

MCQ Question · mcqquestion.com

Alternative Powertrain Vehicles: BEV, FCEV, and FCHEV Explained

Free · Share

Alternative Powertrain Vehicles: BEV, FCEV, and FCHEV Explained

Practice: 8 MCQs

At a glance

Alternative powertrains replace the plain petrol or diesel engine with batteries, fuel cells or both.

01 **Types**BEV, HEV, PHEV, FCEV and FCHEV mix a fuel, a battery and a motor in different ways.
02 **Batteries**Most EVs use lithium-ion packs. The usual anode is graphite.
03 **Efficiency**Check whether a figure covers the grid, the drive system or the fuel cell alone.
04 **India**FAME II, EMPS, PM E-DRIVE and PLI-Auto back EVs. Sources differ on dates and outlays.

- Only a PHEV among the hybrids can plug in.
- An FCEV does carry a battery pack.
- Zero tailpipe emissions do not mean zero life-cycle emissions.
- UPSC asked about these vehicles in CSP 2025, Q41 and Q43.

PowertrainThe parts that make a vehicle move.
Regenerative braking Braking that turns motion back into electricity.
EPRExtended producer responsibility for waste batteries.
PLIProduction Linked Incentive scheme.

An alternative powertrain is a way to move a vehicle other than a plain petrol or diesel engine. This lesson compares battery electric, hybrid, plug-in hybrid, fuel cell and fuel cell hybrid vehicles. It covers batteries, charging, efficiency, regenerative braking, India’s schemes, the Indian

market, the environmental trade-offs and the exam questions. For fuel cell and hydrogen detail, see the sibling lesson on FCEVs. Where sources differ, both numbers are shown with dates.

Contents

1. Types
2. Batteries and charging
3. Efficiency
4. India's policy
5. Indian market
6. Environment
7. Exams and traps
8. 4 questions to think through
9. 7 understanding checks
0. Related topics

What are the main types of alternative powertrain vehicles?

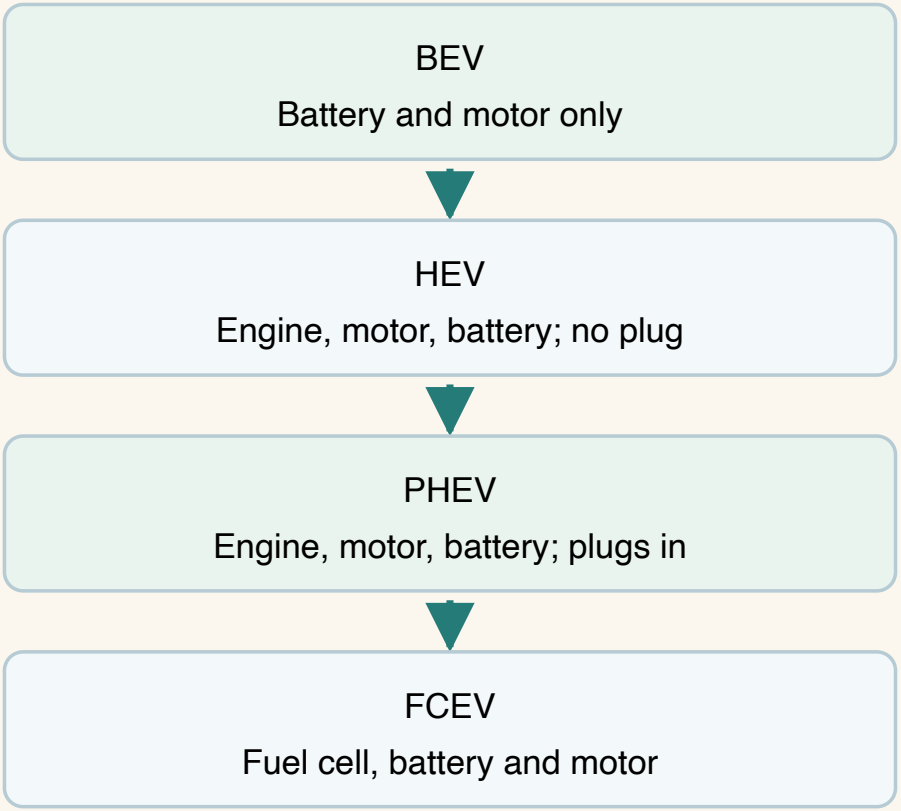
Start with the family tree. Each type mixes a fuel tank, a battery and a motor in a different way.

1. What is an "alternative powertrain" vehicle?

No official Indian or UPSC definition of the term “alternative powertrain” was found in the sources checked. The PIB backgrounder of 5 August 2026 lists the types of electric vehicle instead. They are **battery EVs**, hybrid EVs, plug-in hybrids and fuel cell EVs.

The US law on “alternative fueled vehicles” is a useful comparison. It names fuel cell vehicles and “qualified hybrid” vehicles. So hybrids are not left out of that law.

- PIB (Aug 2026): BEV, HEV, PHEV and FCEV are the four EV types.
- US law (EPAct 1992, as amended in 2008): fuel cell and hybrid vehicles are included.



The PIB lists these as the four EV types.



Tata Nexon EV, a battery-electric car sold in India. Photo: DriveSpark, CC BY 3.0, via Wikimedia Commons. File page. Licence: CC BY 3.0.

Source: PIB, Roads Reimagined: The Rise of India's Electric Vehicles Ecosystem, 5 Aug 2026, item 1

Source: US DOE, NDAA 2008 guidance on alternative fueled vehicles, item 1

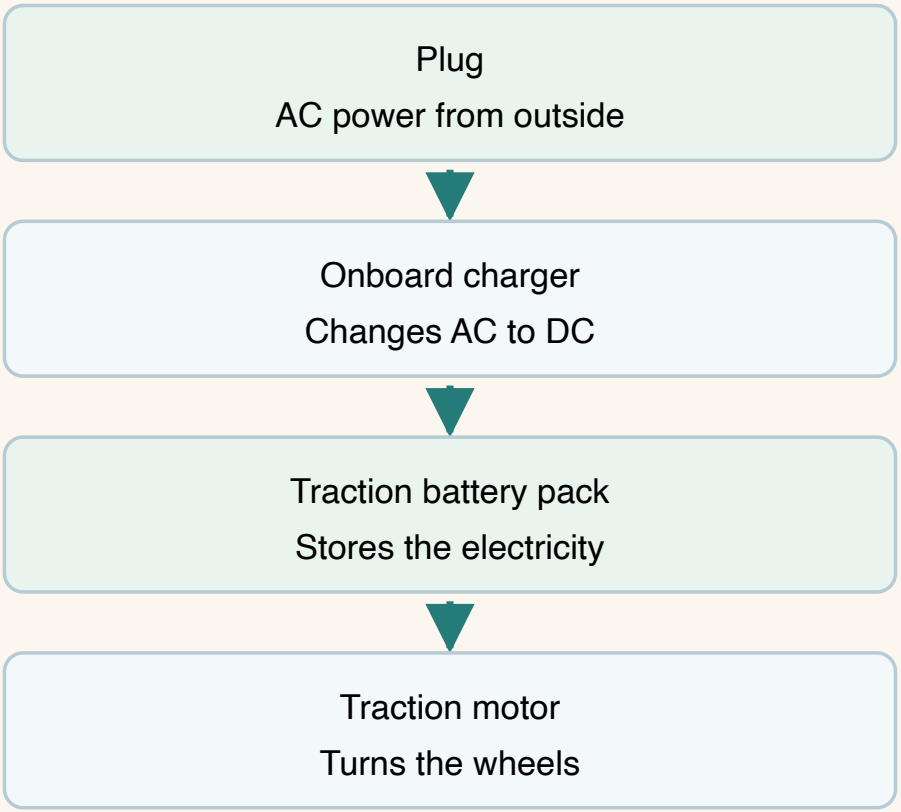
2. How does a battery electric vehicle (BEV) work?

A BEV runs on an electric motor. The motor draws power from a **traction battery pack**. The vehicle must plug in to charge.

The AFDC says a BEV has **no tailpipe exhaust**. It also has no fuel pump, fuel line or fuel tank.

- Traction battery pack: stores the electricity.
- Electric traction motor: turns the wheels.
- Onboard charger: changes AC from the plug into DC for the battery.

- Power electronics controller: manages the flow of energy to the motor.
- DC/DC converter: steps voltage down for accessories.



A controller manages the flow of energy.

Source: US DOE AFDC, How Do All-Electric Cars Work?, item 2

3. What is a hybrid electric vehicle (HEV)?

An HEV pairs an internal combustion engine with one or more electric motors. The motors use energy stored in a battery. The AFDC says an HEV **cannot be plugged in**.

