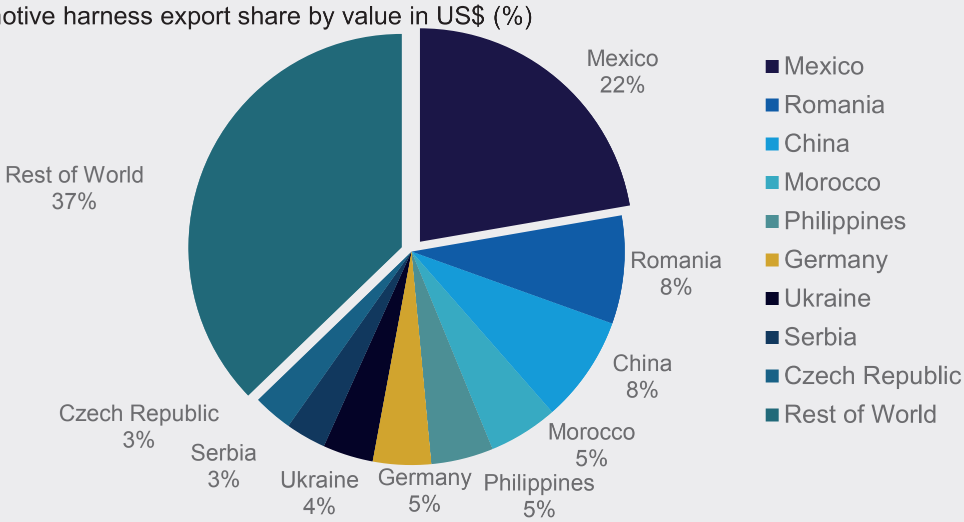
Automotive harness manufacturing is extremely labour intensive. Due to its high complexity, a significant portion of the manufacturing process must be done manually, with cable connectors/terminations being added by hand. As a result, labour costs comprise a large part of the manufacturing costs, and therefore automotive harness manufacturing plants are often built in low-wage countries.

Therefore, it comes no surprise that almost all major automotive harness producers such as Yazaki, Sumitomo, Delphi, Leoni, Lear, Fujikura and Furukawa have set up harness factories in countries with relatively low labour costs. For example, Leoni has manufacturing sites in Egypt, Tunisia and Morocco in North Africa, Ukraine, Slovakia and Romania in Eastern Europe. Sumitomo has manufacturing sites in Cambodia, India, Indonesia, Philippines, Thailand and Vietnam in Asia Pacific, Brazil, Mexico and Paraguay in North and South

America. These are only a selection of their global footprints and of course, almost all of these large players have a presence in China either through wholly owned subsidiaries or JVs. As shown in the pie chart below, all top nine countries who have exceeded US$1 bn in automotive harness exports in 2018 are from low-income economies, except for Germany.

Mexico exported far more automotive harness than other countries in 2018

Automotive harness export share by value in US$ (%)



DATA: IHS Markit, CRU

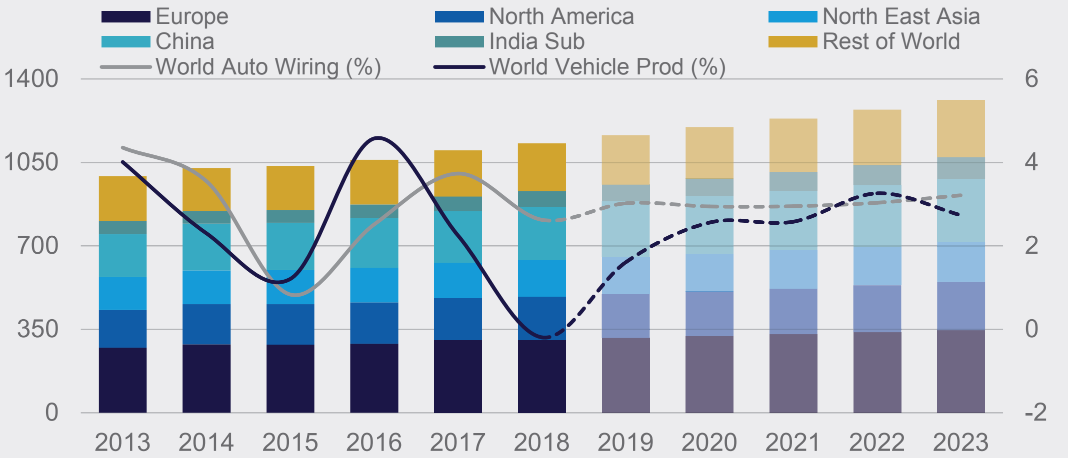
Will harness consumption levels grow in the future?

