



POWDERMET2017: The future of electrification and autonomous driving: Coming sooner than you think

SPECIAL FEATURE

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Related themes were explored in a special interest program on electrification during the Las Vegas conference. Isaac Chan of Roland Berger, LLC, made the case for accelerated adoption of EVs through ongoing technical developments and the economic effect of autonomous driving and ride sharing. Burak Ozpineci, ORNL, reviewed some of the technology advances that were being pursued in government/industry partnership programs, in particular projects at ORNL related to metals applications.

One of the most topical and relevant subjects was addressed at the POWDERMET 2017 conference in Las Vegas. This was in a Special Interest Program entitled “Developments in Hybrid and Electric Vehicles”. The first speaker was Mr. Isaac Chan, Senior Consultant with Roland Berger LLC, Chicago, IL, on “The Future of Electrification”. He began by saying that the big strategic issues facing the automotive industry were electrification and autonomous driving, which were surprisingly more related than one would think.

Chan admitted there were still a lot of skeptics as well as proponents: from Sergio Marchionne (CEO, Fiat Chrysler) at one end, who complained about losing money on every electric car sold, to Elon Musk of Tesla at the other end, grabbing more headlines than anyone else in the industry. So who was right? Chan suggested there was historical data to support both sides of the argument. Despite rapid (~20%) growth in hybrids and EVs since 2010, they still represented only about 2+% of global volume (Fig. 1). Growth even slowed during 2014–2015, possibly due to the fall in oil prices. But Chan submitted that there were five reasons why electrification will be the future and its coming faster than we think:

- 1) Regulations at all levels
- 2) OEM strategies – where they are placing their bets
- 3) Consumer pull for both hybrid and EV technology
- 4) Item (3) and the other factors are driving improved economics
- 5) The future of mobility – this is where autonomous driving comes in.

On the emissions regulation side, the US is debating about rolling back the time-scale of EPA regulations from 2022 to 2025. But regardless, the OEMs still have to deal with the global problem. They have to meet European standards, and China is also increasing its regulations (Fig. 2). So OEMs are not that fazed about a US roll-back. Certain countries and even cities such as London and Paris were proposing to restrict or ban internal combustion engines (ICEs) altogether, or setting specific requirements for battery EVs and hybrids. In total, this could add up to a large fraction of the global market for autos.

How will the OEMs react to all this? Chan said that over the next six years the number of EV models available in advanced countries plus China was going to double. He went on to quote from some (recent) announcements: 26 new hybrids (HEVs) from Hyundai by 2021–2022, 13 HEVs from Ford in the next few years, plus dozens of battery EVs from up-market European OEMs like Daimler, Audi, and BMW with very aggressive targets for 2025. [More recently Volvo announced converting its whole model line to EVs in 2019]. So with all this enthusiasm, Chan asked why had EVs achieved such low penetration globally? Chan thought the reasons were obvious: limited range, finding a plug, long charging times, and the cost. But Chan said for each of these issues, there were new developments that were breaking down the barriers (Fig. 3). On ‘range-anxiety’ German OEMs were going to be launching EVs with ranges up to 500 km. ‘Finding a plug’ was a big issue that required a lot of infrastructure investment, but at the same time huge sums were being poured into developing super-charger networks. “Tesla has a super-charger with [about] 110–130 kWh

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Global hybrid and electric car sales [‘000 units]

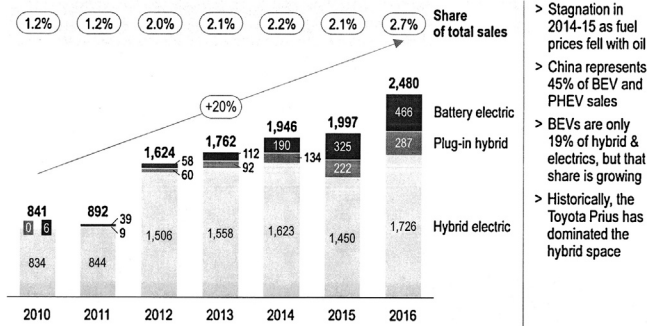


FIGURE 1
Despite rapid growth since 2010, hybrid and electric vehicles still represent only a very small fraction of the global auto market. Source: Isaac Chan, Roland Berger, LLC.