The electric motor adds power. So the maker can fit a smaller engine. The battery can also run accessories and cut engine idling at a stop.

The AFDC separates mild hybrids from full hybrids. Mild hybrids cost less and give less benefit. Full hybrids cost more and give better fuel economy.

The DOE says the **Toyota Prius was released in Japan in 1997**. It used a nickel metal hydride battery. The DOE calls it the world's first mass-produced hybrid.

HEV	PHEV
Cannot plug in	Can plug in
Braking charges it	Engine can charge it
Smaller engine	15 to 60+ miles electric

Only the plug-in type has an external charge.



Cutaway of a 2023 Toyota Prius plug-in hybrid (European spec). Photo: TTTNIS, CC0, via Wikimedia Commons. File page.

True or False: A hybrid electric vehicle (HEV) can be plugged in to charge its battery.
Source: US DOE AFDC, Hybrid Electric Vehicles, item 3

Source: US DOE, The History of the Electric Car, item 3

4. What is a plug-in hybrid electric vehicle (PHEV)?

A PHEV has a battery-driven motor and an engine. It can also plug in to charge. The AFDC says current PHEVs travel about **15 to 60-plus miles** on electricity alone. That is roughly 24 km to about 97 km or more. The AFDC gives miles only.

The engine starts when the battery runs low. It also starts during rapid acceleration or heavy heating and cooling demand.

A PHEV battery charges in three ways:

- From external charging equipment on the grid.
- From the engine.

- From **regenerative braking**.

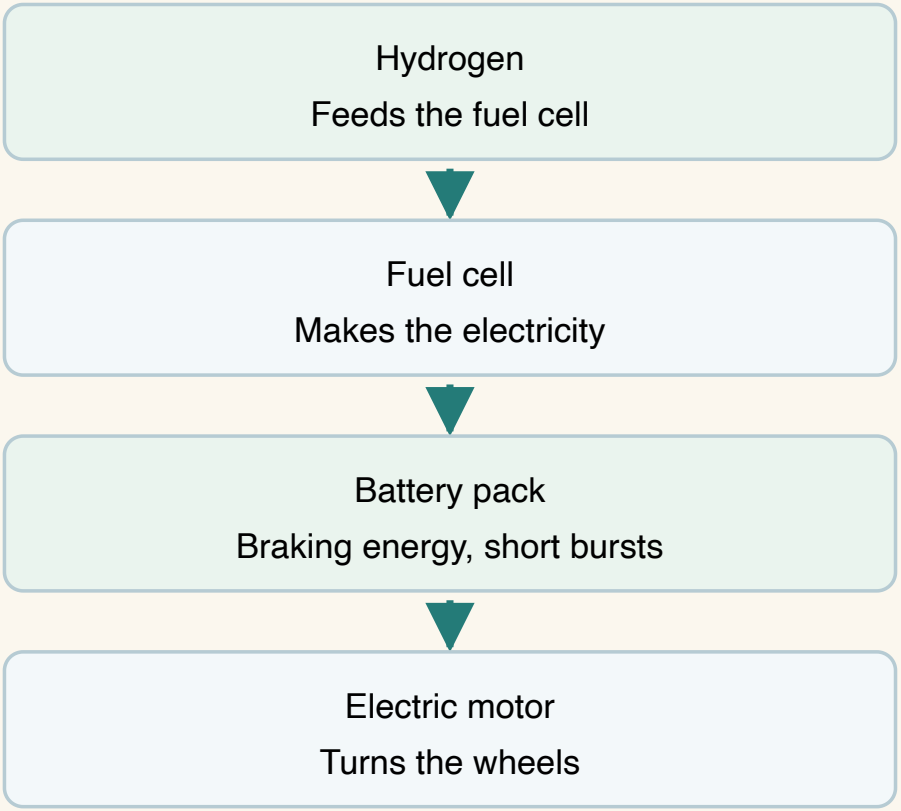
Source: US DOE AFDC, Plug-In Hybrid Electric Vehicles, item 4

5. What is a fuel cell electric vehicle (FCEV), and does it carry a battery?

An FCEV makes its own electricity from hydrogen in a fuel cell. It then sends that power to an electric motor. The AFDC says this is unlike a BEV, which draws power only from a battery.

An FCEV does carry a battery. The AFDC says most FCEVs today use it to recapture braking energy. The battery also gives extra power in short bursts. It also smooths the power coming from the fuel cell.

So the claim “an FCEV has no battery” is false. The AFDC component list shows a **high-voltage battery pack**.



A BEV draws power only from a battery.



Toyota Mirai fuel-cell stack and hydrogen tank, cutaway display, Sao Paulo Auto Show 2016. Photo: Mariordo (Mario Roberto Duran Ortiz), Wikimedia Commons, CC BY-SA 4.0.

True or False: In most FCEVs, a battery recaptures braking energy and adds power in short bursts.
Source: US DOE AFDC, How Do Fuel Cell Electric Vehicles Work Using Hydrogen?, item 5

Source: US DOE AFDC, Fuel Cell Electric Vehicles, item 5

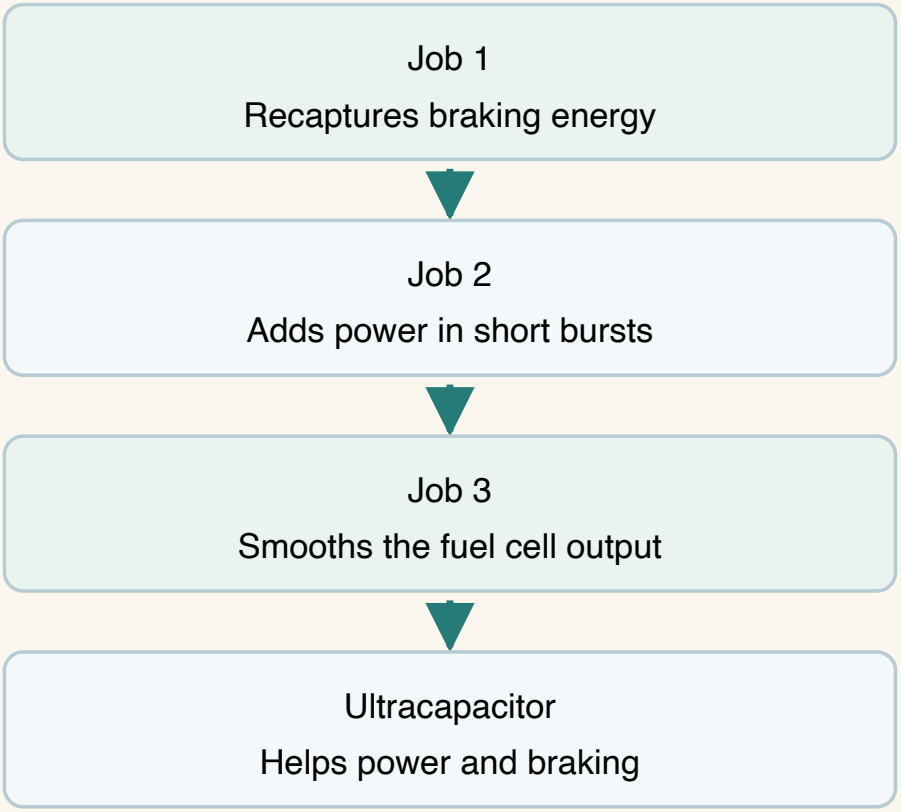
6. What is a fuel cell hybrid (FCHEV), and what does the battery or supercapacitor do?

This lesson uses “FCHEV” as its own label for a fuel cell vehicle with an energy buffer beside the fuel cell. The AFDC does not use the term. The UPSC stem says “fuel cell-electric hybrid vehicles”. The buffer is a battery, and sometimes an ultracapacitor. The AFDC says ultracapacitors are secondary energy-storage devices. They help with power delivery and braking energy recovery.

The AFDC says the battery in an FCEV does three jobs. It **recaptures braking energy**. It adds power during short acceleration. It smooths the fuel cell output.

The AFDC says a maker can also idle or switch off the fuel cell at low power demand.

The AFDC does not call the fuel cell slow. It only lists the jobs of the battery.



An ultracapacitor is a secondary energy-storage device.

Source: US DOE AFDC, How Do Fuel Cell Electric Vehicles Work Using Hydrogen?, item 6

Source: US DOE AFDC, Batteries for Electric Vehicles, item 6

How do batteries and charging work?

Next, look at the battery pack and the plug.