Generally, we expect automotive harness consumption to grow over the coming years, being driven by two key factors:

- **Automotive production growth**, which we expect to grow over the next decade and plateau during the 2030s
- **Per-vehicle automotive harness consumption**, which we expect to grow in line with wider EV adoption, although there is some downside risk surrounding wiring technology advancements.

Auto wiring consumption growth aligns with vehicle production growth

Consumption: '000t of conductor (LHS), year-on-year % change (RHS)

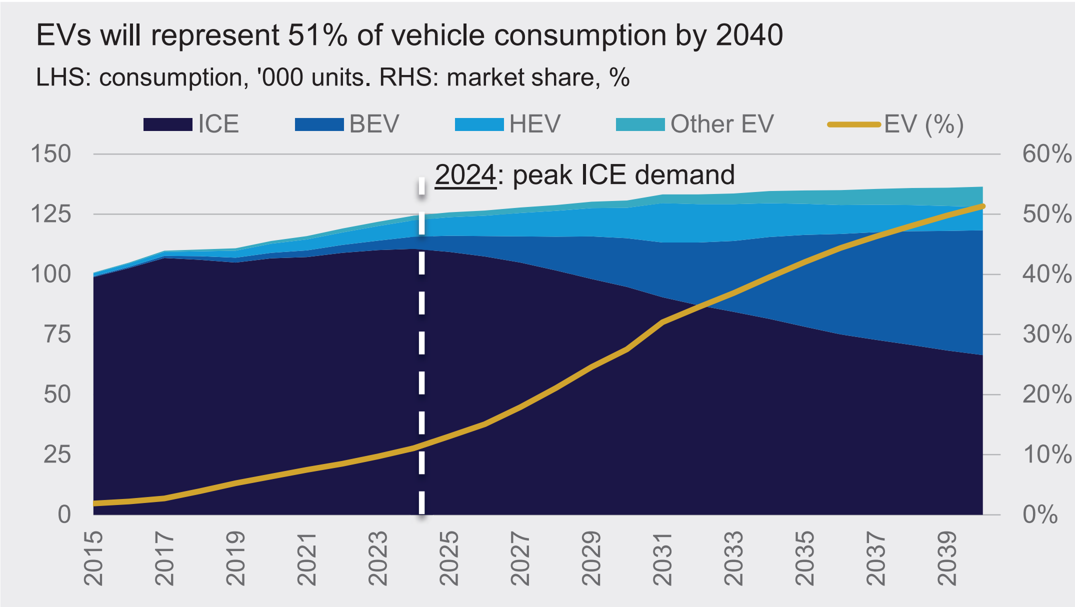


DATA: CRU, LMC Automotive

With regards to automotive production growth, 2018 experienced a 0.2% y/y contraction in global output, which was partially driven by a pullback in Chinese demand. However, despite only a marginal improvement in 2019, we have a more positive outlook in the mid-term. Indeed, CRU forecast a 2.3% CAGR in global automotive production over the period 2018-2023. In light of this, we expect automotive wiring consumption to grow by a CAGR of 3.0% over the same forecast horizon, up from 2.6% CAGR for the 2013-2018 period as shown in the chart above. On a regional basis, China and India will grow at faster rates of 3.4% CAGR and 6.6% CAGR between 2018 and 2023, though the latter only accounts for 6-7% of the total market share.

In terms of per-vehicle automotive harness volume consumption, it is difficult to forecast due to its high dependence on technological developments. However, one development which will have an important impact is the growth of EVs, due to their higher wiring requirements: a larger market share for EVs will ultimately translate into higher wiring harness volumes per vehicle. CRU believes that the main reason currently holding back wider EV adoption is limited manufacturing capacity, instead of a lack of demand or affordability. As a result, we expect an early 2020's "inflection point", when OEM's manufacturing capacity will have increased sufficiently to allow for the widespread adoption of EVs.

Wider EV adoption will lead to a decreasing market share for ICE vehicles, which are expected to reach maximum consumption levels in 2024. We currently forecast EVs to capture 51% of the automotive market by 2040, as shown in the chart below, which will lead to higher future per-vehicle. wiring harness consumption. On the downside however, we are wary of technological developments surrounding wiring simplifications, which could lower wiring volume requirements. For example, the wider adoption of a centralised automotive ethernet networks, could significantly lower wiring requirements on a per vehicle basis.



DATA: CRU, LMC Automotive

Will there be copper-to-aluminium substitution?

