

## NAND Storage EV Market Application

### Growth of NAND Requirements in the Car

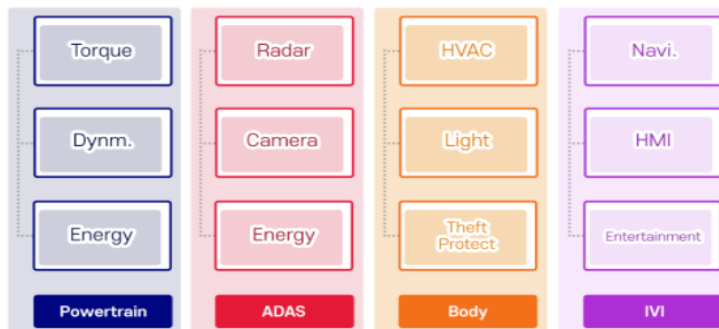
3D/HD Mapping • Infotainment/Navigation • Digital Clusters • Telematics Gateways • V2V/V2I Comms • Autonomous Drive • Data Recorders

- Application stack + HMI** (voice, gesture, etc) **32GB**
- Maps (3D/HD)** **64-128GB+**
- Augmented Reality** **16-128GB+**
- Hypervisor + multiple OS** **8-64GB**
- Autonomous drive OS + App Stack** **32-512GB**
- Drive Recorder** **32GB-2TB+**
- DashCams, Cluster, Telematics/V2X, Body control** **8-64GB**

The surge in electric vehicles (EV) and hybrid vehicles, accompanied by the emergence of ADAS, Graphic Instrument Cluster (GIC), infotainment systems and fully autonomous driving solutions has created a need for Electronic Control Units (ECU) – automotive computer controllers used to receive and process signals from sensors and export control commands to the actuator to execute.

In traditional automotive Electrical / Electronic (E/E) modular architecture, each distributed ECU handles a single function independently. As modern vehicles contain many electronic functions, the number of ECUs increases dramatically from low/mid-end cars (around 30) for high-end cars (around 100). As a result, integrated ECU controllers like vehicle integration platforms and functional centralization have been introduced as a way to reduce cost and maximize power efficiency in four main areas: Powertrain, ADAS, Body, and IVI

### Distributed ECU (Modular)



## EV Market Overview

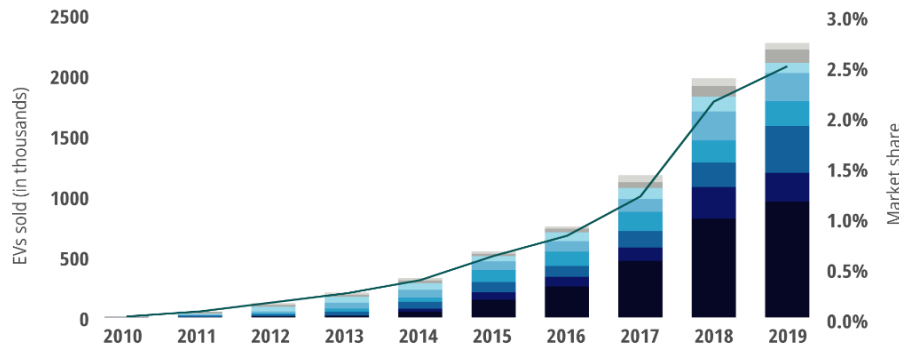
The EV market’s collective accomplishments over the past two years offer hope, despite the short-term impact of COVID-19: a pattern of continued growth, which is expected to be sustained throughout the 2020s. As BEV and PHEV sales surpassed two million vehicles in 2019 (see figure 1), EVs staked their claim on a 2.5 per cent share of all new car sales last year.

Looking back at BEVs in 2019, they accounted for 74 per cent of global EV sales: an increase of six percentage points since 2018. This rise was partly stimulated by new, stricter European emissions standards that persuaded manufacturers to favour the production and sale of zero-emission vehicles. Another factor is the advanced state of the BEV market in China, compared to the rest of the world. Although BEVs are still the dominant EV technology in the United States and Europe, they command a smaller share of the market than in China.

