TRANSJOVAN CAPITAL
STRATEGY | M&A | ADVISORY

Automobile Industry

Impact of macroeconomic trends on the current and future state of the industry – A Perspective

December 2022

Executive Summary

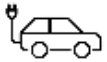
The electric vehicle revolution is here, with tech players breaking technology barriers and unleashing autonomous vehicle capabilities causing a paradigm shift in the industry

Key focus areas	Key findings and observations
Trends – EV and AV	• Growing EV production, rising focus on developing **FCEV technologies** and EV supporting infrastructure is expected to continue amid favorable government policies and greater corporate investments • While players are collaborating and making significant progress in AV tech, **fully autonomous driving** is still years away
Effect of macroeconomic factors	• **High interest rates** are increasing the cost of debt and is negatively impacting the customer demand • **Inflated commodity prices**, further worsening due to the Russia-Ukraine war, is impacting the industry margins • Supply chain issues continue to persist, increasing lead times of parts availability and slowing down production
Current opportunities	• OEMs, tech firms and service providers are forming **ecosystems** supporting R&D and use of advanced technologies, e.g., LIDAR, RADAR, ADAS, 5G connectivity, AI/ML models on large datasets, which assists building the next generation of connected mobility • Major automaker are making huge moves towards electrifying vehicles and massively investing in **AV technology** • Opportunities in **battery manufacturing** are emerging in Europe, Americas
Future possibilities	• The industry is continuing to move towards EVs and **connected vehicles**, equipped with autonomous features. Production is becoming **agile**, leaner and more environmental conscious • In the medium to long term, as infrastructure of smart cities develops, vehicles-to-infrastructure interaction will realize the full potential of connected AV across functions like smart parking, ride hailing, and shared ownership which will enable the creation of a **new mobility ecosystem**
Evolution of transportation	• Automotive industry can potentially become an integrated ecosystem, having a single platform offering variety of services under a centralized operator • The new ecosystem of shared mobility can potentially be highly customizable, efficient and convenient enabling consumers to move away from private ownership of vehicles

EV = Electric vehicles, AV = Autonomous vehicles, FCEV = Fuel cell electric vehicles

Current Trends – Automotive Industry

The current focus is on widescale adoption of EV, development of AV and phasing out of ICE. The FCEV market is nascent and will require significant R&D and investments



Automakers ramping up production as demand for EVs is accelerating

- **EV sales doubled** to 6.6Mn in 2021. In 2021, 10% of global car sales were electric[1]. China, Europe and America being the top adopters of EVs
- Automakers are testing **FCEVs**, however the refueling infrastructure remains nascent. Toyota and Hyundai recently launched mass-produced FCEVs

Favorable government policies and regulations for EVs and semi-autonomous vehicles

- Many countries are planning to **phase out ICE** cars by 2030-40 and are employing policies to support EV infrastructure
- Driving and safety laws from governments are encouraging automakers to offer semi-autonomous driving features or ADAS in newer cars

Supply chain issues continue to plague the industry as players take steps to mitigate the impacts

- Supply chain constraints, further worsened by Covid-19 and the Russia-Ukraine war, are causing severe shortages of minerals, semiconductors, and metals. This is leading to longer lead times, increasing input prices and low inventory levels,
- Automakers are **vertically integrating** for greater control over supply chains by investing in mines and co-developing electronic components

AV technology is steadily progressing

- ADAS equipped semi-autonomous vehicles are common today. Fully autonomous driving is still in the testing phases in multiple countries
- Some of the fully AVs currently in testing and development phase include AutoX in China that hit 1,000 Level-4 AV vehicle fleet through its robo-taxis, Waymo in the US launched a fully autonomous public ride-hail service in Phoenix, Arizona

