DEMYSTIFYING THE ELECTRIC CAR

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Contents

Introduction

Should we buy an electric car? After all, this is an environmentally responsible consumer decision to contribute towards fighting health threatening toxic emissions and cataclysmic global warming. Science shows that replacing internal combustion engines (ICE), that power our diesel and petrol cars, can eliminate toxic tailpipe emissions in our polluted cities, along with significantly lowering heat trapping carbon emissions from fuel combustion. Even electricity that fuels the electric car can be decarbonized if generated from renewable energy.

Global trends show that this shift from ICE to electric vehicles (EVs) is inevitable as carbon and pollution reduction become more aggressive over the next few decades. Already, nearly 20 countries have pledged to completely phase out ICE powered cars in the time horizon of 2030–2040. India cannot remain insulated. Policies are already taking shape to incentivize the process against a target.

Rules for electrification are being written. Incentives for the vehicle industry and consumers are taking shape to make the cost of EVs more competitive. Battery management systems and charging infrastructure is expanding. Policies have prioritized electrification of public transport modes to make a sizeable fraction of daily travel trips zero emissions. Two-wheelers and cars are beginning to see more electric models.

But the overall market for EVs is still very small. A lot more needs to happen in all these areas to make this trend transformative. In this jigsaw of change, consumers are critical actors. It's the market demand that can define the scope of this change.

Consumers are still very hesitant and are full of doubts about the new technology. Despite the irrefutable evidence available about the cost benefits they offer, electric cars have not found too many takers in India. Of the 2.77 million passenger cars sold in the 2020–21 financial year[1], only 3400 were electric cars.[2] That amounts to a 0.12 per cent share even after five years of being pushed by government support schemes. The lack of consumer interest in the e-car is often attributed to lack of confidence and clarity in the new technology and limited model choices buyers find in the market.

New technologies often tend to get mired in a web of misinformation and myths. An information deficit environment aids the spread of myths. Centre for Science and Environment (CSE) has begun this series to clear doubts and answer some

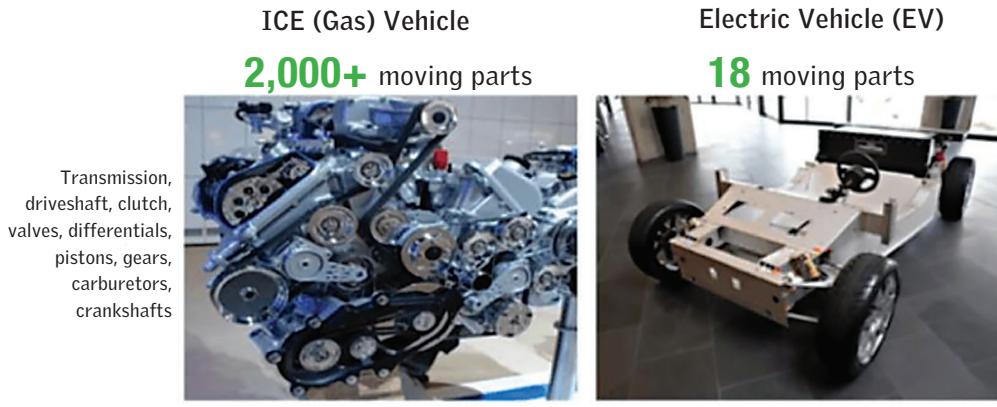
frequently asked questions that worry the consumers. This aims to bring more clarity and to translate interest into real consumer demand. This first publication in the series answers questions about the electric car that is used for personal mobility. This series will sequentially cover other vehicle segments including electric two-wheelers. This process will remain dynamic with regular update of information.

1. ARE THEY SIMPLE TO HANDLE?

Electric cars use new generation technology which is much simpler than the technology used in ICE vehicles. To begin with, e-cars have simpler architecture. Compared to the ICE vehicle that has almost 2,000 parts, an e-car has about 20 moving parts. With fewer parts, it is far easier and cheaper to maintain. It is the battery that is the key component of the e-car. Owners do not need a tune-up or oil change. It has basic gears and can accelerate smoothly and quickly so it feels like driving a sports car. The e-car is so quiet that automakers have been looking at adding noise to the vehicle so that it at least alerts people when rolling in. Simpler technology reduces the hassle and cost of routine maintenance.

This is very different from a highly complex diesel vehicle meeting Bharat Stage VI (BS VI) emissions standards. Diesel car technology, already packaged with common rail direct injection, turbocharger, and exhaust gas recirculation combined with advanced diesel oxidation catalyst, now has more complex emission control systems like diesel particulate traps with regeneration options and selective catalytic reducing system for NOx control (that requires regular urea refill at extra cost), among other complex techniques. This will get more complicated when regulations for controlling emissions in the real world kick in from 2023 onwards. This will also push up costs and vulnerability to emissions frauds.

Figure 1: Look at the difference between E-car and IC engine car



Source: https://www.youtube.com/watch?v=duWFnukFJhQ[3]

2. WHAT IS AVAILABLE IN THE MARKET?

While buying a car, we need choices that satisfy our needs for mileage, performance, accessories and comfort. ICE cars come in so many different variants with tantalizing features. From that perspective the e-car models are still very limited as the market is small.

