Easter Parades in New York City

Year 1900: One Motor Vehicle

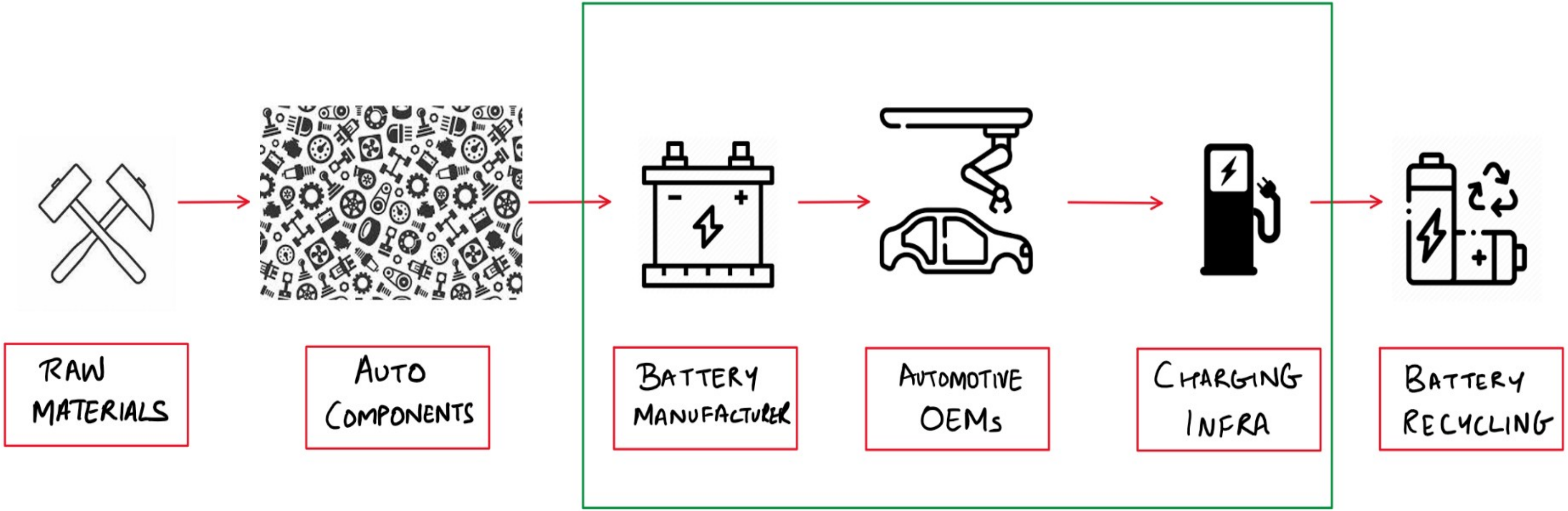
Year 1913: One Horse & Carriage

Narrative Driven Industry

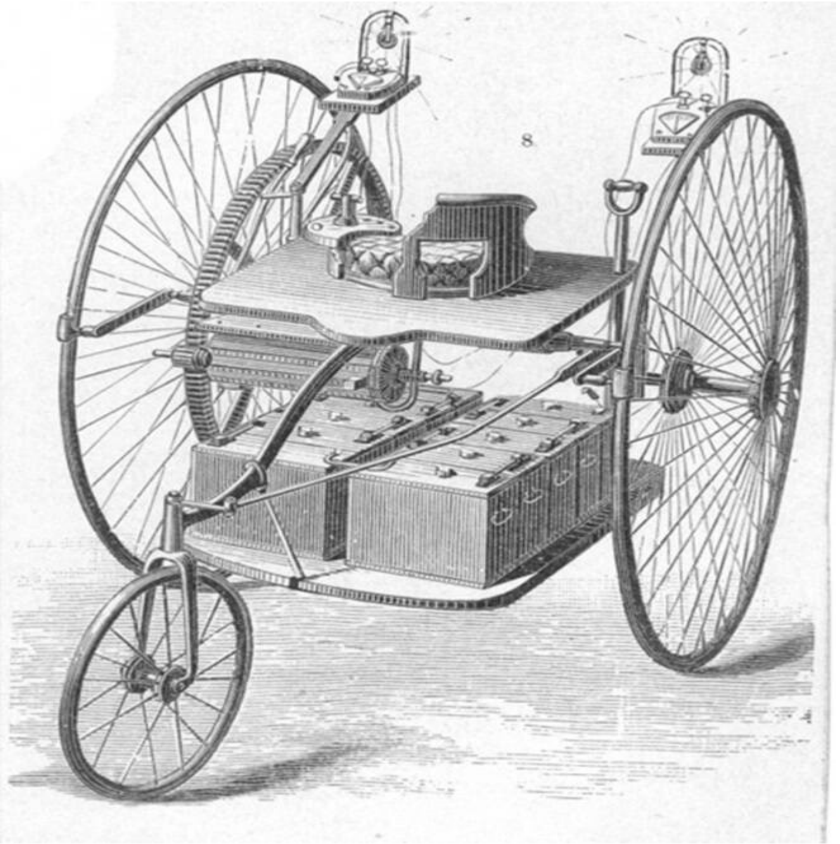
- **Company A:** Returns of 15x in ~2 years. However, company turned profitable just last year. (Listed in US)
- **Company B:** Core business was of setting up power generation units in India. In April 2021, company bought a 43% stake in India's first electric motorcycle company for Rs 150 Crores. The EV company sold ~2,000 units in CY 2020. Company B has returned ~4.4x since April (After a ~40%+ drop from peak). (Listed in India)
- **Company C:** Company had advertised a prototype electric commercial vehicle. Share price rose by ~5x between March to June 2020. However, after certain news flow, the price has dropped by ~85% till date. (Listed in US)

ELECTRIC VEHICLE ECOSYSTEM

08 August 2021 00:54



Electric Vehicle OEMs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M1052

TATA POWER

Why EVs adoption is going up?

TATA

Decline in Battery Cost

Stringent Environmental Norms

Government's Push

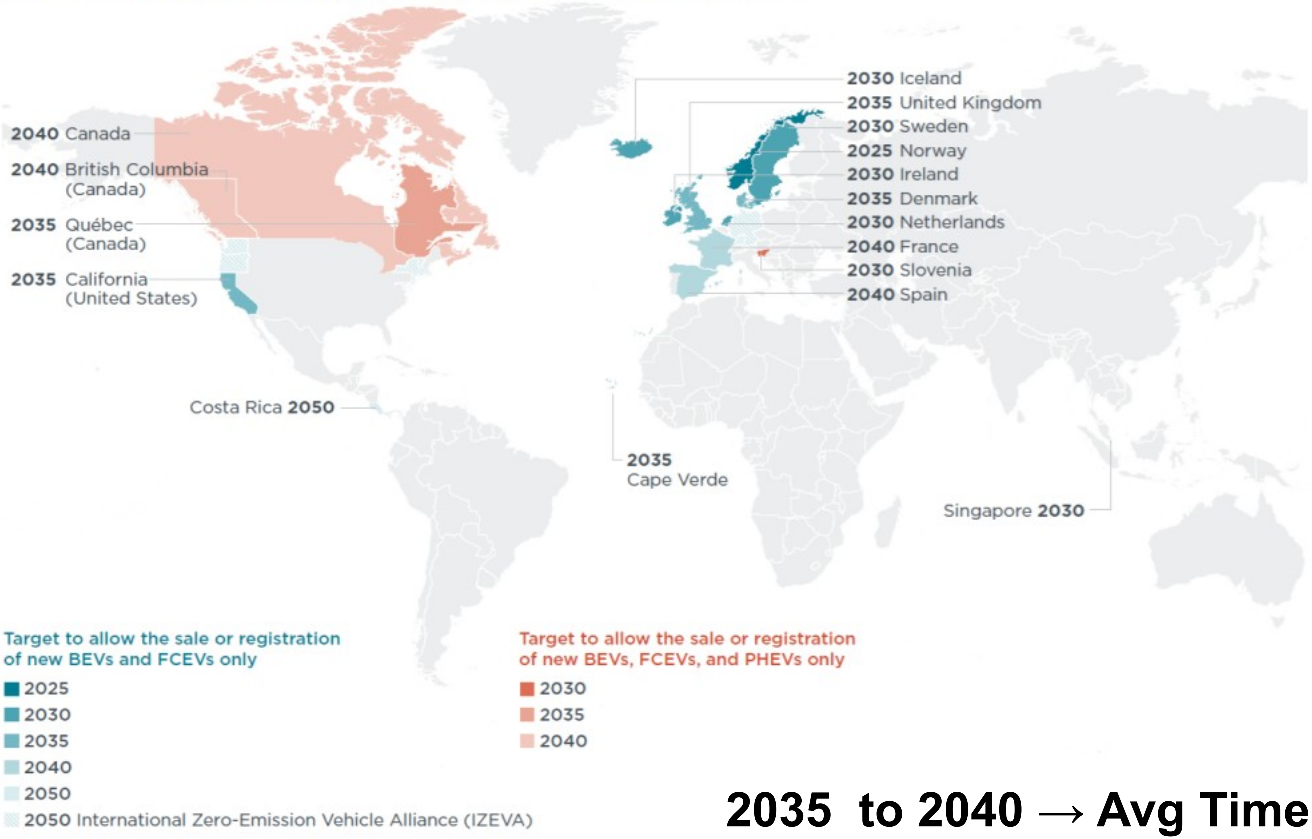
Technological Advancements

EV Vs ICE*

- 5x cheaper to charge/refuel
- 100x fewer moving parts
- 10x-100x cheaper to maintain
- Electric motor more powerful & 5x energy efficient