7. What is inside a lithium-ion EV battery?

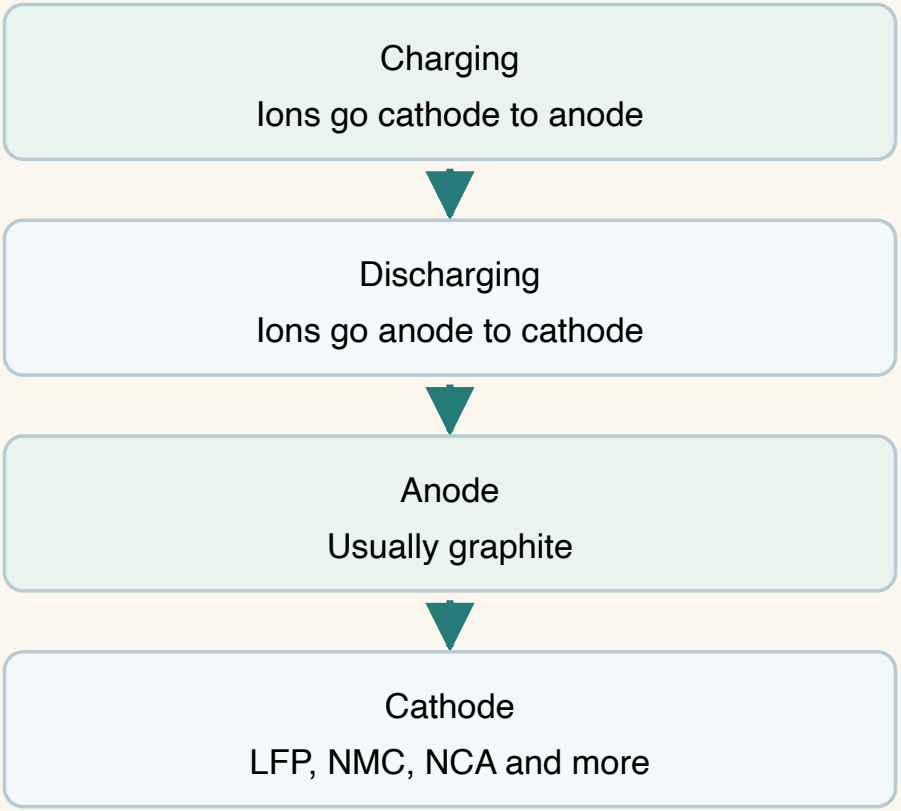
The AFDC says lithium-ion batteries are used in most of today's all-electric vehicles and PHEVs. The AFDC lists their strengths. They store high energy per unit mass and volume, with long life and low self-discharge.

The DOE describes a "rocking chair" design. Lithium ions move from the cathode to the anode while charging. They move back to the cathode while discharging.

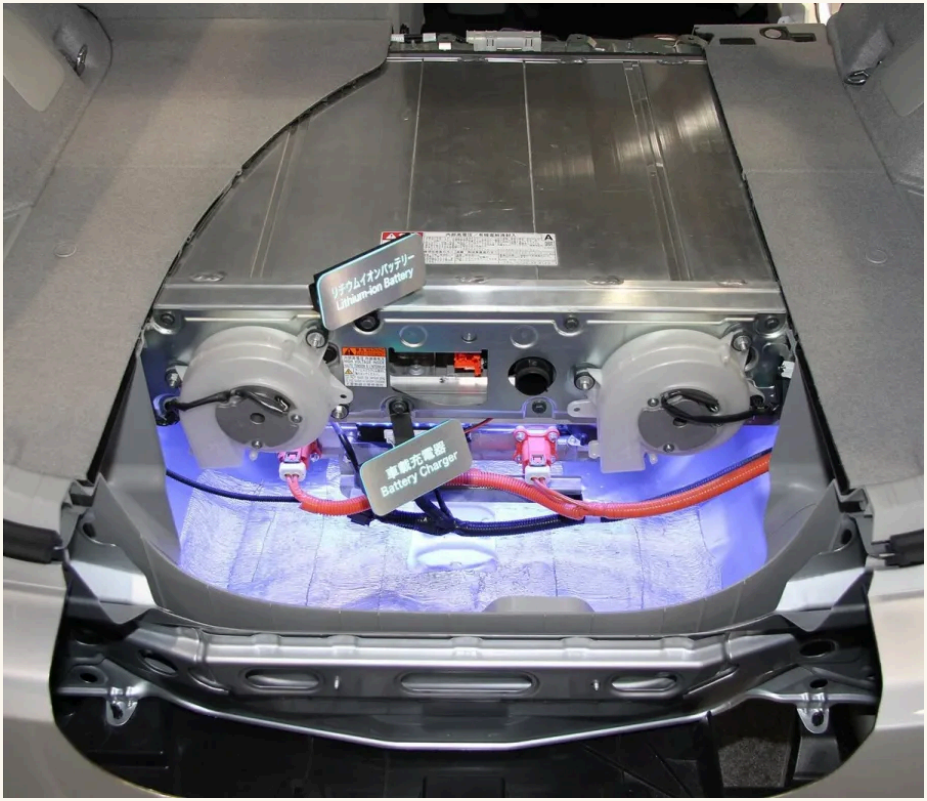
The DOE says the usual anode is **graphite or another carbon**. The cathode comes in several classes. Examples are LFP (lithium iron phosphate), NMC (lithium nickel manganese cobalt oxide) and NCA.

The DOE says NMC and LFP dominate the lithium-ion battery industry today. It says NMC is valued for energy density and LFP for safety. It names cobalt, nickel and lithium as the most critical elements.

- Anode: usually graphite.
- Cathode: LFP, LCO, NMC, LMO or NCA.
- HEVs: the AFDC says nickel-metal hydride has been widely used in HEVs.



The DOE calls this the rocking chair design.



Lithium-ion battery and battery charger in a Toyota Prius plug-in hybrid. Photo: TTTNIS, public domain, via Wikimedia Commons. File page.

True or False: Graphite is the usual anode material in an EV lithium-ion battery.
Source: US DOE AFDC, Batteries for Electric Vehicles, item 7

Source: US DOE, Technology Strategy Assessment: Lithium-ion, July 2023, item 7

8. How long does an EV battery last?

A DOE study says EV batteries may last **12 to 15 years** in moderate climates. It says 8 to 12 years in severe climates. A replacement can be costly.

The AFDC says studies find a battery has **at least 70% of its initial capacity** left at the end of its vehicle life. It can serve another 10 years or more in second-life uses, such as stationary storage.

Source: US DOE, fueleconomy.gov, Electric Vehicle Technology, item 8

Source: US DOE AFDC, Batteries for Electric Vehicles, item 8

9. What are the three charging levels?

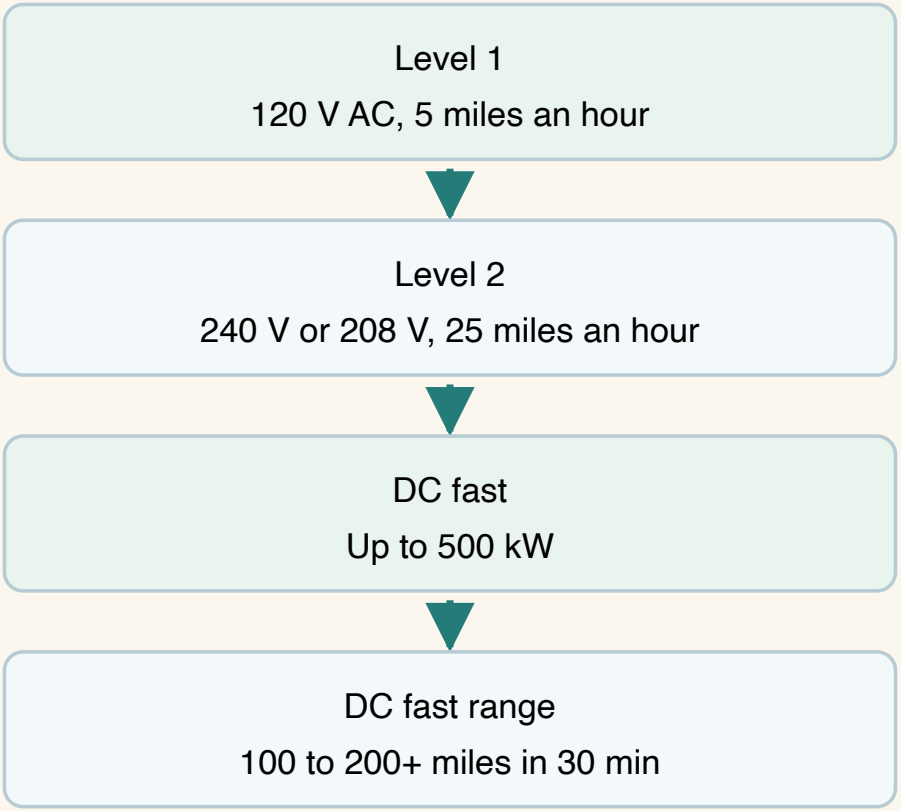
The AFDC groups chargers by how fast they charge. The numbers below are US figures. These are US figures and may differ in India.