FIGURE 1

### EVs: annual passenger-car and light-duty vehicle sales in major regions

■ China BEV ■ China PHEV ■ Europe BEV ■ Europe PHEV ■ US BEV ■ US PHEV ■ Other BEV  
 ■ Other PHEV — EV share



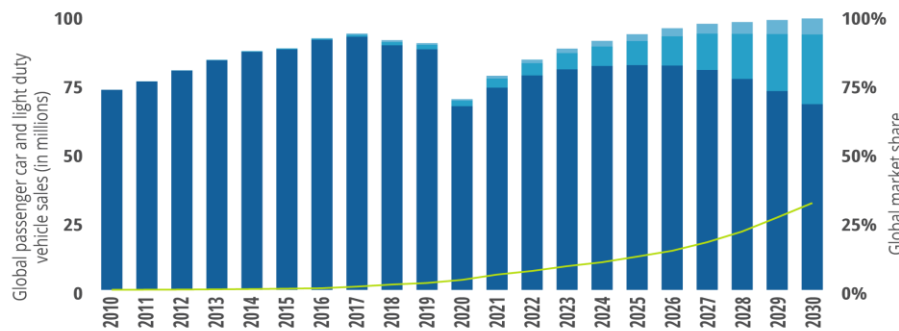
Source: Deloitte analysis, IHS Markit, EV-volumes.com<sup>2</sup>

Deloitte Insights | deloitte.com/insights

FIGURE 2

### Outlook for annual global passenger-car and light-duty vehicle sales, to 2030

■ Global ICE ■ Global BEV ■ Global PHEV — EV share



Source: Deloitte analysis, IHS Markit, EV-Volumes.com<sup>16</sup>

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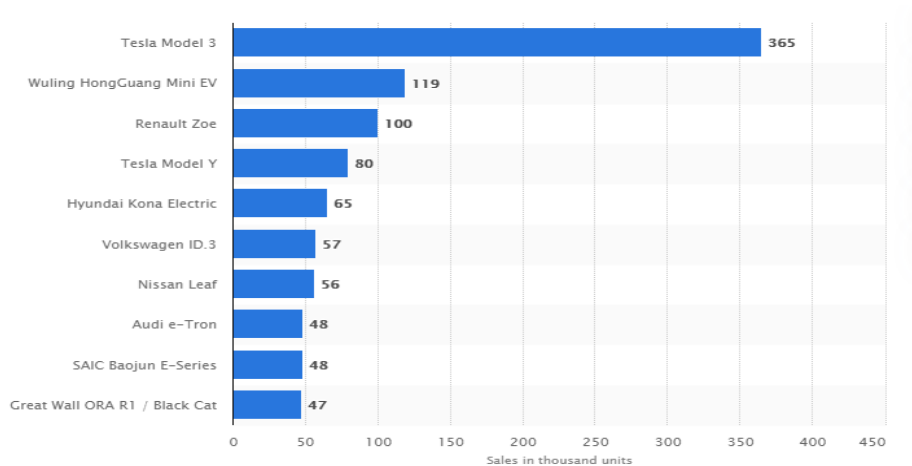
The Tesla Model 3 was the world’s most popular plug-in electric vehicle with worldwide unit sales of roughly 365,000 in 2020. That year, deliveries of Tesla's Model 3 and Model Y increased by almost 90 percent year-on-year, and these two models accounted for 60 percent of Tesla's sales volume in 2020.

### Competition increases in electric vehicle manufacturing

Tesla continued its role as the leading electric vehicle brand and yet, 2020 saw competition in the field of electric vehicles intensify. GM-SAIC-Wuling's HongGuang Mini EV also made its debut in 2020, while Volkswagen began delivering its new ID.3 model. Both models made it into the list of best-selling plug-in electric vehicle models worldwide.

### Technology drives automotive electrification

Electric vehicles are growing in popularity. Consumers have become more interested in plug-in electric vehicles following important technological developments. Technology has significantly increased the range of electric vehicles and charging infrastructure, meaning that plug-in vehicles are more accessible and practical. It is expected that solid-state batteries will be a step up on battery technology and have the possibility to extend range even further. Japanese manufacturers hold the most patents in this field.



### Estimated density and storage type of NAND Flash memory for each application

Application		'20	'23	'25	'30
IVI (In-Vehicle Infotainment)	Density	~64/128GB	~128/256GB	~256/512GB	~512/1TB
	Storage	eMMC	UFS	UFS	UFS
Autonomous (ADAS)	Level	~Lv.2(ADAS)	Lv.3	Lv.4	Lv.5
		Partial	Conditional	High	Full
	Density	8~64GB	~128/256GB	~512GB/1TB	~1TB/2TB ↑
	Storage	eMMC	UFS	SSD	

## Data Storage Enabling the Car of the Future

*Changing Storage Usage Models*



### Faster Boot and Read Speeds

Operating systems and applications are getting more complex



### Wider Temperature Environments

More powerful processors



### New Write-intensive Workloads

Multi-camera recording, autonomous drive, data telematics

## Automotive Data Storage Tomorrow



### Market Players for Storage

Several companies participate in the automotive memory and storage market including Micron, SanDisk and Toshiba. Micron makes various volatile memories as well as NOR and NAND flash and SanDisk makes NAND flash memory. Toshiba makes a special HDD with up to 320 GB capacity, primarily for infotainment applications. There are also automotive applications using new memory technologies using MRAM products made by Everspin.



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