Ecosystem plays in the automotive industry

- Automakers are partnering with **tech companies** to jointly develop AV driving technology. For e.g., Toyota has partnered with Tesla; Qualcomm teamed up with BMW, Volkswagen, NIO, et al.; Nvidia has provided their self driving toolkit to BYD, Mercedes-Benz, Volvo, et al.
- Automakers also collaborating to create **FCEVs infrastructure**. For e.g., Renault and Plug power have formed HYVIA to sell hydrogen products throughout Europe; Nikola and OPAL Fuels have partnered to co-develop and construct hydrogen fueling stations and infrastructure
- **Shared mobility firms** partnering with automakers. For e.g., Kia and Uber have partnered to provide EV at discounted prices to drivers; Didi Chuxing formed D-Alliance with 31 automotive players with the aim of promoting a cheap, on-demand ride alternative to private vehicle ownership

Source: 1. International Energy Agency

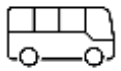
EV = Electric vehicles, AV = Autonomous vehicles, FCEV = Fuel cell electric vehicles, ICE = Internal combustion engines, ADAS = Advanced driver-assistance system

Electric Vehicles (EV) – Industry Overview

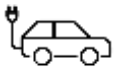
Electric vehicles are no longer a niche market with surging demand around the globe. Current incumbents and new entrants are moving fast to tap into the growing EV market

Trends

EV charging infrastructure is growing rapidly, and is expected to quadruple by 2025 to meet the high EV demand



Electrification of fleet vehicles (buses, commercial vehicles) continues to grow



Automakers are also focusing towards developing FCEVs, to prevent overdependence on battery EVs

Rising demand for critical minerals such as lithium, cobalt, nickel, as battery markets expand

"Porsche is the last bastion of cars for petrol heads. So, when they start making EVs, you realize the world really is changing"

- Chris Harris (Journalist, Top Gear)

Market Attractiveness

Zero carbon emissions, high fuel costs, falling EV prices and tax subsidies are growing EV demand

OEMs are phasing out the ICE vehicles and moving to EVs to adhere to stricter emission regulations

Diverse range of EV models from multiple OEMs are serving the varying needs and lifestyles of consumers

Besides passenger cars, electrification in public transportation and taxis are also in high demand

"The car industry has invested a lot in hybrid, but my opinion is electric cars will take over a lot of hybrids quickly"

- Henrik Fisker (Designer, Ex-Aston Martin)

Barriers to EV Adoption

Underdeveloped charging infrastructure is a major hurdle in the large-scale adoption of e-transport

Lack of consumer awareness of EV, for e.g., in developing economies is slowing the adoption rate

Additionally, high cost of ownership, low performance and range is making some customers skeptical

Hybrid electric vehicles are preferred over fully EV as they are cheaper and offer better performance

"I don't believe in the electric cars, but I strongly believe in hybrids"

- Luca Cordero di Montezemolo (Ex Chairman Ferrari)

Autonomous Vehicles (AV) – Industry Overview

While ADAS are mainstream in today's cars, fully autonomous vehicles are still years away due to the lack of sophisticated systems to deal with dynamic road and driving conditions

Trends

Increasing number of OEMs are implementing advanced driver assisted system (ADAS) features

OEMs, tech players and ride-sharing companies are collaborating to build a more conducive mobility ecosystem

Several OEMs are developing autonomous trucks to perform shipping deliveries in the future

Globally, governments are working on regulations around AV to ensure its safe use before its wide scale adoption

"Auto industry's real gamechanger is software and autonomous driving"

- Herbert Diess (CEO- Volkswagen)

Market Attractiveness

Rising government support and advancements by tech giants are positively influencing the AV market

AVs hold the potential of greatly reducing the number of accidents, lowering deaths and healthcare costs

E-commerce industry is also exploring the use and potential of autonomous trucks for delivery of their shipments

Advanced autonomous driving features and high-end vehicle systems are particularly attractive to the consumers

"This system can double the efficiency of the drivers, keep the trucks running more often, and speed up deliveries"

- Cetin Mericli (Co-founder- Locomation)

Barriers to AV Adoption

AVs are facing stringent regulations and scrutiny around their safe use on roads due to the lack of sufficient trial data

Huge capital requirements and years of R&D in complex AV technology are limiting many emerging startups

Consumers and states are hesitating to adopt fully driverless cars due to their safety concerns

AV Infrastructure, e.g., traffic flow sensors, parking space detectors, are still in early stage of development