Advent of EVs is inevitable not just because of Government push but also because of its standalone commercial/economic benefits

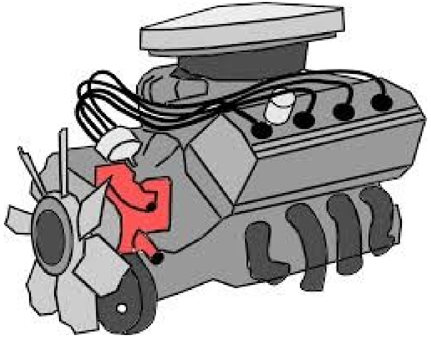
EXHIBIT 5: **Governments targeting 100% phase-out of new ICE car sales**

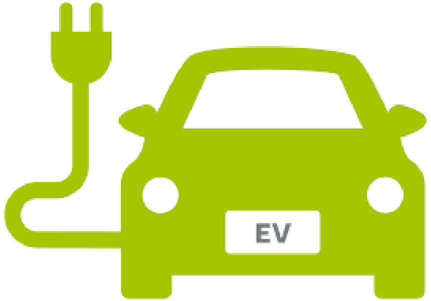


2035 to 2040 → Avg Timeline

Source: International Council on Clean Transportation (ICCT), Bernstein analysis

Common Jargons





Greenhouse Gas Emissions

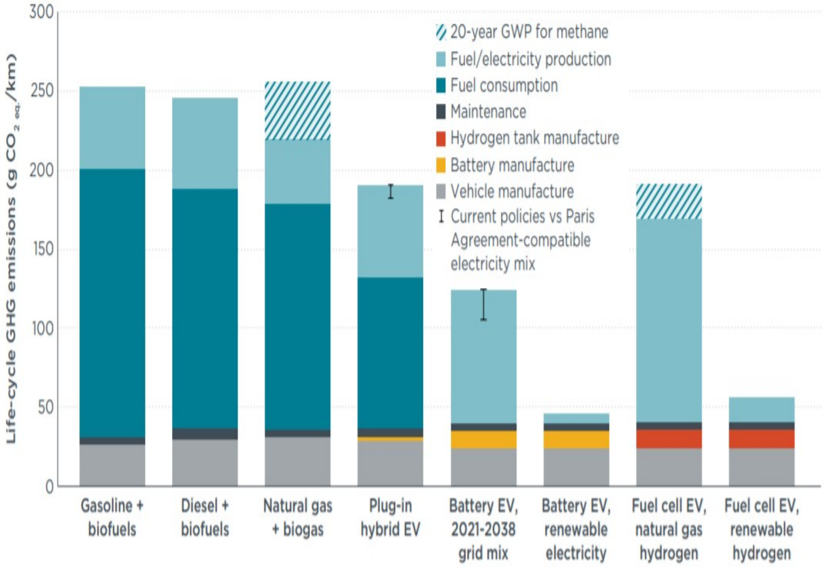


Figure 7.1. Life-cycle GHG emissions of average medium-size gasoline, diesel, and CNG ICEVs, PHEVs, BEVs, and FCEVs registered in China, Europe, India, and the United States, in 2021.

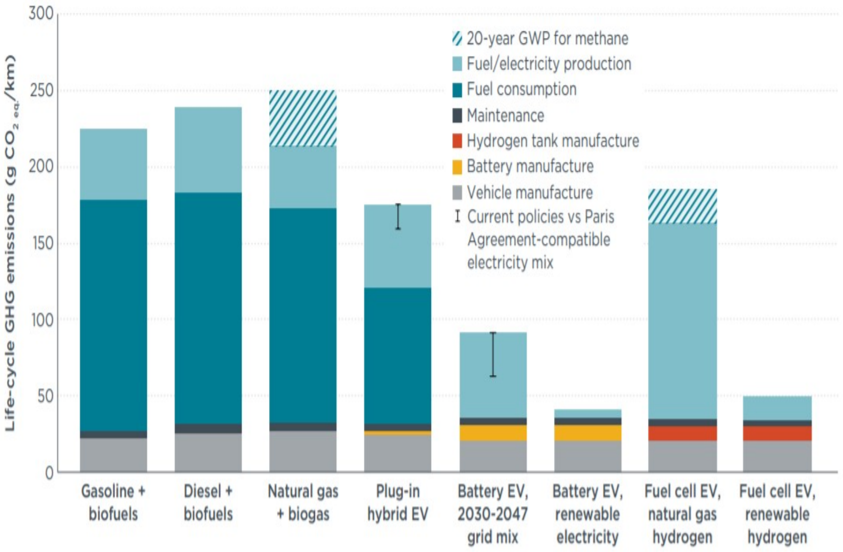


Figure 7.2. Life-cycle GHG emissions of average medium-size gasoline, diesel, and CNG ICEVs, PHEVs, BEVs, and FCEVs projected to be registered in China, Europe, India, and the United States in 2030.

Source:
International Council of Clean Transportation Report

FAME II Incentives

Vehicle Segment	Total Funds (₹ Crs)	Max Ex-Factory Price	Incentive per KWh	Max Incentive per Vehicle	Max No. of Vehicles
2 Wheelers	₹ 2,000.00	₹ 150,000.00	₹ 15,000.00	₹ 60,000.00	1,000,000
3 Wheelers	₹ 2,500.00	₹ 500,000.00	₹ 10,000.00	NA	500,000
4 Wheelers	₹ 530.00	₹ 1,500,000.00	₹ 10,000.00	NA	35,000
4W Hybrids	₹ 30.00	₹ 1,500,000.00	₹ 10,000.00	NA	20,000
Electric Bus	₹ 355.00	₹ 20,000,000.00	₹ 20,000.00	NA	7,000

Internal Combustion Engine v/s Electric Vehicles - 2Ws

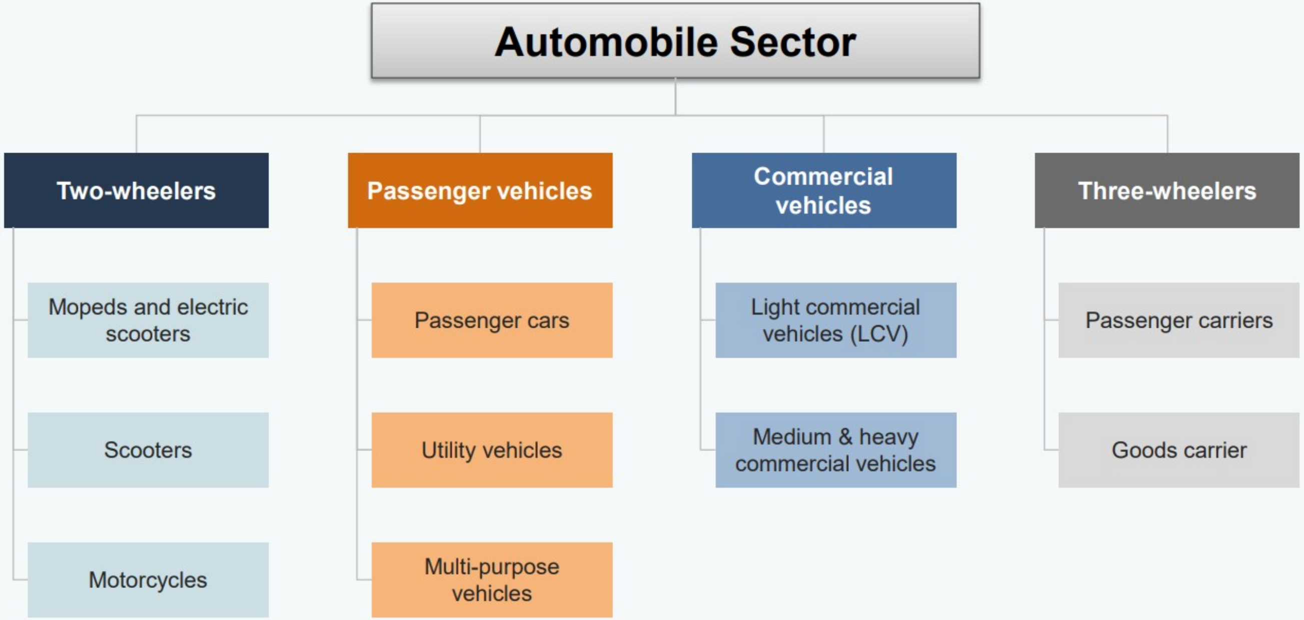
	Activa 125	**NTorq**	**Ather 450X**	**TVS iQube**	**Ola S1**	**HF Deluxe**	**CB Shine**	**Revolt RV 400**
Peak power (in kW)	6.1	6.9	6.0	4.4	8.5	5.9	7.9	3.0
Max Speed (km/hr)	85.0	95.0	78.3	78.0	90.0	85.0	100.0	65.0
Range (kms)	265.0	272.6	117.0	75.0	121.0	617.5	577.5	100.0
Engine / Battery Size (cc/kWh)	125.00	125.00	2.90	2.25	2.98	100.00	125.00	3.20
Cost - Ex Showroom Bangalore	82,701.00	83,451.00	144,500.00	110,506.00	99,000.00	63,425.00	79,715.00	106,000.00
Cost ex Subsidy			188,000.00	144,256.00	143,700.00			154,000.00