- **Level 1**: a 120 V AC plug. About 5 miles of range per hour.
- **Level 2**: 240 V or 208 V AC. About 25 miles of range per hour.
- **DC fast charging**: power up to 500 kW. About 100 to 200+ miles of range per 30 minutes.

The AFDC says total charging time can range from under 20 minutes on a DC fast charger to 20 hours or more on Level 1.

The DOE (fueleconomy.gov) gives a looser view. It says fully recharging can take 3 to 12 hours. It says even a fast charge to 80% can take 30 minutes.

For India, the PIB splits chargers into “fast” and “slow”. See item 21.



These are US figures.

True or False: In AFDC figures, Level 2 charging adds about 25 miles of range per hour.
Source: US DOE AFDC, Electric Vehicle Charging Stations, item 9

Source: US DOE, fueleconomy.gov, Electric Vehicle Technology, item 9

10. How is an EV's driving range stated in India?

Makers quote a certified range from a test cycle. Tata Motors' Nexon.ev page shows **489 km**. It labels this the "certified full charge range as per MIDC Part 1 + Part 2". The page also shows a fast-charge time of 40

minutes. A footnote marks the range figure: it says the figure is ARAI certified and actual performance may vary.

A test-cycle range is not a road figure. The page does not give real-world range.

The DOE gives a US view. It says most EVs travel more than 100 miles per charge. Some go beyond 200 miles, and a few beyond 400.

Source: Tata Motors, Nexon.ev, item 10

Source: US DOE, fueleconomy.gov, Electric Vehicle Technology, item 10

How do regenerative braking and efficiency compare?

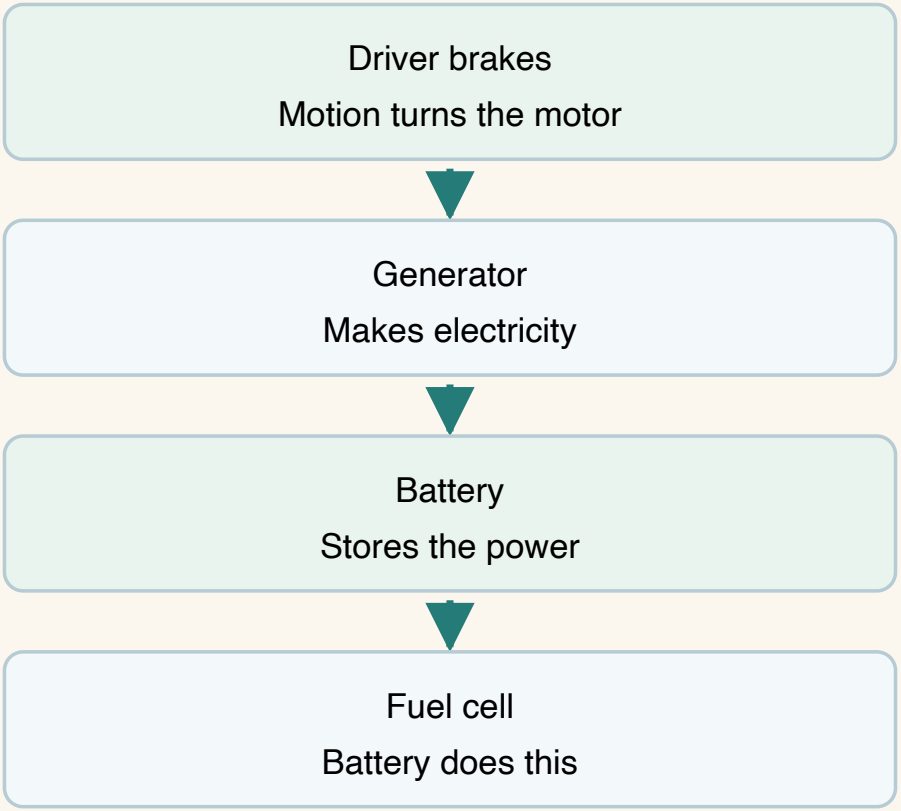
Different efficiency numbers measure different things. Keep them apart.

11. How does regenerative braking work?

When a driver brakes, the car's motion turns a motor-generator. The generator makes electricity. That power goes into the battery.

The DOE says stop-and-go traffic gives the most benefit. An HEV uses the same idea. The AFDC says the motor becomes a generator and stores the power in the battery.

In an FCEV, the AFDC says a battery stores this energy. See item 5.



Stop-and-go traffic gives the most benefit.

Source: US DOE, fueleconomy.gov, Electric Vehicles, item 11

Source: US DOE AFDC, Hybrid Electric Vehicles, item 11

Source: US DOE AFDC, How Do Fuel Cell Electric Vehicles Work Using Hydrogen?, item 11

12. What do the efficiency figures actually mean?

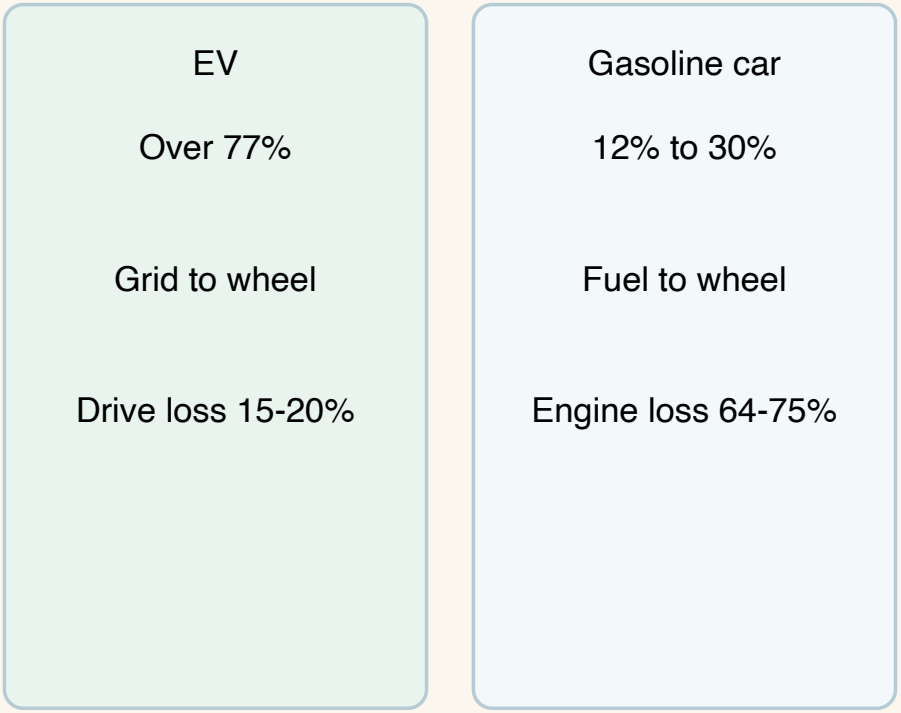
Three different numbers appear in books. They are not interchangeable.

- Grid-to-wheel, EV: the DOE says EVs convert **over 77%** of grid electricity to power at the wheels. It says gasoline vehicles convert

about 12% to 30% of the energy in the fuel.

- Drive-system loss: the DOE says an EV drive system loses 15% to 20%. A gasoline engine loses **64% to 75%**.
- Fuel cell alone: the DOE says fuel cells **can exceed 60% efficiency**. This is the efficiency of the cell itself.

The DOE also gives a combined-driving breakdown for EVs. Charging losses are 10% and accessory losses 3%. Drive losses are 22%. Energy to the wheels is 65% to 69%. Regenerative braking recovers another 22%.



The fuel cell alone can exceed 60%.

Source: US DOE, fueleconomy.gov, Electric Vehicle Technology, item 12

Source: US DOE, fueleconomy.gov, Electric Vehicles, item 12

Source: US DOE, Fuel Cells, item 12

13. How do a fuel cell car and a battery car compare on refuelling and range?

The AFDC says an FCEV fills with hydrogen in **about 5 minutes**. It says range is more than 300 miles. The AFDC says this is similar to a conventional vehicle.

The DOE says a BEV standard recharge takes 3 to 12 hours. A fast charge to 80% can take about 30 minutes.

For buses, the AFDC hydrogen basics page gives 10 to 15 minutes.

BEV	FCEV
Full charge: 3 to 12 h	About 5 minutes
Fast to 80%: can take 30 min	Over 300 miles

Buses take 10 to 15 minutes to fill.