"It will still require a significant amount of time for autonomous driving to be commercialized on a large scale,"

- Dong Wei (Chief safety officer- Baidu)

Impact of Macroeconomic Factors on the Automobile Industry

High interest rates, rising commodity prices combined with volatile energy prices are indicating bleak demand outlook and depressed profit margins for the industry

Impact of macroeconomic factors

Inflation and Geopolitical issues

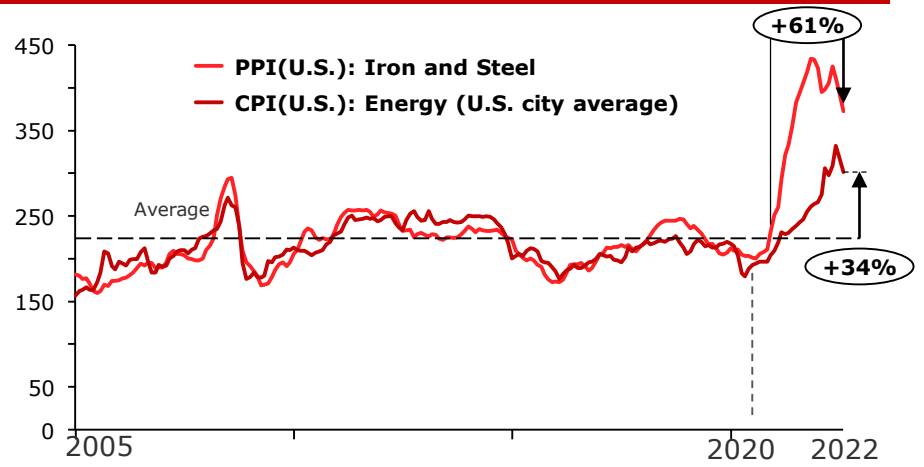
- **Soaring metal prices** due to the Russia-Ukraine war and supply chain constraints are increasing the input costs. S&P GSCI index, a benchmark for commodity sector, had increased nearly 50% YoY
- **Tensions** between Taiwan and China is increasing the risk of supply chain delays and higher costs (90% of the world's largest ships by tonnage passed through the Taiwan Strait in 2021)
- While supply chain constraints and high demand for autos fueled the auto price inflation, the IMF expects the average inflation rate to fall to 3.5% in 2023. This is likely to bring down the auto prices

Energy Prices

- **Fluctuating oil prices** have a direct impact on the cost of auto ownership, affecting demand
- Closure of Nord Stream 1, the pipeline supplying 40% of total gas imports to Europe, and the fire damage at Freeport LNG Texas plant have impacted global energy prices
- Oil prices in the US have risen from ~$76 a barrel in Jan'22 to ~$90 barrel in Oct'22. Energy prices are expected to stay at **elevated levels in 2023** due to geopolitical uncertainties

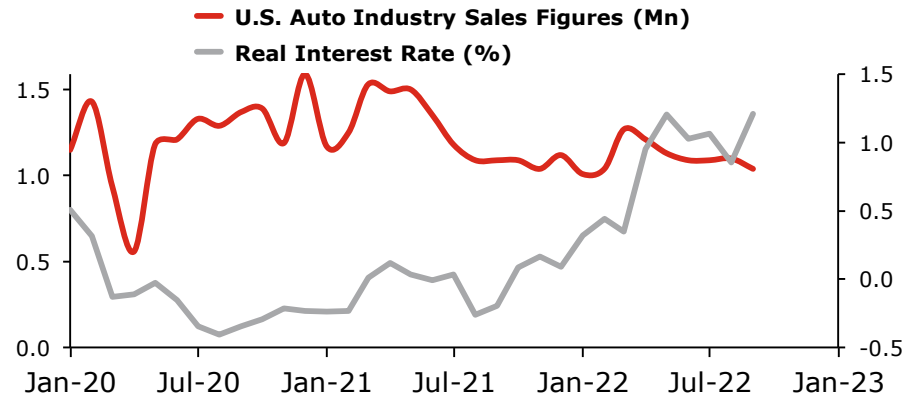
Interest Rates

- **Rising interest rates** paired with worsening economic conditions is making auto financing expensive, hurting demand in the auto industry
- High interest rates is also making it expensive for auto manufacturers to cover their **existing debts**, therefore squeezing their profit margins