Source: Company Website

Challenges for Electric Vehicles

- Range Anxiety for Consumers
- Availability of Charging Infrastructure
- Charge Time
- High Dependency on Government subsidies 
- Different requirements for different segments → High cost of R&D 
- High rate of change in battery technology 
- Lower Profitability v/s High Cash Generation 
- Continuous supply of Electricity (Rural areas) 

Market overview



Source: *Society of Indian Automobile Manufacturers (SIAM)*

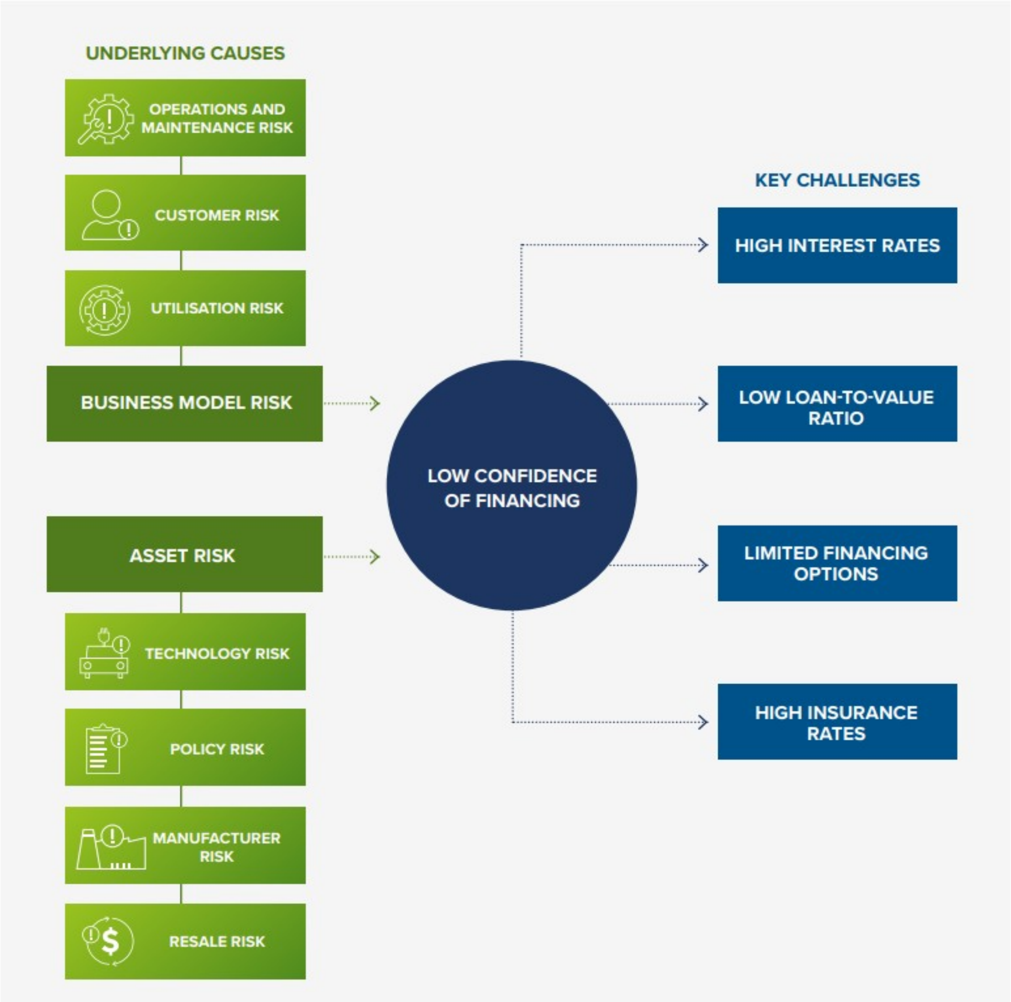
Differentiation in Strategy

- Fixed Batteries → Requires a Charging Network
- Battery Swapping
- Detachable Batteries
- BEVs - Hybrids - Alternative Fuels (Hydrogen, CNG, Flexifuel)
- Direct to Consumer, Dealership Model
- Outright Sale, Leasing Options

Pros & Cons of Battery Swapping

Pros	Cons
● Reduces Initial Acquisition Cost ● Eliminates Long Charging Time ● Alleviates Range Anxiety ● Better Grid Load Management ● Easier Battery Recycling & Disposal ● No change required in consumer behaviour	● Standardisation of Battery Packs ● Reliability of leased battery pack

EXHIBIT 7: KEY CHALLENGES AND UNDERLYING CAUSES IN EV FINANCE



Source:
NITI Aayog + RMI Institute Report

Incumbents are here to stay......

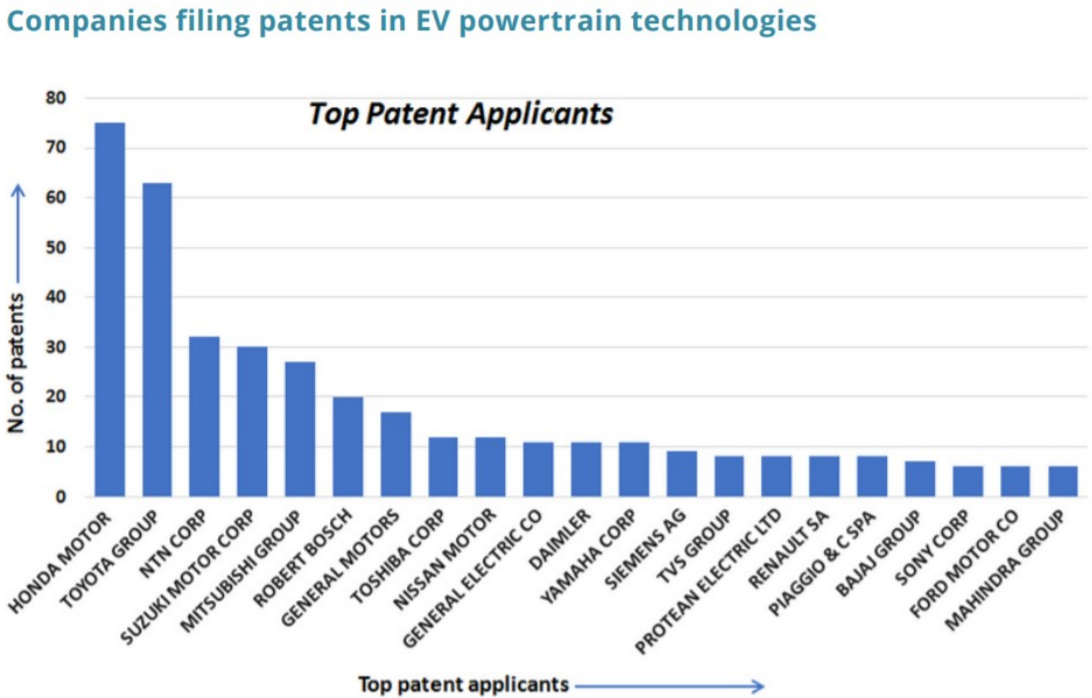


Fig. 3 Bar graph showing the number of patents filed by top patent applicants in the EV powertrain segment to date.