Weight saving is critical to the automotive industry to improve vehicle fuel efficiency and to reduce emissions. Automotive harnesses are the third heaviest and third costliest component in a typical home-owned vehicle, behind the chassis and the engine. CRU estimates the average weight of wiring per vehicle to be around 25 kg. Wiring normally accounts for 60-70% of the total weight of an automotive wiring system, which translates to 35-42 kg per vehicle. This number can rise to as much as 60 kg for some of the latest luxury car models.

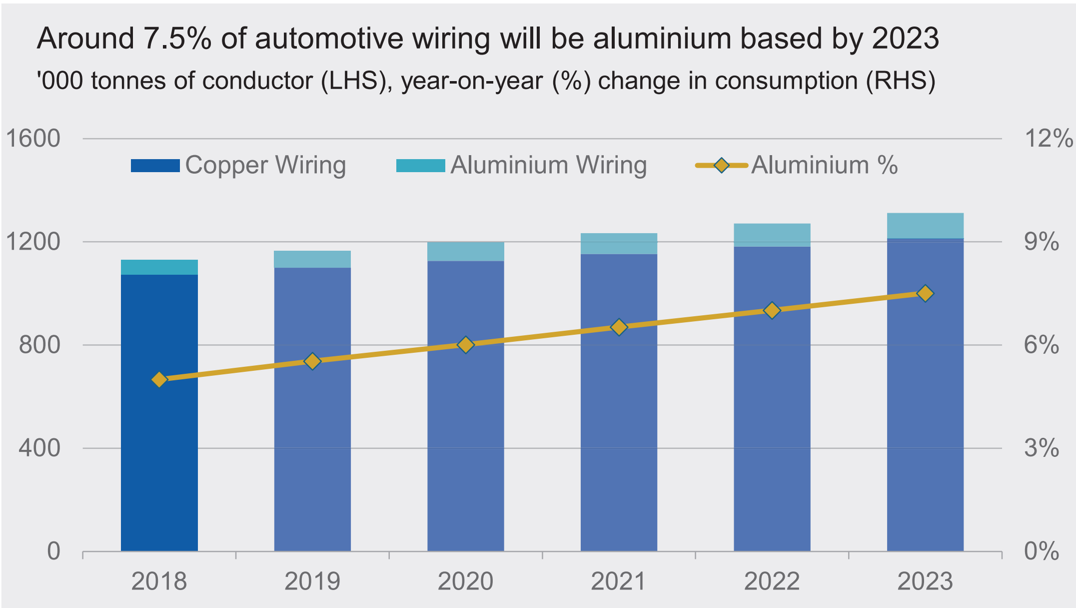
Moreover, automotive harness weight per vehicle is gradually increasing due to additional electronic controls and features, such as more complex chassis functions and interior entertainment to improve driving and on-board experience. With the growing production of hybrid and electric vehicles, we anticipate there will be further increase in automotive harness content to be driven by additional usage of HV harnesses such as for DC/AC charging, HV auxiliaries, battery harness, traction etc.

Currently, copper (including copper-based alloys) remains as the predominant material of choice for wiring conductor in automotive harnesses, which accounts for approximately 95% of market share. Aluminium has been considered as an attractive alternative option to substitute copper for many years now, largely attributed to its weight and cost benefits.

To put this into context, aluminium based wiring could reduce the total automotive harness weight by approximately 10-20%. This is a significant reduction in weight for an industry where every kilogram counts. Indeed, aluminium is also noticeably cheaper than copper. At the time of writing the LME 3-Month copper price sits around $6,215 /t, whilst the equivalent aluminium price is around $1,880 /t, and we expect this gap will remain at this level for the foreseeable future. As a result, there is continuous debate over the possible substitution options which are available for car manufacturers.

However, CRU remains cautious over this substitution narrative for a variety of reasons. Firstly, an aluminium wire's cross-sectional area will need to be approximately 56% larger than that of a copper wire to provide the same level of conductivity. As a result, space-economy concerns can prevent substitution. Furthermore, there are technological costs regarding aluminium wiring termination clips and connectors, as well as costs with replacing copper wiring harness production lines with aluminium. It is not impossible that such issues could be resolved with technological development. This can be seen from Furukawa's and Fujikura's recently developed automotive aluminium alloy wires below 2.5 mm^2 in cross-section. Although more improvements on a wider scale will need to be realised to see more meaningful substitution.

Driven by aluminium's inherent benefits over copper regarding its cost and weight, CRU expects such technological developments will continue and enable substitution, albeit at a very gradual rate. As a result, we are currently forecasting 7.5% of automotive wiring to be aluminium based by 2023, up from 5.0% in 2018, as can be seen in the chart below.



DATA: CRU