PPI – Producer Power Index, CPI – Consumer Power Index

Source: U.S. Bureau of Labor Statistics



Source – St. Louis Fed, U.S. Bureau of Economic Analysis

Automotive Landscape (1/2)

The industry is making swift moves to EV manufacturing as ~33% of the top 20 auto OEMs have moved away from ICE vehicle production

Players	EBIT 2021 $B	EV Sales 2021 (000's)	EV sales growth YoY	ICE	EV	PHEV* (Hybrid)	AV	AV Tech	Recent developments
TOYOTA	26.7	90	-12%	✓	✓	✓	Level 2	Self-engineered	Toyota, with its JV with Denso, is building chips. Its subsidiary Woven Planet develops the self driving system
	23.64	320	0%	✓	✓	✓	Level 2	Partnered	VW is road testing its vehicle with Level 4 capabilities. The vehicles will use the Qualcomm chips
Great Wall	21.47	80	+23%	✓	✓	✓	Level 2	Partnered	GWM has invested in multiple self driving startups and has formed partnerships with firms, including Qualcomm
STELLANTIS	18.74	230	+42%	✓	✓	✓	Level 2	Partnered	Stellantis and Foxconn are developing Level 2 & 3 systems chips. It has collaborated with Qualcomm for its chips
	17.78	150	+13%	✓	✓	✓	Level 3	Partnered	Mercedes-Benz has reached world's first road ready status for its Level 3 system which is based on Nvidia's Orin chip
	15.83	190	+19%	✓	✓	✓	Level 2	Partnered	BMW plans to have Level 3 ready cars by 2025 where the system will be based on Qualcomm chips
gm	11.43	260	+15%	✓	✓	✓	Level 2	Partnered	GM recently unveiled its Level 4 self driving system which is due in 2023 and will be based on Qualcomm chips
Ford	10.59	90	+41%	✓	✓	✓	Level 2	Partnered	Currently on Level 2 cars, Ford plans to launch its Level 4 autonomous system on Intel's Mobileye chip by 2025
HONDA	7.76	30	+16%	✓	✓	✓	Level 2	Partnered	Honda currently uses Renesas chips but will also start using Intel chips in models rolling out from 2023
TESLA	6.52	550	+46%		✓		Level 2	Self-engineered	Tesla uses its own Autopilot technology. It has recently started building its own chips inhouse

Source : CapIQ, EV-Volumes, Company websites

* PHEV : Plug-in Hybrid electric vehicle

Automotive Landscape (2/2)

Most of the top OEMs are using specialized chips from Nvidia, Qualcomm and Intel while building their AV with the latest features and technology

Players	EBIT 2021 $B	EV Sales 2021 (000's)	EV sales growth YoY	ICE	EV	PHEV*	AV	AV Tech	Recent developments
HYUNDAI	5.84	230	+86%	✓	✓	✓	Level 2	Partnered	Hyundai uses Nvidia's chips for its in-vehicle systems
KIA	4.43	N/A	N/A	✓	✓	✓	Level 2	Partnered	KIA uses Nvidia's chips for its in-vehicle systems
SAIC	2.57	120	+24%	✓	✓	✓	Level 4	Partnered	SAIC vehicles use Intel chips for its in-vehicle systems while also heavily investing in a domestic chip startup
FERRARI	1.2	N/A	N/A	✓		✓		Partnered	Ferrari plans to limit its AV technology to Level 2
BYD	0.65	630	+320%		✓	✓		Partnered	BYD plans to use Nvidia's Drive Hyperion Platform in its vehicles starting 2023
SUZUKI	0.32	N/A	N/A	✓				N/A	Suzuki Motor plans to convert all its minicars in Japan to connected vehicles by 2025
RIVIAN	N/A	N/A	N/A		✓	✓	Level 2	N/A	Rivian has filed a patent that uses location signals and wireless network to help connected AV find passengers
LUCID	N/A	N/A	N/A		✓		Level 2	Partnered	Lucid Motors uses Nvidia's Orin for its in-vehicle systems
理想	-0.024	N/A	N/A		✓	✓	Level 2	Partnered	Li Autos systems are based on Nvidia's Orin chip, and it plans to develop its own automotive chips
NIO	-0.697	70	+21%		✓		Level 2	Partnered	NIO has teamed up with Nvidia, Qualcomm and Intel to develop its AV system