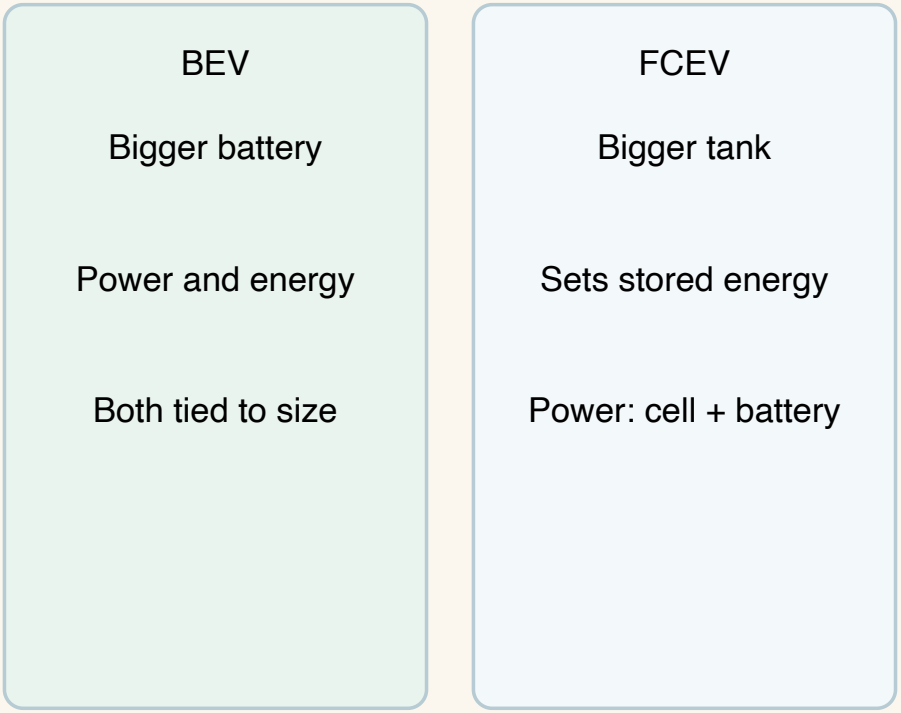
True or False: The AFDC says an FCEV fills with hydrogen in about 5 minutes.
Source: US DOE AFDC, Fuel Cell Electric Vehicles, item 13

Source: US DOE, fueleconomy.gov, Electric Vehicle Technology, item 13

14. Why does an FCEV's stored energy depend on the tank, but a BEV's on the battery?

The AFDC explains the design split. In an FCEV, the stored energy depends on the **hydrogen tank size**. The power depends on the fuel cell and battery.

In a BEV, both power and energy are closely tied to battery size.



Tank size sets the stored energy in an FCEV.

Source: US DOE AFDC, How Do Fuel Cell Electric Vehicles Work Using Hydrogen?, item 14

What is India's policy for electric and hydrogen vehicles?

India supports these vehicles through demand incentives, factory incentives and tax cuts. Scheme dates and amounts changed over time. Both figures are shown where sources differ.

15. What was FAME India Phase II?

FAME stands for Faster Adoption and Manufacturing of (Hybrid and) Electric Vehicles. The Ministry of Heavy Industries (MHI) says Phase II had an outlay of **Rs 10,000 crore** for 3 years from 1 April 2019. The PIB later gives the period as 5 years, to 31 March 2024.

The PIB of December 2025 gives a different outlay. It says Phase II ran for 5 years, 1 April 2019 to 31 March 2024, with **Rs 11,500 crore**.

FAME II supported e-buses, e-3Ws, e-4Ws including strong hybrids, and e-2Ws. The MHI says about 86% of the funds was set aside for demand incentives. The scheme also covered public charging stations.

Source: MHI, FAME II, item 15

Source: PIB, Promotion of EVs and Installation of EV Charging Stations, 16 Dec 2025, item 15

Source: PIB, Initiatives to Improve EV Sector, 5 Aug 2025, item 15

16. What was the Electric Mobility Promotion Scheme (EMPS) 2024?

EMPS 2024 was a fund-limited scheme with a **Rs 500 crore** outlay. It ran from 1 April 2024 to 31 July 2024. It covered e-2Ws and e-3Ws. It aimed to support 3,72,215 EVs. The release said incentives would go only to vehicles fitted with an advanced battery.

Later dates differ. The PIB of 1 April 2025 says EMPS ran 1 April to 30 September 2024. It says PM E-DRIVE then subsumed it.

Source: PIB, MHI announces Electric Mobility Promotion Scheme 2024, 13 Mar 2024, item 16

Source: PIB, MHI achieves sales of more than one million EVs in FY 2024-25, 1 Apr 2025, item 16

17. What is PM E-DRIVE, and what changed?

PM E-DRIVE stands for PM Electric Drive Revolution in Innovative Vehicle Enhancement. The Union Cabinet approved it; the PIB release is dated **11 September 2024** with an outlay of Rs 10,900 crore over two years.

Key parts of the original plan:

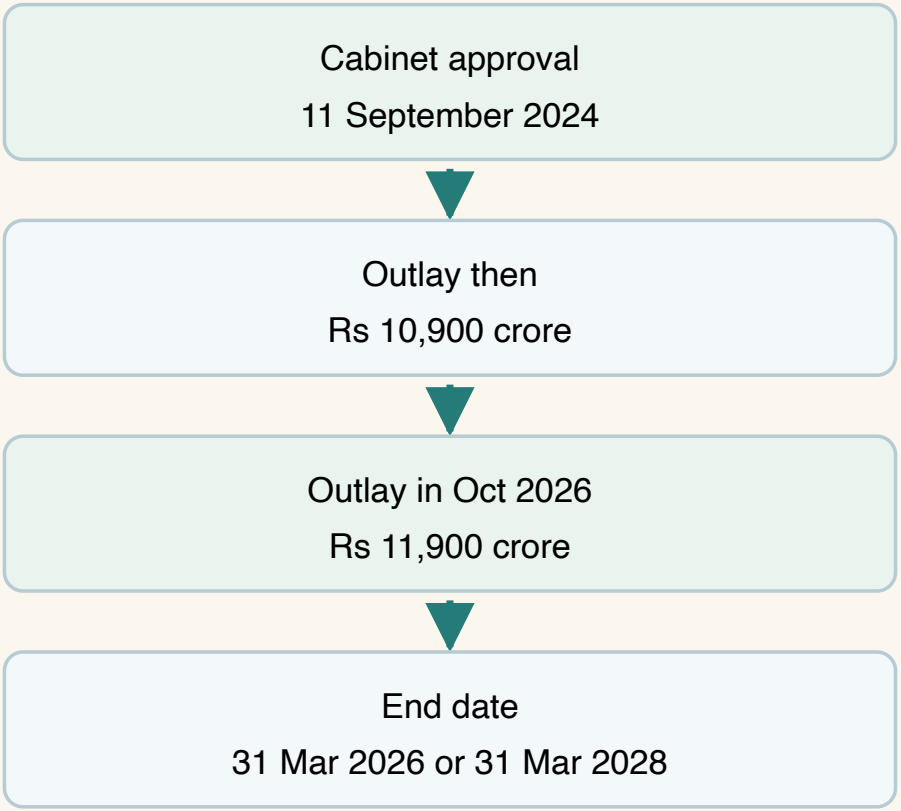
- **Rs 4,391 crore** for 14,028 e-buses.
- Rs 2,000 crore for public charging stations.
- Rs 500 crore each for e-ambulances and e-trucks.
- Rs 780 crore to upgrade vehicle testing agencies.
- Aadhaar-linked e-vouchers for buyers.

By October 2026 the PIB factsheet shows changes. The outlay is Rs 11,900 crore. The end date is 31 March 2028. The e-2W incentive is Rs 2,500 per kWh, capped at Rs 5,000 per vehicle. The PIB says **26.59**

lakh EVs were sold under the scheme as of June 2026. The e-3W (L5) segment closed on 26 December 2025.

Sources disagree on several details:

- Start: the PIB of April 2025 says notified on 29 September 2024. The PIBs of August and December 2025 say it ran from 1 April 2024.
- End: 31 March 2026 in the PIBs of April and August 2025. 31 March 2028 in the PIBs of December 2025 and October 2026.
- Outlay: Rs 10,900 crore in the Cabinet release of September 2024. Rs 11,900 crore in the factsheet of October 2026.



Always say which release you are quoting.