Source:
[EVreporter Aug 2021 Magazine]

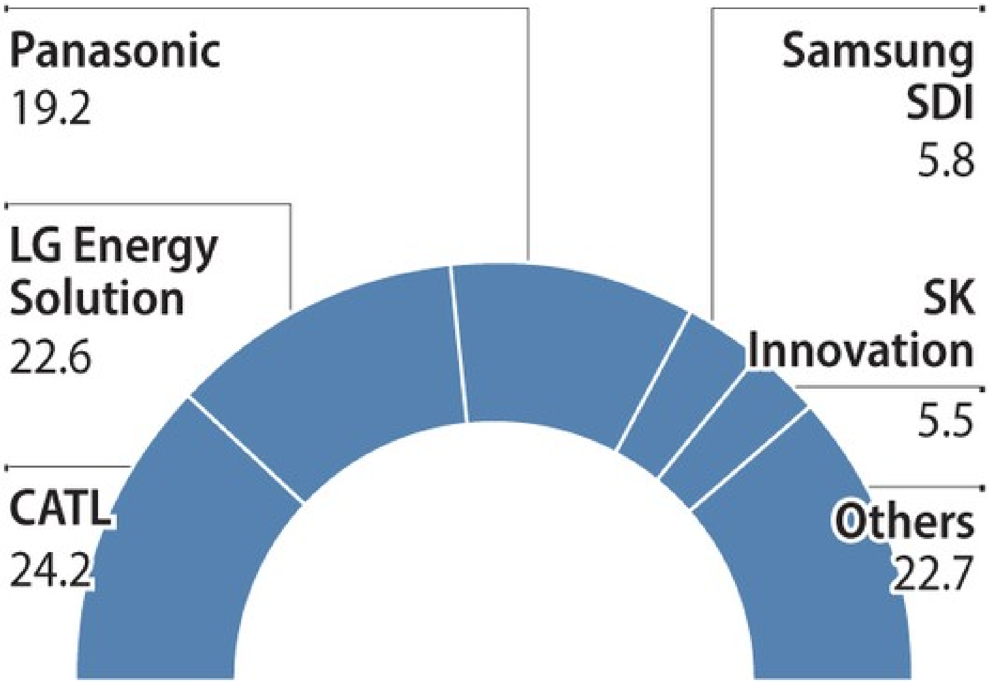
Global Investments and Collaborations

- Major OEMs have announced their Electrification targets (~30% to 50% of new sales between 2025 to 2030)
- VW Group → $85 Billion over 5 years
- Toyota - Suzuki - Daihatsu - Hino - Isuzu collaboration in Japan
- Suzuki - Toyota partnership
- GM & Stellantis → $35 Billion each by 2025
- Hyundai + LG Energy Battery plant in Indonesia (Cost is $1.1 Billion)

Electric Vehicle Batteries

Electric vehicle battery market share in 2020

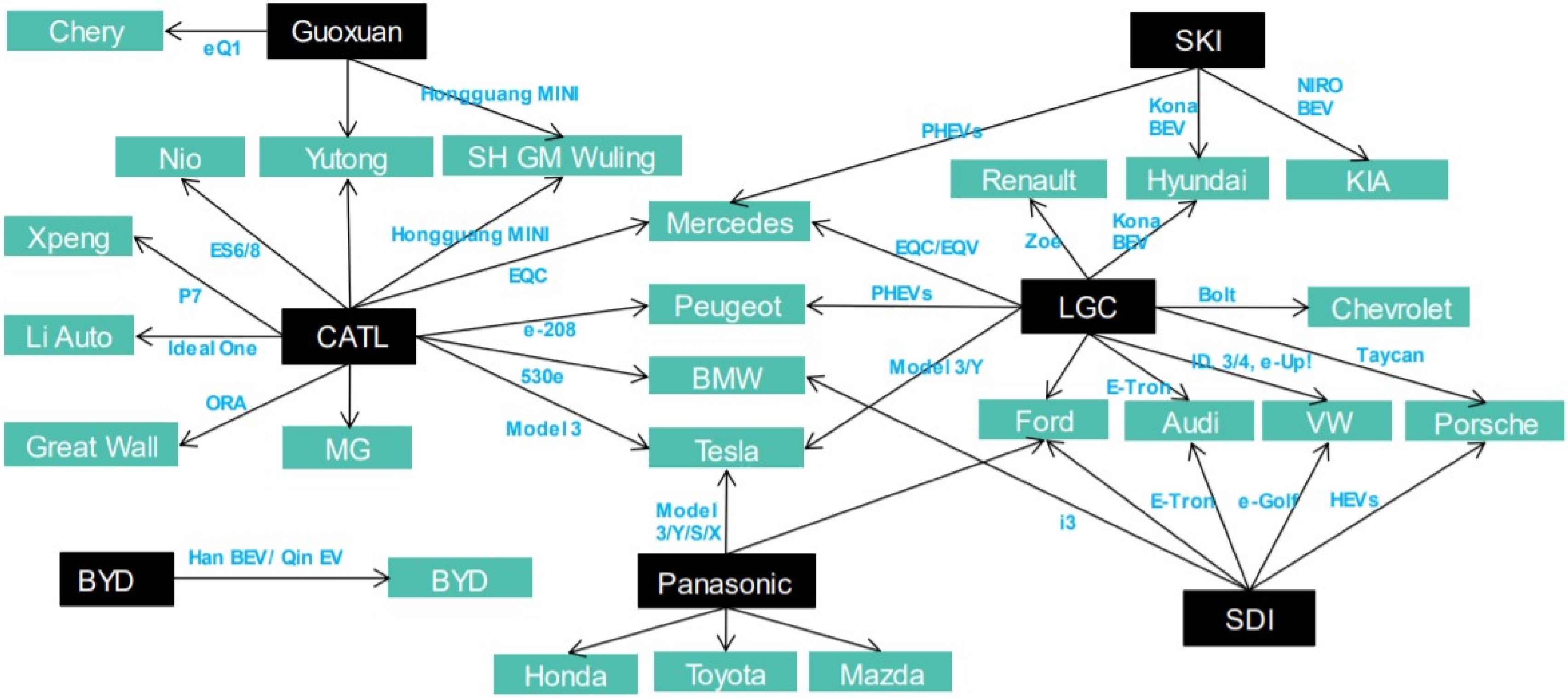
Unit: %



*as of November

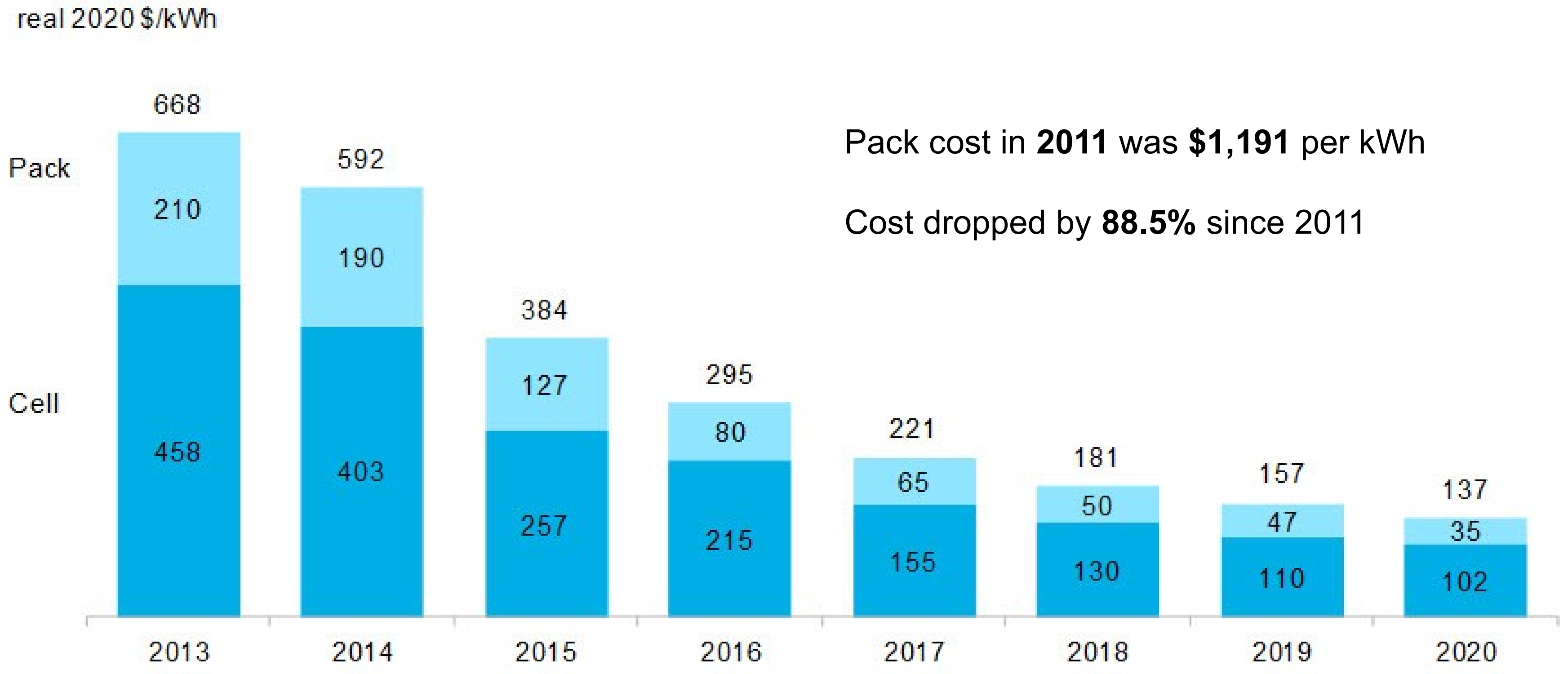
Source: SNE Research

EXHIBIT 36: **Partnership between battery makers and OEMs: CATL has arguably the most diverse customer portfolio amongst battery suppliers**