Source : CapIQ, EV-Volumes, Company websites

* PHEV : Plug-in Hybrid electric vehicle

Current Opportunities at Play

Vehicle electrification, infrastructure connectivity and technological advancements have opened new doors of opportunities for automotive manufacturers

Current opportunities	Recent developments
Battery manufacturing • EV battery manufacturing is dominated by **China, Japan and South Korea** as these countries together hold ~92% share in the global battery manufacturing • Automotive players can invest in battery manufacturing in other regions to reduce dependency on China, Japan, South Korea for lithium-ion batteries	• Volkswagen and Bosch have set up a JV for EV battery production in Europe • Hyundai Motor Group plans to invest $5.5 Bn to build an EV and battery manufacturing facility in the US
Technological advancement • Use of sensors, such as LIDAR, RADAR, and ADAS is rising at a faster pace as the global automotive sensor market is anticipating a double-digit growth rate • Players can build deeper collaboration with technology providers to deploy the latest and the most advanced technology in their vehicles	• Mercedes-Benz collaborated with Qualcomm to utilize its Snapdragon Cockpit and Auto Connectivity Platform • Volkswagen entered a $4 Bn deal with Innoviz for LIDAR sensors for their vehicles
Data centers - Centralized/ Decentralized • Technology driven vehicles generate extensive data for every mile they run which require a large data center to store, analyze and process such data • **Decentralized** data centers with servers, private and hybrid clouds, hosted in third-party data centers across multiple locations help avoid system failures • Data centers help provide timely over-the-air (OTA) updates to upgrade the vehicles	• Tesla has built a data center in China to handle data collected by its vehicles • Stellantis plans to invest Euros 30 Bn towards OTA updates for cars which will generate Euros 20 Bn in annual revenue through subscriptions by 2030
Computing capabilities • Software deployed in modern vehicles generate huge data which requires **edge computing** and 5G connectivity to expand bandwidth for data processing • OEMs can look to invest in computing capability for faster communication between vehicle-to-vehicle and vehicle-to-infrastructure	• General Motors and AT&T have collaborated to bring 5G connectivity that meet the needs of AV • Audi and Verizon have partnered to bring 5G connectivity to select vehicles in 2024

LIDAR = Light detection and ranging, RADAR = Radio detection and ranging, ADAS: Advanced driver-assistance system

Future Possibilities

The future of mobility resides in efficient, sustainable and connected AVs | Players must act swiftly to benefit from the changing market landscape and mobility environment

Short-term (<5 years)

Connected smart cars - Smart cars, connected to 5G internet, offering driving assistance and other semi-autonomous functions, vehicle-to-vehicle communications

Alternative power sources – A paradigm shift towards EV continues, with OEMs planning to phase out ICE by this decade. FCEVs are a promising option for larger vehicles, e.g., trucks and buses

Self driving cars/ fully autonomous vehicles - AVs can become mainstream in the near future. For e.g., Apple car will use LiDAR sensors, radar sensors, and cameras for the AV function on highways set to release in 2026

Automobile manufacturing – Manufacturing has shifted to Industry 4.0 with greater automation, greener production, recyclable car parts and agile supply chains using IIoTs. Agile manufacturing and pop-up factories, that can run within 6 months, are popular

Medium-term (5-15 years)

Smart city integration (IoT)– Future cars can communicate and integrate with the smart city infrastructure, e.g., smart roads, smart parking spaces, charging stations and other facilities, to share and study travel data, and optimize traffic

Servitization – Most cars sit idle for 90% of the time in a day. While shared car ownership and car-as-a-service model can partially solve the problem, mobility-as-a-service offers new opportunities and forms the basis for the future of transportation