True or False: All official releases agree that PM E-DRIVE ends on 31 March 2026.
Source: PIB, Cabinet approves PM E-DRIVE Scheme, 11 Sep 2024, item 17

Source: PIB, Factsheet: PM E-DRIVE Scheme, 1 Oct 2026, item 17

Source: PIB, MHI achieves sales of more than one million EVs in FY 2024-25, 1 Apr 2025, item 17

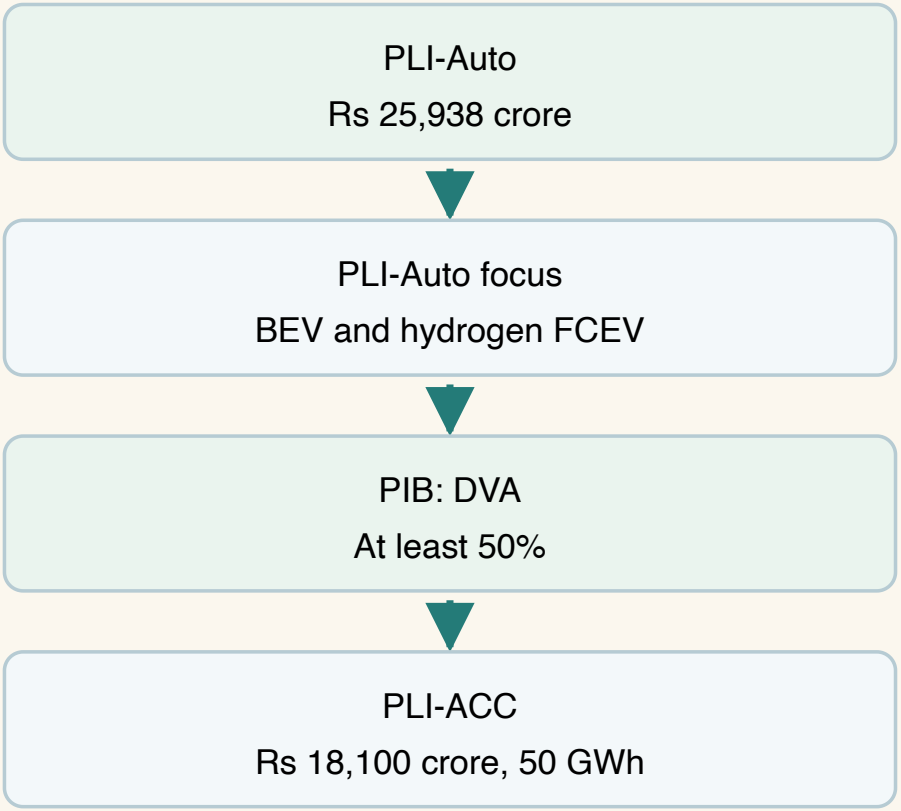
18. What are the PLI-Auto and PLI-ACC schemes?

PLI-Auto has an outlay of **Rs 25,938 crore**. The MHI says the Cabinet approved it on 15 September 2021. It is focused on zero emission vehicles, meaning battery electric and hydrogen fuel cell vehicles. The PIB says the scheme proposes incentives for products with at least 50% domestic value addition.

The PIB of 31 December 2025 gives progress. Cumulative incentive disbursed is Rs 2,321.94 crore, as on 31 December 2025. Cumulative investment is Rs 35,657 crore, as of 30 September 2025. The PIB lists incentivised units: 10,42,172 e-2Ws, 2,38,385 e-3Ws, 79,540 e-4Ws and 1,391 e-buses.

The approval date and period differ by source. The PIBs of August and December 2025 say the Government approved PLI-Auto on 23 September 2021. The MHI says incentives run from FY 2022-23 to FY 2026-27. The PIB of 31 December 2025 gives FY 2023-24 to FY 2027-28.

PLI-ACC is separate. It has an outlay of **Rs 18,100 crore** and was approved in May 2021. It targets 50 GWh of Advanced Chemistry Cell battery capacity.



ACC means Advanced Chemistry Cell batteries.

Source: MHI, PLI Scheme for Automobile and Auto Component Industry, item 18

Source: PIB, PLI Scheme achieves major milestones, 31 Dec 2025, item 18

Source: PIB, Demand for Lithium-ion Batteries, 16 Dec 2025, item 18

19. What are the other EV schemes: SPMEPCI and PM e-Bus Sewa?

SPMEPCI is the Scheme for Promotion of Manufacturing of Electric Passenger Cars in India. It was notified on **15 March 2024**. The PIB says applicants must invest at least Rs 4,150 crore. They must reach 25% domestic value addition by the end of year three and 50% by year five.

PM e-Bus Sewa-PSM was notified on 28 October 2024. It has an outlay of **Rs 3,435.33 crore**. It aims to support more than 38,000 e-buses. It gives payment security to bus operators if a transport authority defaults.

Source: PIB, Initiatives to Improve EV Sector, 5 Aug 2025, item 19

Source: PIB, Promotion of EVs and Installation of EV Charging Stations, 16 Dec 2025, item 19

20. What is the GST rate on EVs, and what is the link to the Green Hydrogen Mission?

The 36th GST Council recommended cutting the GST on all electric vehicles **from 12% to 5%**. It cut the rate on chargers and charging stations from 18% to 5%. The change took effect on **1 August 2019**. The PIB of 5 August 2025 says the Ministry of Finance has reduced GST on EVs from 12% to 5%.

The September 2025 GST reform changed other vehicles. Small cars fell to 18% from 28%. Large cars moved to a flat 40% with no cess. No 2025 change to the EV rate was found in the sources checked. Check the current rate on cbic.gov.in before relying on it.

The National Green Hydrogen Mission is India’s green hydrogen mission. Mobility is one sector it aims to decarbonise. The Cabinet approved it on 4 January 2023 with an initial outlay of Rs 19,744 crore.

It targets at least 5 MMT of green hydrogen a year by 2030. For details, see the sibling FCEV lesson.

Source: PIB, GST rate on all Electric Vehicles reduced from 12% to 5%, 27 Jul 2019, item 20

Source: PIB, Initiatives to Improve EV Sector, 5 Aug 2025, item 20

Source: PIB, The new GST rates and impact on Heavy Industries, 8 Sep 2025, item 20

Source: PIB, Cabinet approves National Green Hydrogen Mission, 4 Jan 2023, item 20

What does the Indian EV market look like?

Numbers here carry their dates. They come from PIB releases.

21. How many EVs does India sell, and how many chargers does it have?

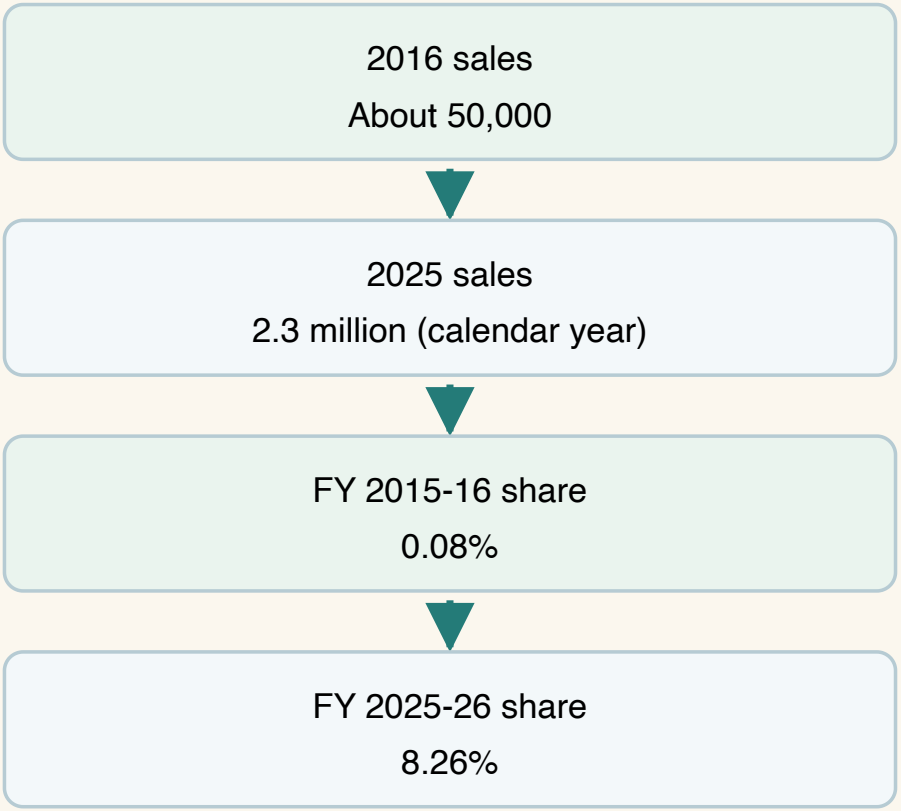
The PIB backgrounder of 5 August 2026 gives market facts:

- EV sales rose from about 50,000 in 2016 to **2.3 million in 2025**.
- EV adoption rose from 0.08% in FY 2015-16 to **8.26%** in FY 2025-26.
- In 2025, motorised two-wheelers (12.8 lakh) and three-wheelers (8 lakh) drove much of this.
- Uttar Pradesh led 2025 EV sales with 4 lakh+ units, 18% of the national total.