Economics of ownership a hybrid or electric car

Consumer expenses	Typical annual ICE cost ¹⁾	Relative xEV cost	
Fuel	17%	↘	Lower operating costs
Maintenance	9%	↘	
Registration & taxes	14%	↔	
Depreciation	44%	↗	Higher vehicle cost
Finance charge	8%	↗	
Insurance	8%	↗	
Total ownership cost	\$8,000		

1) Based on a medium sedan, driven 13,000 miles annually. Calculated on average cost over the first five years of ownership

FIGURE 4
Cost comparison for electric and ICE automobiles. Source: Isaac Chan, Roland Berger, LLC.

Although the future of US federal emission standards is uncertain, OEMs must continue to respond to regulatory pressure globally

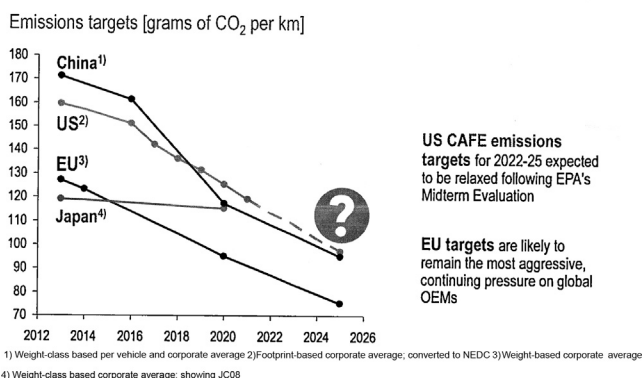


FIGURE 2
Historical and future automotive emissions targets. Source: Isaac Chan, Roland Berger, LLC.

The barriers to widespread adoption are being eroded

Consumer pain points

	HEV	PHEV	BEV	Ongoing developments
Range anxiety			✓	Battery advancements and capacity
Finding a plug		(✓)	✓	Charging stations, supercharger networks, wireless charging solutions
Long charging time		(✓)	✓	Supercharger power levels rising to 350 kW and beyond
Unappealing image	✓	✓	(✓)	Formula-E, Tesla brand, hybrid supercars
High cost	(✓)	✓	✓	Improving total cost of ownership

FIGURE 3
Barriers to widespread adoption of EVs are being eroded. Source: Isaac Chan, Roland Berger, LLC.

capacity, and other companies have super-chargers of 350 kWh [as a frame of reference, a 350 kWh super-charger could “fill” a Tesla in about 15–20 minutes].”

On the question of cost: for the consumer debating whether to get a hybrid or an EV, it was eventually a trade-off between fixed (upfront) costs and operating costs. Typical ownership cost (for a North American mid-sized sedan) was about \$8000/year – averaging the first five years of ownership – and the biggest chunk of that was depreciation. For a hybrid or EV you were going to pay more, so higher depreciation . . . At the same time you are going to have lower fuel costs, and with a battery EV with no ICE you were going to have lower operating costs (Fig. 4). One of the biggest things driving cost now was component cost, of which the [largest] item was the battery. Battery costs have come down a lot over the years, even based on current generation technology. There were still breakthroughs that could come, such as lithium-air, solid-state batteries, etc., but the importance of the scale of production was often under-estimated. So when Marchione says that he’s losing about \$14,000 on every Fiat 500E that he sells, a lot of that is because he is not counting on selling very many. Chan went on to quote from a UBS estimate on the Chevy Bolt, which was said to be losing about \$7000/car on today’s numbers, but by 2025 they estimated the figure would flip to a positive \$6000 per vehicle. That was partly due to battery cost, but a large part was due to volume. The economics didn’t make sense for either the OEMs or the consumer while the volumes were low. This brought Chan to the next item, which was the future of mobility. Chan argued that future changes in mobility would come sooner than thought, and would act as a catalyst in bringing electrification.

The average owned vehicle was only utilized about 4% of the time – the rest of the time it was sitting in a drive-way, garage or parking space. A much more economically efficient usage would be to share a vehicle. Sharing the car between 4 and 10 users could cut the depreciation cost dramatically. Depreciation is about 44% of the annual cost of a vehicle, the vast majority of which is time-based, not mileage-based (because of obsolescence in technology and obsolescence in styling). So sharing made a lot of sense from an economic stand-point. But the problem is “sharing today is a pain, no one wants to do it”. But all the issues of picking up and passing on the vehicle, etc., get solved with autonomous driving. To realize that you need SAE level 4 or 5 autonomous driving. The

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