Source: SNE Research and Bernstein analysis

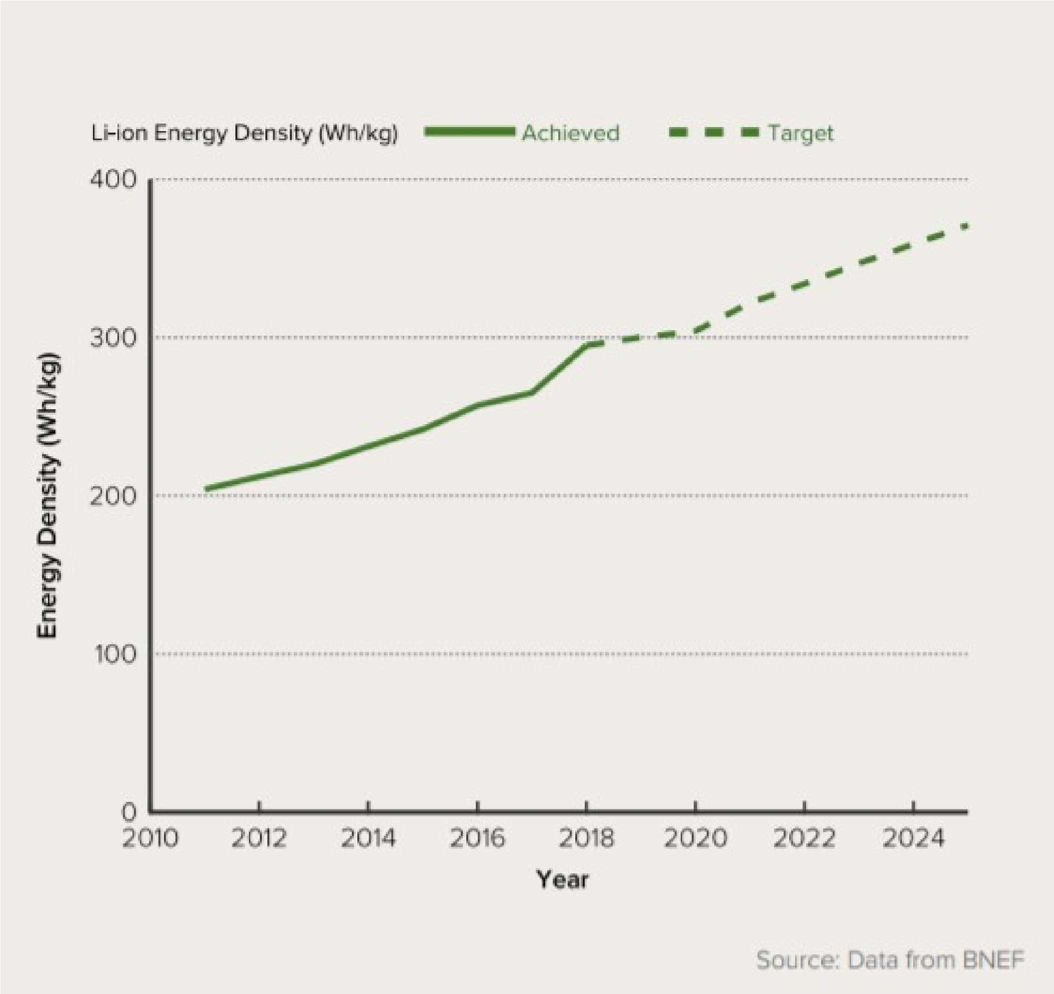
Figure 1: Volume-weighted average pack and cell price split



Source: BloombergNEF

EV Battery Jargons

- Energy Density
- Battery Types
  - Lithium Iron Phosphate (LFP)
  - Lithium Nickel Manganese Cobalt (NMC)
  - Lithium Nickel Cobalt Aluminium Oxides (NCA)
  - Sodium Ion batteries
  - Solid state batteries
  - Hydrogen Fuel Cells (Grey v/s Blue v/s Green)



Source:
[RMI Report - Breakthrough Batteries]