The PIB of 1 April 2025 gives FY 2024-25 sales. These were 11,49,334 e-2Ws and 1,59,235 e-3Ws (L5).

Charger counts differ by date and by source. The PIB of 16 December 2025 says **29,151 EV charging stations** were installed. Of these, 8,805 are fast and 20,346 are slow. The PIB of 5 August 2026 says **52,718**

public charging stations were available as of July 2026. Of these, 16,561 are fast. The 16 December 2025 release (PRID 2204630) says its 29,151 count is from BHEL inputs, and the 5 August 2026 release cites BHEL. Counts of “installed” and “available” may differ.



Do not compare a calendar year with a financial year.



Electric car charging station under Begumpet metro station, Hyderabad. Photo: iMahesh, CC BY-SA 4.0, via Wikimedia Commons. File page. Licence: CC BY-SA 4.0.

Source: PIB, Roads Reimagined, 5 Aug 2026, item 21

Source: PIB, MHI achieves sales of more than one million EVs in FY 2024-25, 1 Apr 2025, item 21

Source: PIB, Electric Vehicle Charging Stations, 16 Dec 2025, item 21

22. What are the rules for charging stations in India?

The PIB says setting up an EV charging station is an unlicensed activity. Private players can do it under the Ministry of Power guidelines of 17 September 2024. The guidelines also cover battery-swapping stations.

PM E-DRIVE sets aside Rs 2,000 crore for public charging. The PIB of 1 October 2026 says **Rs 851 crore** was approved for 8,147 chargers, as of 28 September 2026. These go to three oil marketing companies and 10 states.

Under FAME, 479 charging stations were set up in Phase I. Another 9,097 were set up in Phase II.

16 Dec 2025	5 Aug 2026
29,151 installed	52,718 available
8,805 fast	16,561 fast
20,346 slow	Counts may differ

Do not add them or call it growth.

Source: PIB, Promotion of EVs and Installation of EV Charging Stations, 16 Dec 2025, item 22

Source: PIB, Electric Vehicle Charging Stations, 16 Dec 2025, item 22

Source: PIB, Factsheet: PM E-DRIVE Scheme, 1 Oct 2026, item 22

What is the environmental cost and benefit?

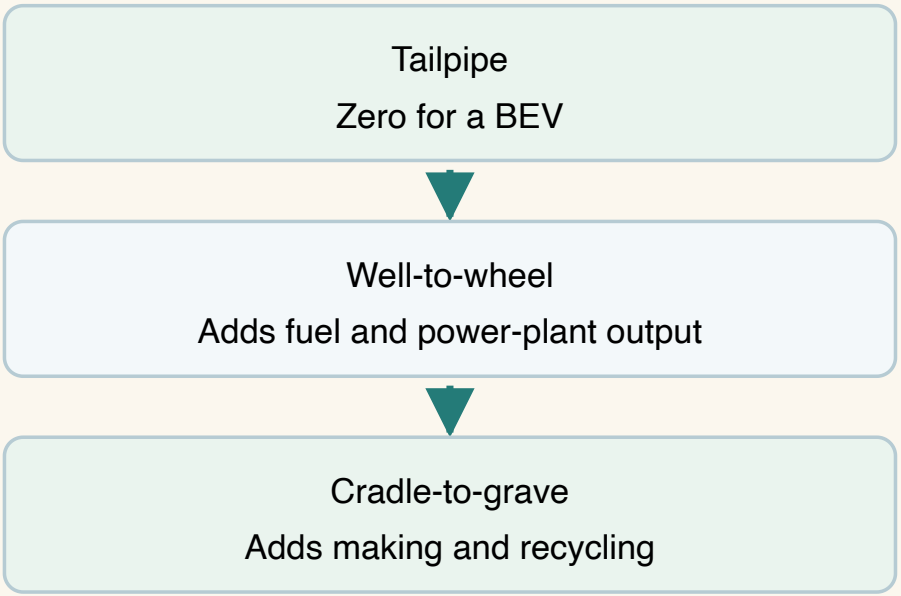
A zero-tailpipe vehicle still has upstream and end-of-life effects.

23. Is an EV really clean? Tailpipe, well-to-wheel and cradle-to-grave

The AFDC separates three views. Tailpipe emissions are zero for a BEV. Well-to-wheel adds fuel production and power-plant emissions. **Cradle-to-grave** adds vehicle and battery making, recycling and disposal.

The AFDC says where the electricity is cleaner, the EV's life-cycle advantage is larger. Where electricity is more polluting, the advantage can be weaker.

India's grid is mixed. The PIB says non-fossil capacity was **300.50 GW** on 31 July 2026. That is over 54% of about 552 GW total capacity. The PIB also says coal supports over 70% of electricity generation. So capacity share and generation share differ.



A cleaner grid widens the EV advantage.

True or False: Zero tailpipe emissions mean a BEV causes no emissions over its whole life.
Source: US DOE AFDC, Emissions from Electric Vehicles, item 23

Source: PIB, India's Energy Journey: Expanding Capacity, Strengthening Security, Aug 2026, item 23

24. What happens to EV batteries at end of life?

The Battery Waste Management Rules, 2022 were published on **24 August 2022**. They cover EV, portable, automotive and industrial batteries. They work on **extended producer responsibility** (EPR). Producers, including importers, must collect and recycle or refurbish waste batteries. Landfill and incineration are prohibited.

The PIB of 16 December 2025 gives progress. 3,391 lithium-ion battery producers and 43 lithium-ion battery recyclers had registered on the EPR portal. Around **15,370 tonnes** of lithium-ion waste had been recycled since the rules.

The PIB cites a NITI Aayog projection of lithium-ion battery demand. It is 40 GWh for 2025 and about 210 GWh by 2030.

Source: PIB, Government notifies Battery Waste Management Rules, 2022, 25 Aug 2022, item 24

Source: PIB, Demand for Lithium-ion Batteries, 16 Dec 2025, item 24

What has the exam asked, and what do students get wrong?

Question numbers and wording come from reading the UPSC paper image.

25. Which electric vehicle questions did UPSC ask in 2025?

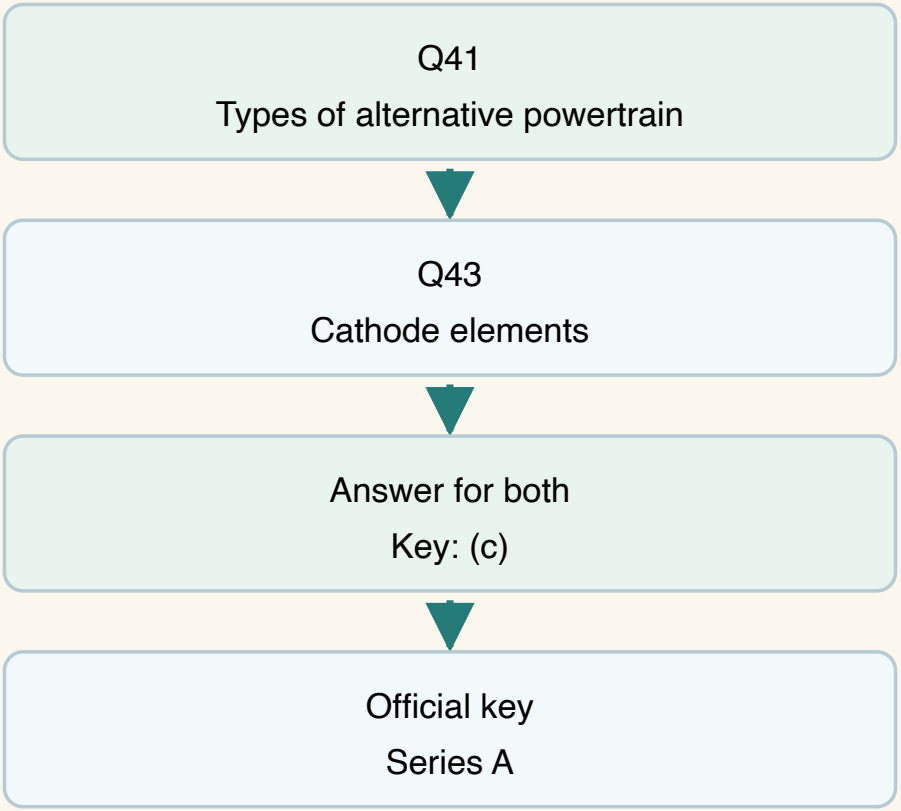
The stems come from the official question paper PDF on upsc.gov.in, Set A (booklet code 56A). The pages are scans and were read by eye. The official UPSC keys for Series A are used: Q41 = (c) and Q43 = (c). No questions were dropped.