Currently, there are five automakers with a maximum of two e-car models each in the market (see *Table 1: Electric four-wheeler model options in India*). Among these models, there is scant competition in each segment, an anomaly that is expected to change in the next couple of years with the entry of several models.

As demand for e-car is sluggish, industry interest is also dormant. This limits the choices for the consumers. Yet, market information shows that several manufacturers are ready or are working with prototypes of new models. There are over 25 models expected to be launched in the next couple of years. They have not launched the products yet only because they fear a lack of demand. This vicious circle, of low demand because of a lack of models and a lack of models because of low demand, will have to be broken. Moreover, very few models are small cars, a

Table 1: Electric four-wheeler model options in India

Company	Model	Price (ex-showroom Rs)	Incentives under FAME II (Rs)	Range (km)	Battery Capacity (kW)	Fast charge (hours)	Slow charge (hours)
TATA	TIGOR EV - XE / XM / XT	11–15 lakh	1,62,000	140	16.2	1.5	6
	TIGOR EV - XE+ / XM+ / XT+		2,15,000	213	21.5	1.5	6
	NEXON EV XM / XZ+		2,79,800	312	30.2	1	8.5
Mahindra	e-Verito C2 / C4 / C6	9–10 lakh	1,59,000	143	15.9	1.5	8.5
	e-Verito D2 / D4 / D6		2,12,000	181	21.2	1.5	8.5
	e20 plus	7.5–11 lakh	-	140	15	1.5	6
Hyundai	Kona	23.5 lakh	-	452	39.2	1	6
MG Motors	ZS EV Excite	21 lakh	-	340	44.5	<1	6-8
	ZS EV Exclusive	24.2 lakh	-	340	44.5	<1	6-8
Mercedes Benz	EQC	1 crore	-	471	80	1.5	10-21

Source: Various sources; compiled by CSE

Table 2: Upcoming EV models in India

Company	Model	Price (Ex showroom Rs)	Range (km)	Battery Capacity (kWh)	Fast charge (hours)	Slow charge (hours)	Expected launch date
Tata	Altroz EV	14 lakh	350	30.2	1	8	December 2021
Mercedes Benz	EQA	60 lakh	426	66.5	0.5	6	December 2021
Maruti Suzuki	Wagon R EV	11 lakh	200	NA	1	7	NA
Haima	Bird Electric EV1-V20.5	10 lakh	200	20.5	No fast charging	9	June 2021
	Bird Electric EV1-V28.5	NA	300	28.5	No fast charging	11	June 2021
Audi	E-tron	1.5 crore	400	95	0.5	9	June 2021
Mahindra	eKUV100	8.25 lakh	120	40	1	6	December 2021
Renault	Renault K-ZE	10 lakh	270	26.8	0.5	4	March 2022
Volvo	XC40 Recharge	50 lakh	400	78	0.75	10	June 2021
Nissan	LEAF	40–45 lakh	458	62	0.5	8	August 2021
Porsche	TAYCAN	2.5 crore	383–463	93.4	0.25	10.5	March 2021

Source: Various sources; CSE compilation

segment that has been historically successful in India (see *Table 2: Upcoming EV models in India*). Stronger market information and demystification of the product are required to increase consumer interest.

3. HOW DO I SELECT MY CAR?

Among the electric cars that are available in the country now, options in a given segment are few. Despite that, selecting an electric car can be daunting, not only because of its high cost, but also because of the new car lingo. The best way to negotiate the new mobility jargon is to use a language that we understand—the language of ICE vehicles.

With an ICE vehicle, especially in small and mid-segments where large numbers of cars are bought and sold, the first question asked is about mileage—how far can the car go on a litre of petrol or diesel? Questions on all other features come later, be it navigation screen, Bluetooth speakers, braking, or alloy wheels.

E-cars, however, are yet to evolve beyond that first question. At least in India. E-cars are typically being bought and sold on the basis of mileage or range i.e., the number of kilometres that can be driven per full charge of the battery. Further, the features of charging options and availability of charging stations matter a lot. This is a little bit like buying a petrol car on the basis of its fuel tank and the number of petrol filling stations available. When one performance defining factor of a product gains extraordinary attention, others pale in comparison and are often overlooked.

Nonetheless, range related questions are important and have to be addressed, especially in a nascent market that is working on building a following. Questions that buyers should ask when planning to buy an e-car should cover areas like daily distance travelled, real time battery range of the vehicle, charging time (both fast and slow) and discharge speed, access to charging points, and battery and car warranty. And then come questions on brakes, wheels, and navigation as in any other car.

How far can I drive on one charge?

Range anxiety is the overriding concern of consumers to influence the purchase decision of e-cars. There is a wide variability in range that the models promise. Tata Nexon has a range of 312 km per charge, MG ZS EV Excite and Exclusive have ranges of 340 km, and Hyundai Kona has a range of 452 km. The rest vary between 140 to 181 km. Altroz EV promises a range of 450 km and Nissan's Leaf of about 458 km. Both are upcoming models.