Energy Density by Fuel Type

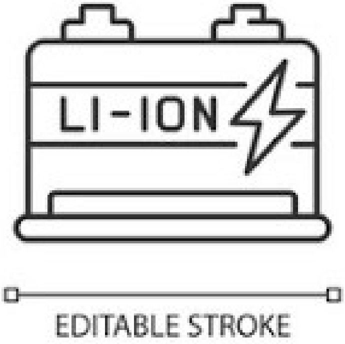


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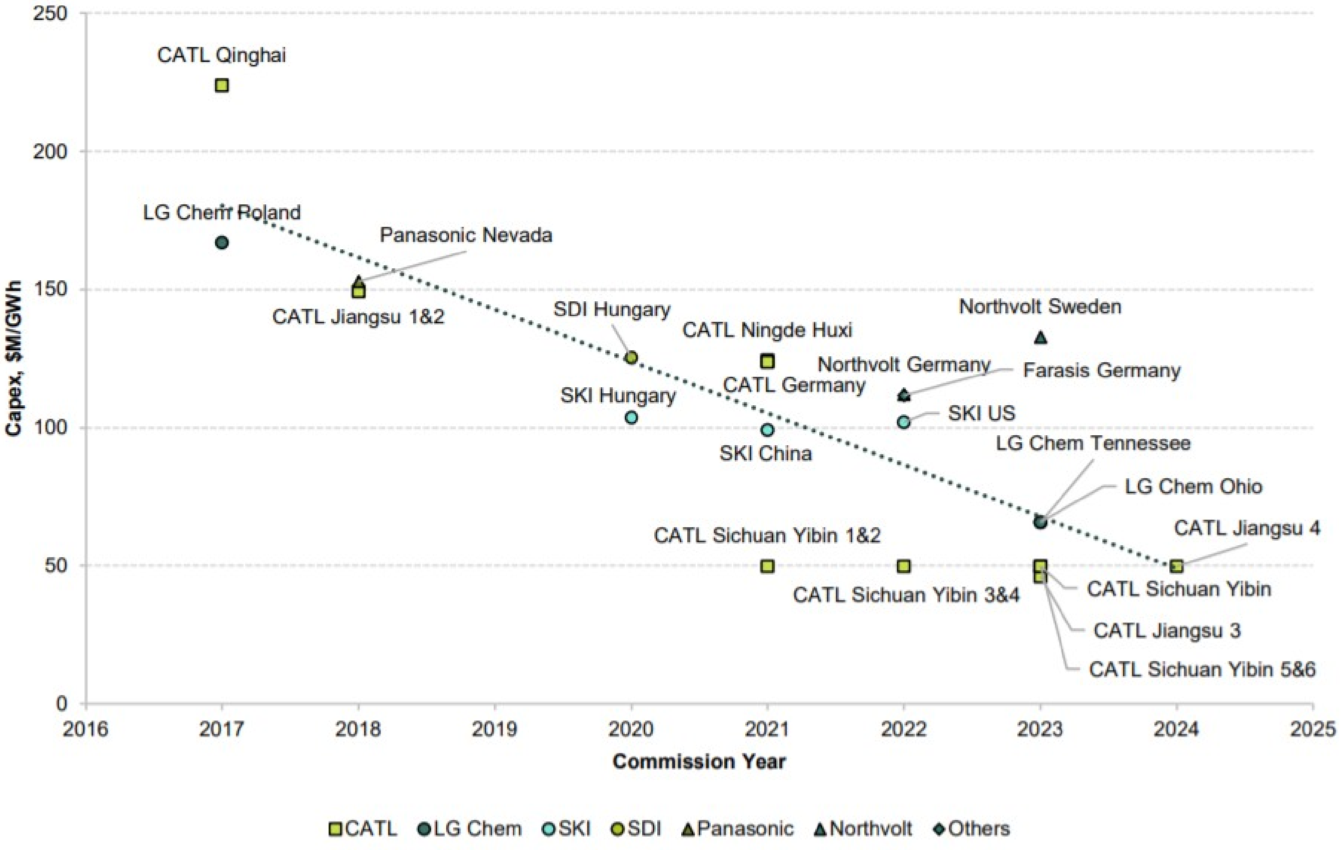
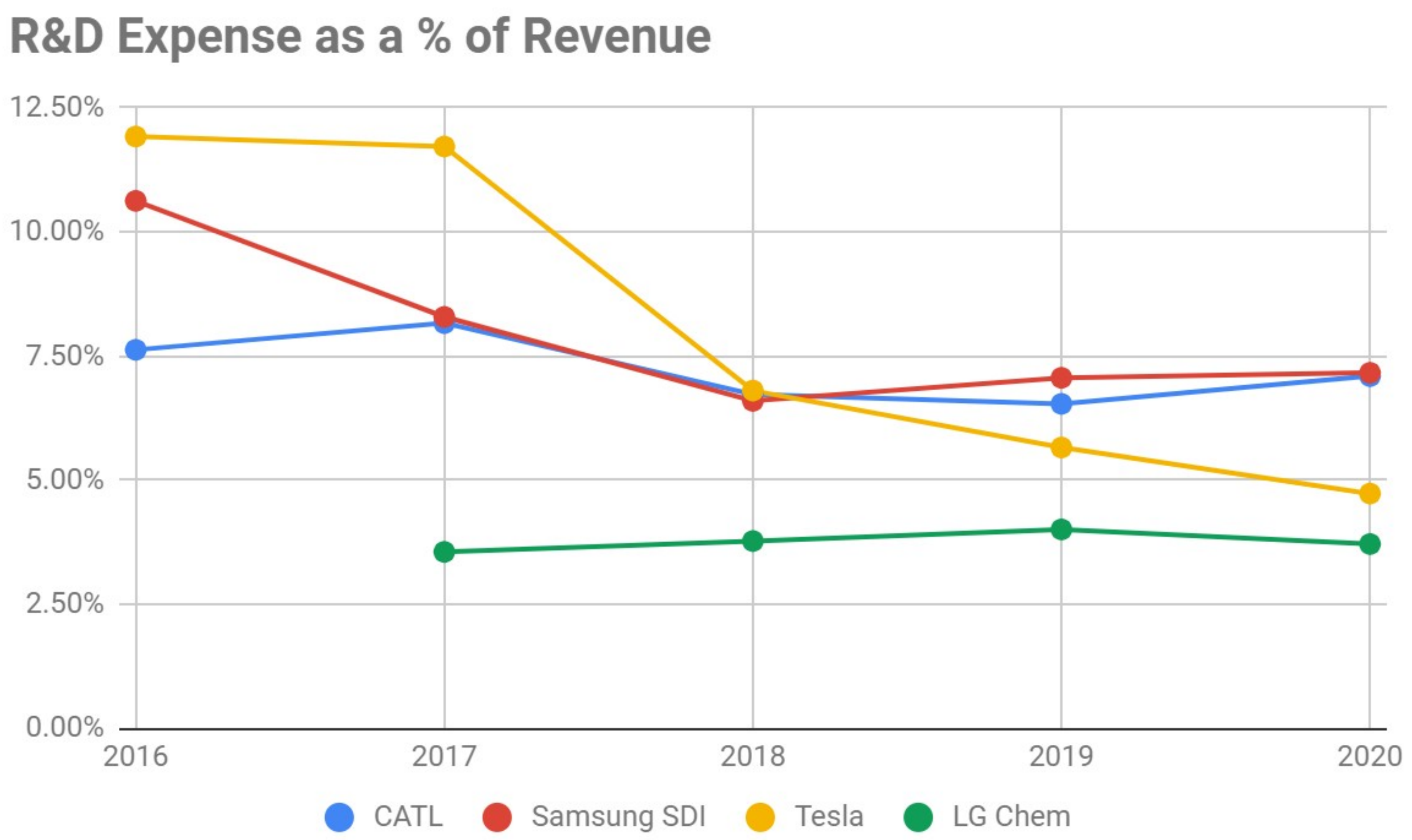
EXHIBIT 22: **Battery plant capital costs have fallen from around >$150M/GWh few years ago to $50-100M/GWh**