Q41, verbatim: “Consider the following types of vehicles : I. Full battery electric vehicles II. Hydrogen fuel cell vehicles III. Fuel cell-electric hybrid vehicles. How many of the above are considered as alternative powertrain vehicles? (a) Only one (b) Only two (c) All the three (d) None”.

Evidence for Q41: the PIB lists BEV and FCEV as EV types. The AFDC says FCEVs carry a battery, but no source checked names a fuel cell-electric hybrid type. The MHI’s PLI-Auto page names battery electric and hydrogen fuel cell vehicles as zero emission vehicles. Types I and II appear in official sources. Type III is not named in any source checked. Official key (Series A): (c).

Q43, verbatim: “In the context of electric vehicle batteries, consider the following elements : I. Cobalt II. Graphite III. Lithium IV. Nickel. How many of the above usually make up battery cathodes? (a) Only one (b) Only two (c) Only three (d) All the four”.

Evidence for Q43: the DOE says graphite is the usual anode. It says cobalt and nickel are key cathode components. The names LCO, NMC and NCA show these cathodes also contain lithium. So cobalt, lithium and nickel are cathode elements. Graphite is not. Official key (Series A): (c). Note that LFP cathodes have no cobalt or nickel, and the stem says “usually”.



Official key confirmed.

Source: UPSC, CSP 2025 General Studies Paper I question paper, item 25

Source: PIB, Roads Reimagined, 5 Aug 2026, item 25

Source: MHI, PLI Scheme for Automobile and Auto Component Industry, item 25

Source: US DOE, Technology Strategy Assessment: Lithium-ion, July 2023, item 25

Source: US DOE AFDC, How Do Fuel Cell Electric Vehicles Work Using Hydrogen?, item 25

Source: UPSC, official answer key CSP 2025 GS Paper I, item 25

26. What history facts and exam traps should students know?

The DOE says it is hard to pinpoint one inventor of the electric car. It says **Robert Anderson**, a British inventor, developed the first crude electric carriage in the early 19th century. Practical electric cars came in the second half of that century.

The DOE says electric cars made up around a third of vehicles on the road by 1900.

The DOE says **Ferdinand Porsche developed an electric car called the P1 in 1898**. It says he also made the world's first hybrid electric car around then. The Prius came later, in 1997.

Common traps:

- "FCEV has no battery." False. The AFDC lists a high-voltage battery pack.
- "A hybrid can plug in." Among hybrids, only a PHEV can. The AFDC says an HEV cannot.
- "Graphite is in the cathode." False. It is the usual anode (DOE).
- "Zero tailpipe means zero emissions." False. Power-plant emissions count in well-to-wheel (AFDC).

Wrong claim	Right fact
FCEV has no battery	It has a battery pack
A hybrid can plug in	PHEV only, of hybrids
Graphite is a cathode	Graphite is the anode

Zero tailpipe does not mean zero emissions.

Source: US DOE, The History of the Electric Car, item 26

Source: US DOE AFDC, Hybrid Electric Vehicles, item 26

Source: US DOE AFDC, Emissions from Electric Vehicles, item 26

Four questions to think through

Why does the DOE give both over 77% and 65% to 69% for an EV?

The two figures cover different stretches of the energy chain. Over 77% is the share of grid electricity that becomes power at the wheels. In combined driving, charging, accessory and drive losses leave 65% to

69% for the wheels, and braking recovers another 22%. Always ask which stretch a quoted figure covers.

Why does a hybrid appear on the PIB list of EV types if it has an engine?

The PIB of August 2026 lists BEV, HEV, PHEV and FCEV as the four EV types. No official Indian or UPSC definition of alternative powertrain was found in the sources checked. The US law on alternative fueled vehicles also includes hybrids.

Why must the two charger counts of 29,151 and 52,718 not be added?

They come from two PIB releases, dated December 2025 and August 2026. Both releases cite BHEL. One counts stations installed, and the other counts stations available. Do not add them or call the gap a growth rate.

Why does a bigger tank help an FCEV differently from a bigger battery in a BEV?

The AFDC ties the stored energy of an FCEV to its hydrogen tank size. Its power depends on the fuel cell and battery. A BEV ties power and energy together through battery size. So tank size sets the energy in an FCEV, while battery size ties to both power and energy in a BEV.

Check your understanding

Your 7 quick checks Answered 0 of · Correct
This score resets when the page reloads.

Continue to the 8 MCQs

✅ Test Yourself

Try 8 practice questions on alternative powertrain vehicles.

Practice MCQs

1. Which type of alternative-powertrain vehicle draws its power entirely from an onboard battery charged by an external power source, with no internal combustion engine and no fuel-cell stack?

A. Hybrid Electric Vehicle (HEV)

B. Plug-in Hybrid Electric Vehicle (PHEV)

C. Fuel Cell Electric Vehicle (FCEV)

D. Battery Electric Vehicle (BEV)

See answer ↓

2. Which type of vehicle has an engine, a motor and a battery, and can also be plugged in to charge?

A. Battery electric vehicle

B. Plug-in hybrid electric vehicle

C. Fuel cell electric vehicle

D. Hybrid electric vehicle

See answer ↓

3. In a lithium-ion EV battery, which material is usually the anode?

A. Lithium iron phosphate

B. Graphite

C. Nickel manganese cobalt oxide

D. Lithium manganese oxide

See answer ↓

4. According to the DOE, how long may EV batteries last in moderate climates?

A. 20 to 25 years

B. 3 to 5 years

C. 12 to 15 years

D. 8 to 12 years

See answer ↓

5. In 2019, the GST rate on electric vehicles was reduced from 12% to which rate?

A. 28%

B. 18%

C. 5%

D. Nil

See answer ↓

6. What is the outlay of the PLI-Auto scheme, which focuses on zero emission vehicles?

A. Rs 25,938 crore

B. Rs 10,900 crore

C. Rs 19,744 crore

D. Rs 18,100 crore

See answer ↓

7. Which principle underlies the Battery Waste Management Rules, 2022?

A. Mandatory battery swapping

B. A cash incentive for scrap

C. Extended producer responsibility

D. A landfill levy on batteries

See answer ↓

8. According to the AFDC, what does the battery in most fuel cell electric vehicles do?

A. Replaces the fuel cell at all times

B. Recaptures braking energy

C. Charges only from a wall plug

D. Stores the hydrogen fuel

See answer ↓

Answer Key

1. **D.** The answer is the battery electric vehicle. A BEV runs on an electric motor that draws power from a traction battery pack. It must plug in to charge. The AFDC says it has no tailpipe exhaust, fuel pump, fuel line or fuel tank. An FCEV makes its own power in a fuel cell, while a PHEV and an HEV still carry an engine. ↑ Q1
2. **B.** A plug-in hybrid electric vehicle can plug in. The AFDC says its battery charges from external equipment, from the engine and from regenerative braking. A plain hybrid cannot be plugged in. Current PHEVs travel about 15 to 60-plus miles on electricity alone. ↑ Q2
3. **B.** The DOE says the usual anode is graphite or another carbon. The cathode comes in several classes. Examples are LFP, NMC and NCA. NMC is valued for energy density and LFP for safety. Lithium ions move from the cathode to the anode while charging. ↑ Q3
4. **C.** A DOE study says EV batteries may last 12 to 15 years in moderate climates. In severe climates the figure is 8 to 12 years. The AFDC says a battery keeps at least 70% of its initial capacity at the end of vehicle life. It can then serve another 10 years or more in second-life uses. ↑ Q4
5. **C.** The 36th GST Council recommended cutting the GST on all electric vehicles from 12% to 5%. It cut the rate on chargers and charging stations from 18% to 5%. The change took effect on 1 August 2019. The PIB of 5 August 2025 says the Ministry of Finance has reduced GST on EVs from 12% to 5%. Check the current rate before relying on it. ↑ Q5
6. **A.** The MHI gives the PLI-Auto outlay as Rs 25,938 crore. Its focus is battery electric and hydrogen fuel cell vehicles. The PIB says the scheme proposes incentives for products with at least 50% domestic value addition. The Rs 18,100 crore figure belongs to PLI-ACC, which targets battery capacity. ↑ Q6
7. **C.** The Rules work on extended producer responsibility, or EPR. Producers, including importers, must collect and recycle or refurbish waste batteries. Landfill and incineration are prohibited. The rules were published on 24 August 2022. They cover EV, portable, automotive and industrial batteries. ↑ Q7
8. **B.** The AFDC says most FCEVs use the battery to recapture braking energy. The battery also gives extra power in short bursts. It smooths the power coming from the fuel cell. The battery does that job. ↑ Q8

Curated by Arsalan Zuberi · mcqquestion.com



Scan to read online

https://mcqquestion.com/articles/scitech0157-alternative-powertrain-vehicles-bev-fcev-and-fchev-explained/