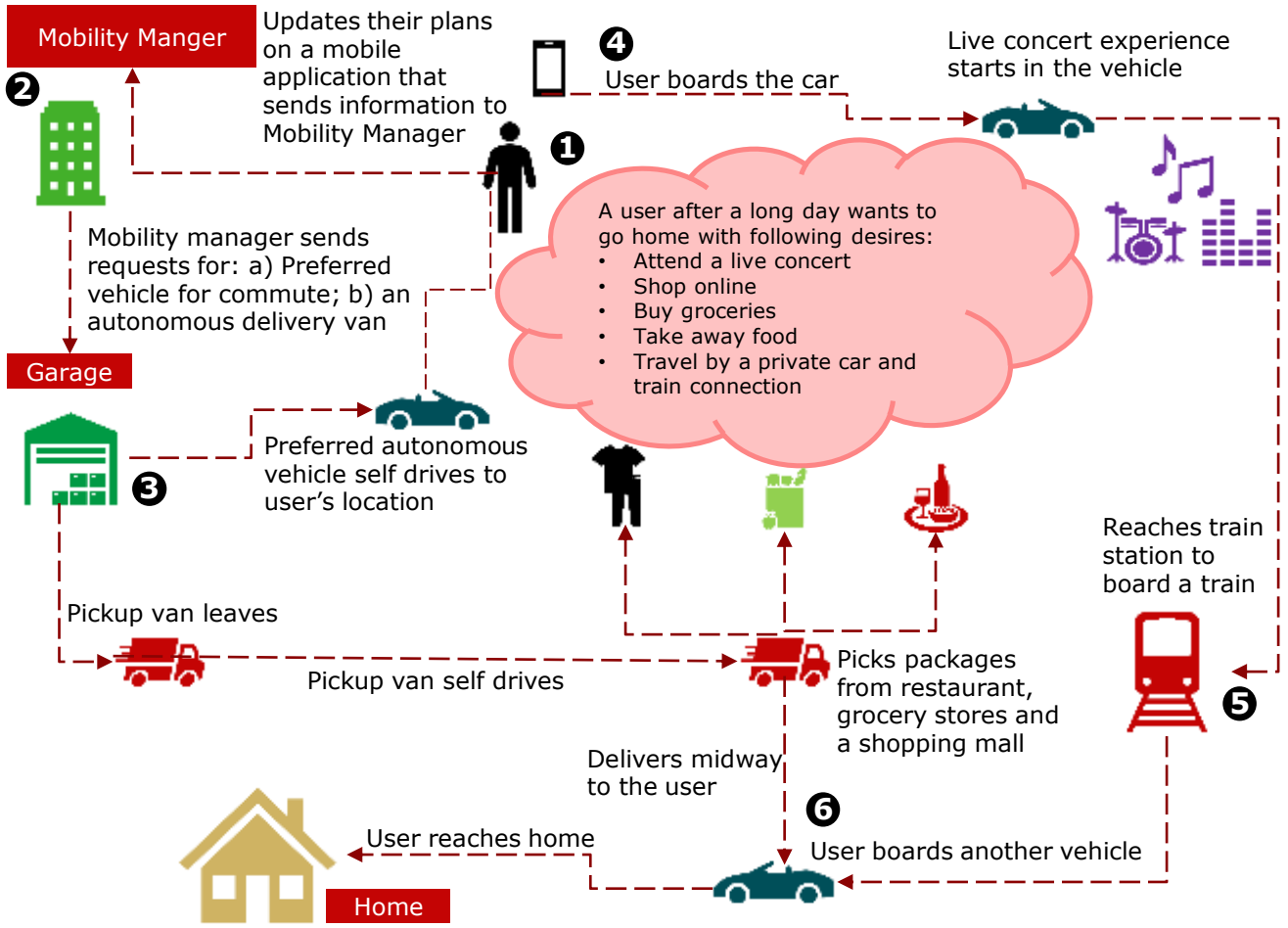
Long-term (>15years)