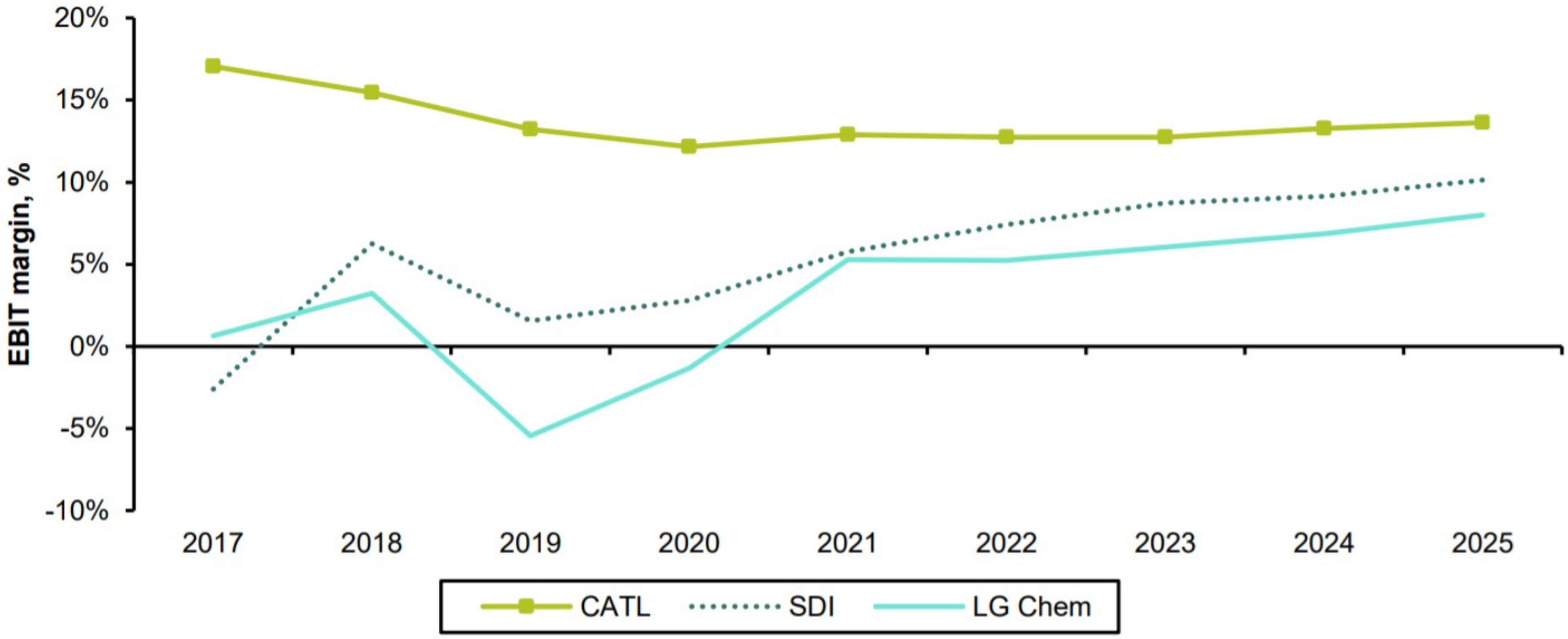


Source: Company data, Bloomberg, Bernstein analysis



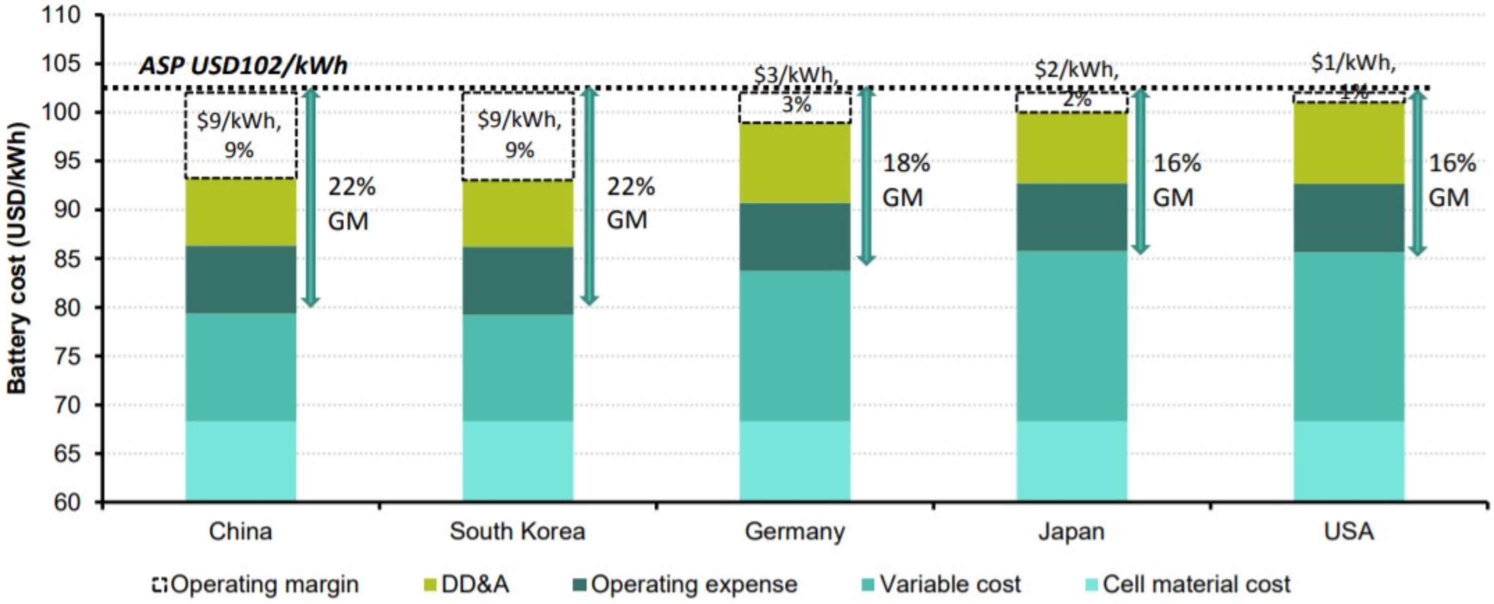
R&D Expense as a % of Revenue
12.50%
10.00%
7.50%
5.00%
2.50%
0.00%
2016
2017
2018
2019
2020
CATL
Samsung SDI
Tesla
LG Chem

EXHIBIT 26: **EBIT margin for the battery business is close to 10%**



Source: Company data, Bernstein estimates (2021+) and analysis

EXHIBIT 58: **Players in China and South Korea could achieve a higher GP margin due to lower labor and utility cost**

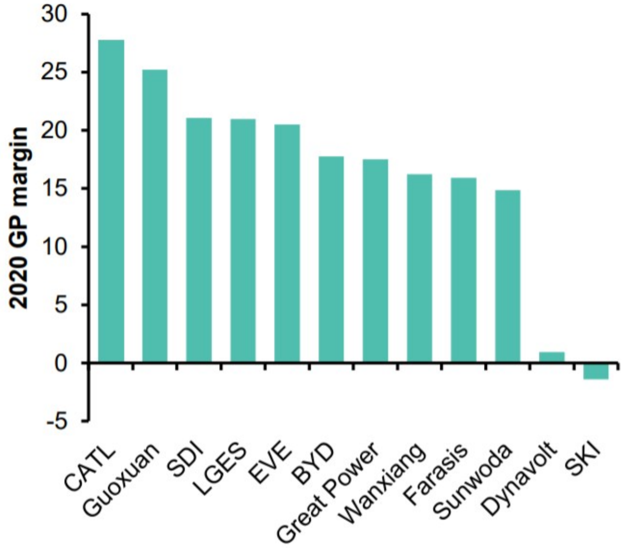


Source: BNEF, Bernstein analysis and estimates (all)

NB: assuming material cost of $62/kWH for all countries

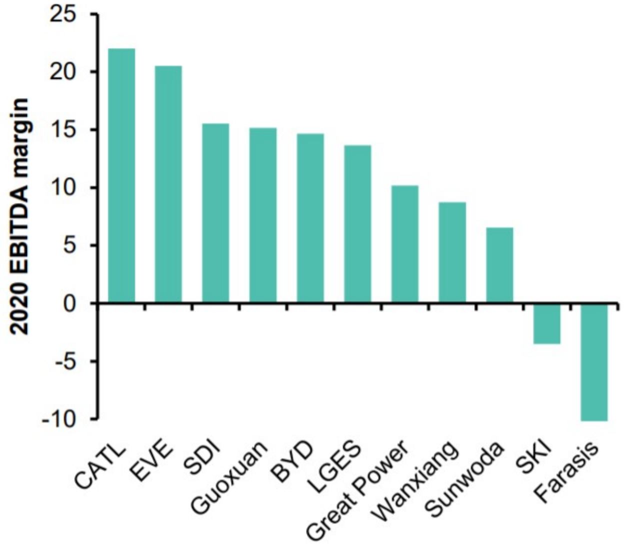
High Operating Leverage

EXHIBIT 60: **CATL has the highest GP margin of Chinese battery makers**



Source: Company, Bernstein analysis

EXHIBIT 61: **EBITDA margins are also the highest relative to peers**



Source: Company, Bernstein analysis

Make in India?

Exhibit 41: Even at a 10 million production scale, the raw materials used are a fraction of existing reserves

Battery capacity/vehicle(kwh)	Total vehicles sold p.a. (mn)	Gwh	Assuming 50% share of both NMC and LFP (tonnes)						
			Lithium	Manganese	Cobalt	Nickel	Iron	Phosphorus	Graphite
2.5	0.5	1.25	171	142	142	361	658	362	800
	1.0	2.5	341	285	285	722	1317	724	1599
	5.0	12.5	1706	1424	1424	3611	6585	3622	7995
	10.0	25	3411	2847	2847	7222	13169	7243	15991
Production global (mn tonnes)			0.082	19	0.14	3	1500	223	1
Global reserves (mn tonnes)			21	1300	7.1	94	84000	71000	320
Global Production % of reserves			0.4%	1.4%	2.0%	2.7%	1.8%	0.3%	0.3%
Production India (mn tonnes)			0	0.64	0	0	140	1.5	0.034
India reserves (mn tonnes)			0	34	0	0	3400	46	8
India Production % of reserves				1.9%			4.1%	3.3%	0.4%
Share of current reserves used at 25Gwh									
% of global			0.016%	0.0002%	0.04%	0.008%	0.00002%	0.00001%	0.005%
% of India				0.008%			0.0004%	0.016%	0.20%

Source: USGS, Ambit Capital

THE WALL STREET JOURNAL.

Scientists in Japan and the U.S. have led the development of lithium battery technologies since the 1990s. When China sought to catch up in the 2000s, LFP was an easier option to meet safety standards because the batteries are less prone to catching fire, said Tokyo University professor Atsuo Yamada.

Before 2017, LFP was the mainstay battery for what was then a tiny EV market in China. It briefly lost market share, in part because a government-subsidy program favored longer-range vehicles, but made a comeback last year when the subsidies were pulled back and technology improved.

SHARE YOUR THOUGHTS

Would you buy an electric vehicle with a lithium ferrophosphate battery? Join the conversation below.

Mr. Yamada, who has been studying LFP batteries for more than 20 years, said he believed the technology was good enough to take a leading role in the EV market. He cited the low cost, rapid charging speed, long life and stable performance at high temperature.

He described the cold-weather issue as manageable, saying it could be fixed with a better temperature-control system.

Penn State's Prof. Wang and colleagues published a paper in the journal Nature Energy in January demonstrating technology for self-warming LFP batteries that could charge adequately in all climates.

Elon Musk
@elonmusk

Replying to @RationalEtienne and @skorusARK

Nickel is our biggest concern for scaling lithium-ion cell production. That's why we are shifting standard range cars to an iron cathode. Plenty of iron (and lithium)!

3:17 AM · 26/02/21 · Twitter for iPhone

Govt notifies ₹18,100 cr PLI scheme for promoting manufacturing of ACC batteries

The scheme will incentivize manufacturing and storage of lithium-ion cells and batteries in the country, essential for developing electric vehicles. **(REUTERS)**

2 min read . Updated: 21 Jun 2021, 06:17 PM IST

Investments in India

- Amara Raja to invest $1 Billion over the next 10 years (10 GW facility)
- Suzuki - Denso - Toshiba → Rs 5,000 Crores
- Amperex Technology Limited → Rs 7,000 Crores
- Exide Industries
- Reliance Industries → Rs 60,000 Crores for 4 Gigafactories (Solar PV modules, Electrolyzers, Fuel Cells and Batteries)

Charging Infrastructure

India to require 400,000 charging stations for 2 mn EVs by 2026: Report

As per EV industry body - Society of Manufacturers of Electric Vehicles - there are 1,800 charging stations in India as of March 2021

Topics

Electric Vehicles | Auto sector | electric cars

IANS | New Delhi

Last Updated at June 12, 2021 19:56 IST

Source: Business Standard

Table 6. List of Commonly Used Charging Connectors From IEC 62196

Level 1 and Level 2 Couplers (AC Charging)	
Type 1	Also known as the SAE J1772 connector. Type 1 can be used for Level 1 and Level 2 charging. This connector is most common in North America and Japan.
Type 2	Also known as the "Mennekes" connector. Type 2 can be used for Level 1 and Level 2 charging. This connector is most common in the EU.
GB/T (AC)	A connector designed by and used exclusively in China.
DCFC Couplers (DC Charging)	
CCS1	Combined Charging System 1 (CCS1): A charging connector that can be used for DCFC only. This connector type is an extension of the SAE J1772 connector (detailed above). This charging standard is most common in North America.
CCS2	Combined Charging System 2 (CCS2): A charging connector that can be used for Level 1, Level 2, or DCFC. This connector type was originally developed in Germany. This charging standard is most common in the EU and India.
CHAdeMO	CHAdeMO: A charging connector that can only be used for DCFC. This connector type was developed by a group of Japanese automakers and occurs primarily in Japanese EVs sold to the United States and Japan.
GB/T (DC)	GB/T: A connector designed by and used exclusively in China.
AC Level 2 and DCFC	
Tesla	Tesla: A charging connector that can be used for both DCFC and Level 1 and Level 2. Proprietary to Tesla vehicles. Used in all Tesla markets except China and Europe.