Energy storing body panels and renewable energy – Using a car's body panels to store energy can make the battery lighter and the car more fuel-efficient. It also shortens the charging time necessary for plug-in vehicles. Some OEMs have also explored using solar panels on cars to capture energy

Vertical take-off and landing vehicles/ flying cars – The future of safe on-demand flying cars seems optimistic, although the technology is still nascent with safety and cost being two of the biggest hurdles in its development

Evolution of transportation – Potential Scenario

Advancements in the vehicle technology may yield to an integrated ecosystem that will make shared mobility cheaper, convenient, and customizable as per individual needs



***Potential Scenario**

Challenges in mobility ecosystem

Ebbing investment in technology

- After billions invested in the integrated ecosystem, the pace of developments stays slow, receding the flow of investment as prospects of financial returns are feeble in the near term
- Lyft sold its AV unit to Toyota; Uber sold its AV unit to Aurora due to lack of funding for further R&D

Roadblocks in infrastructure development

- Success of integrated ecosystem depends on smart cities, defect free roads etc. requiring public-private coordination and address concerns like privacy issues and cyber threats;
- Inability to address such concerns by the current ecosystem players and the government is another major pothole in the development of such a modern infrastructure

Lack of synergy among the ecosystem players

- To built an integrated ecosystem, all stakeholders like automakers, tech companies, telecommunication providers and others should be brought together on a consolidated platform
- Satisfaction of interests of each business partner will be crucial for the ecosystem players, as a defecting partner can lead to a major halt in the entire range of goods/ services

Glossary

Common Terms	Definitions
Autonomous vehicles (AV)	An autonomous vehicle/ driverless car is a vehicle that uses a combination of sensors, cameras, radar, and artificial intelligence (AI) to travel between destinations without a human operator
Advanced Driver Assisted System (ADAS)	ADAS is a group of electronic technologies that assist drivers in driving and parking functions. ADAS use automated technology, such as sensors and cameras, to detect nearby obstacles or driver errors, and respond accordingly
Artificial Intelligence (AI)	Artificial intelligence is the simulation of human intelligence processes by machines, especially computer systems
Electric vehicles (EV)	An electric vehicle is a vehicle that uses one or more electric motors for propulsion. It can be powered by a collector system, with electricity from extravehicular sources, or it can be powered autonomously by a battery (sometimes charged by solar panels, or by converting fuel to electricity using fuel cells or a generator)
Fuel cell Electric Vehicle (FCEV)	An electric vehicle that uses hydrogen as a source of energy to generate electricity from its fuel cell system. It is emission-free since it emits only water and heat
LIDAR	Lidar (Light Detection and Ranging) is a remote sensing method that uses light in the form of a pulsed laser to measure ranges (variable distances) to the Earth
RADAR	Radar (radio detection and ranging) is a detection system that uses radio waves to determine the distance (ranging), angle, and radial velocity of objects relative to the site
Levels of automation	Society of Automotive Engineering (SAE) has defined levels of automation for autonomous vehicles which range from Level 0 (no driving automation) to Level 5 (full self-driving capabilities under all conditions)
Level 0	The driver is responsible for all core driving tasks. However, Level 0 vehicles may still include features like automatic emergency braking, blind-spot warnings, and lane-departure warnings
Level 1	Vehicle navigation is controlled by the driver, but driver-assist features like lane centering or adaptive cruise control are included
Level 2	Core vehicle is still controlled by the driver, but the vehicle is capable of using assisted-driving features like lane centering and adaptive cruise control simultaneously
Level 3	Driver is still required but is not needed to navigate or monitor the environment if specific criteria are met. However, the driver must remain ready to resume control of the vehicle once the conditions permitting ADAS are no longer met
Level 4	The vehicle can carry out all driving functions and does not require that the driver remain ready to take control of navigation. However, the quality of the ADAS navigation may decline under certain conditions such as off-road driving or other types of abnormal or hazardous situations. The driver may have the option to control the vehicle
Level 5	The ADAS system is advanced enough that the vehicle can carry out all driving functions no matter the conditions. The driver may have the option to control the vehicle

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