Coupler images adapted from (EnelX JuiceBlog 2019)

Source: USAID & NREL Report

The cost of a charging station mainly depends on the charging standard used, the power output you want from the charger (or, in other words, how fast you want a battery to get a charge).

Charger type	Output power (KW)	Cost of charger
Bharat AC-001	3.3	70,000
Bharat DC-001	15	2,40,000
Type 2 AC	22	1,25,000
CHAdeMO	50	14,50,000
CCS	50	14,50,000

Source: E-vehicleinfo.com

Providing EV charging infra in India is like doing social service: Magenta Power

ngi Bhatia, ETAuto • Last Updated: Aug 21, 2021, 09:55 PM IST

SHARE FONT SIZE SAVE PRINT

Synopsis
The electric vehicle charging infrastructure is the backbone of electric mobility but given the chicken and egg situation of what should be implemented first, it is often also seen as one of the barriers to EV adoption in India given its limited availability and long charging times.

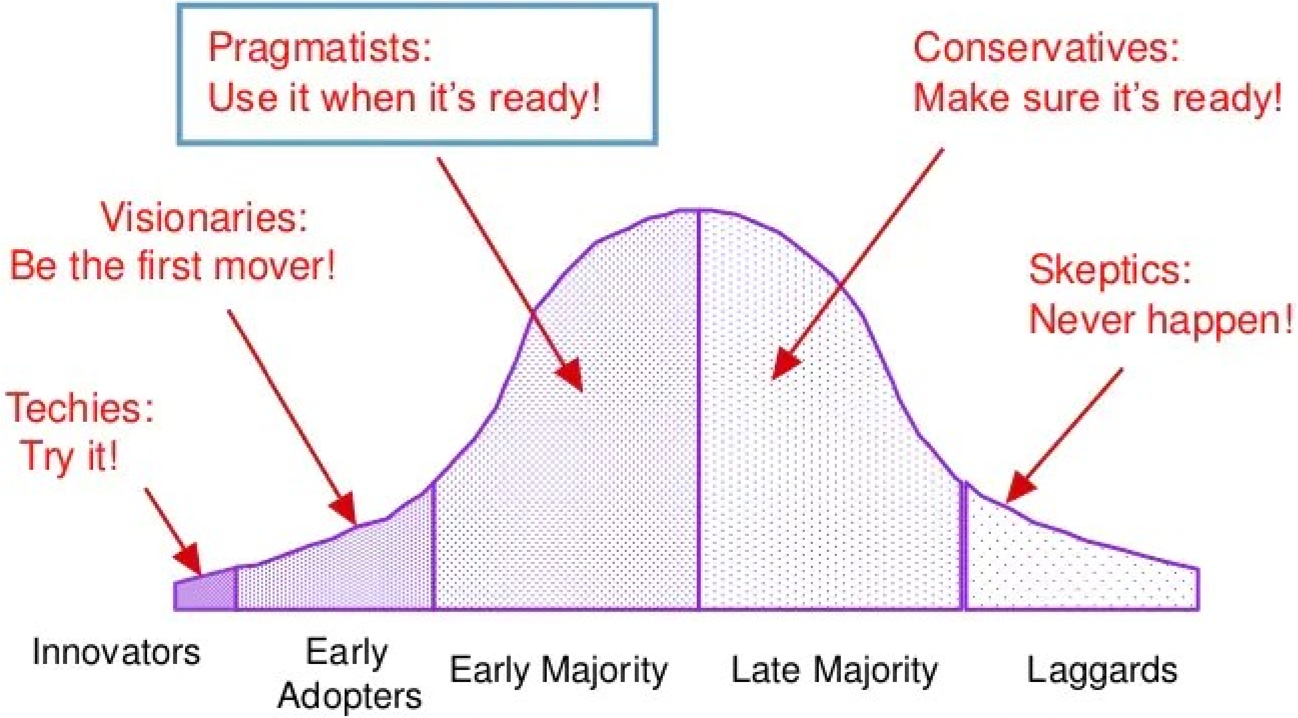
Maxson Lewis, co-founder and MD, Magenta Power, says the company has three revenue streams namely hardware, installation and charging-as-a-service.

Providing charging infrastructure for electric vehicles (EVs) in India is like doing social service. As a business model in the Indian context very little money can be made from it at this point of time, says **Maxson Lewis**, co-founder and MD, **Magenta Power** at the latest episode of #StartupAdda.

On a normal DC charger one can make money only if it is used for 5 charging sessions a day and continue to use it every day for 5 consecutive years, he said.

Average charging in India is around 1 to 1.5 sessions per charger or even less than that. Thus, the breakeven point for the industry would be 5 charging sessions a day. "Globally also the utilisation rate for the best charging stations is around 26% only," he said.

Technology Adoption Life Cycle



Pragmatists' view of whole product maturity drives the adoption of new technology.

How to get exposure to the EV theme today?

Listed entities which may benefit from shift to EVs (Not Exhaustive)

- **Manufacturing OEMs** - Tata Motors, Hero MotoCorp, Bajaj Auto, Maruti, M&M, TVS Motors, RattanIndia Enterprises, Bharat Forge, Ashok Leyland
- **Battery Manufacturing** - Amara Raja, Exide Industries, Reliance Industries, BHEL, JSW Energy
- **Charging Infrastructure** - Tata Power, NTPC, Indian Oil
- **Auto Components** - Sona Comstar, Bosch, Minda Industries, Endurance Technologies
- **Battery Recycling** - Tata Chemicals
- **Raw Material Suppliers**
- **Third Order Effect**

LOGISTICS

TAGLINE GOES HERE

Overview Hydrogen Concepts

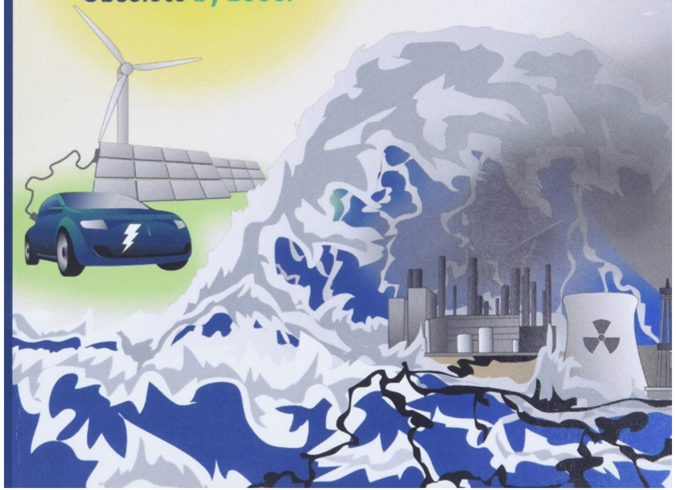
At Airbus, we have the ambition to develop the world's first zero-emission commercial aircraft by 2035. Hydrogen propulsion will help us to deliver on this ambition. Our ZEROe concept aircraft enable us to explore a variety of configurations and hydrogen technologies that will shape the development of our future zero-emission aircraft.

CLEAN DISRUPTION

OF ENERGY AND TRANSPORTATION

Tony Seba

How Silicon Valley Will Make Oil, Nuclear, Natural Gas, Coal, Electric Utilities and Conventional Cars Obsolete by 2030.



Sources

- EVreporter
- Society of Manufacturers of Electric Vehicles
- E-vehicleinfo
- Autocar review videos
- Company Presentations
- Faster Adoption and Manufacturing of Hybrids and EVs (FAME)
- NITI Aayog
- National Renewable Energy Laboratory
- FICCI Reports
- Sell Side Reports