Technically, once a car has been charged at home and at the work place parking for daily use there is no real reason to worry about regular errands. Public charging then can be used for a shorter duration only for a top up. Most models are well within the range of the average travel distance in our cities. In fact, real time data reveals that buyer anxiety on account of the charging network is largely unfounded. Depending on the size and urban form, cities like Delhi, Mumbai, Bangalore, Chennai, Ahmedabad, Hyderabad, Chandigarh, and Kochi have a daily average trip length of 10–13 km. More compact cities like Kolkata, Lucknow, Vijayawada, Bhopal, and Jaipur have an average trip length of 3–7 km. This is evident from the city mobility plans and city development plans. An EV with a 30kW battery, therefore, can easily last longer than generally needed.

Tata offers suggestions about its Nexon EV to optimize range with the use of braking for power regeneration and speeds that enable better range. Braking or slowing down of the car on the road converts the kinetic energy to be stored in the battery. Regenerative braking in e-cars is a useful method of energy recovery as it

takes the wasted energy from the process of slowing down a car for recharging of the car's batteries. Moreover, information about warranty needs special attention as the battery's durability and operating range can also be optimized with driving behaviour. While alignment with the owner's requirements is key, it pays to overestimate the requirements, since mileage will likely vary depending on use. Highway speeds that require more acceleration will, for instance, consume more energy compared to driving at an even and optimum speed within the city.

What else can affect the run per charge?

It is not just the distance and conditions of driving that affect the range. It is also the usage pattern of ACs and heaters in the car, which also draw upon the battery, that determine the range. Even a longer-range e-car could experience a deflated range with the use of ACs in summer and heaters in winter. That could lead to buyer disappointment as they are not consciously accounting for this usage.

There is another issue. There can also be a mismatch between the range promised by the manufacturers based on the certification level and what is actually experienced during driving experience. This happens even in ICE engines. But this matters more for the range anxious e-car consumer. This is exactly the story that has unfolded in Delhi with the Tata Nexon EV. After buyers complained about the range performance being much below what the manufacturers had assured of, the Delhi government delisted the vehicle from the subsidy list in March 2021.[4] The buyers' complaint pointed at the difference between the range certified by the Automotive Research Association of India (ARAI) and the real-world range of the vehicle.

We know that there is always a variation between certified mileage and range on road. Certification test is done in ideal conditions with no load, no AC or lights, and shows much better results. But there is no clarity about the extent of this variation. Real-world mileage (range) will vary from the certified level as this will be influenced by driving cycle and style—AC, traffic and even weather. This is more pronounced in the case of EVs. Thus, we have to work harder on the testing parameters and make them more representative of real-world conditions or on-road conditions that affect the depletion of battery. This experience has also demonstrated how much more range matters to the consumers of e-cars.

It is also the responsibility of the consumers to ask for improvement in testing parameters and adoption of driving cycle for certification of e-cars that is closer to real-world driving and can reduce the gap in certified and real-world range.

4. HOW EXPENSIVE IS MY E-CAR?

Everyone wants to know how expensive e-cars are. In people's minds, the ICE counter-part is always the benchmark. Many shy away as e-car is expected to be more expensive. Though the listed price is spread over a large range—Rs 7 lakh to Rs 1 crore—a larger number of mid to high segment models entails a higher average price. At one end of the spectrum is Tata Tigor EV priced at Rs 7.5 lakh, while at the other end is the Mercedes EQC priced close to Rs 1 crore. Global automakers have clearly opted for the low-risk option of launching higher priced low volume vehicles in India that offer higher margins per unit. Increasing scale in the mid-segment is possible only with tangible demand building up.

The battery in the car makes up for most of the car cost—nearly 40 per cent. But over a period of time the cost of lithium-ion battery that powers the car has reduced substantially, by 89 per cent between 2010 and 2020 according to Bloomberg NEF.[5] With scale and innovation this is expected to come down further. Usually the cost of e-car is compared with ICE car based on total cost of ownership. This includes the upfront cost of the car, the lifetime operational cost, and also the cost of battery replacement that might be needed during the lifetime of the car.

How do I understand the cost of owning and running an e-car?

Let us understand the cost differences for comparable models. Normally, such a comparison is done based on the lifetime use of the cars. The major cost components that have a bearing on the difference between the cost of ICE and e-car are the upfront purchase cost, fuelling cost and maintenance cost. There are other costs including vehicle insurance, etc. that are not usually unique to technology but may have some variation and are normally included when experts calculate total cost of ownership of cars.

Let us compare the upfront cost of ICE and e-cars. Let us compare the most popular e-car in Delhi— Tata Nexon EV XM—with its petrol version. Offering maximum power of 127 BHP, which is slightly higher than its petrol version, the upfront cost of Nexon EV is Rs 16 lakh, almost Rs 7 lakh higher than the petrol Tata Nexon. This cost is being deflated now by government incentives.

How about fuel cost? The Nexon EV has an automaker announced range of 312 km per charge though owners of cars have reported a real-world range of 200–220 km. The Tata Nexon petrol offers real world mileage of 14 km/litre. To cover 100

kilometres, a Nexon driver will spend Rs 642, if petrol costs an average of Rs 90/litre, while a corresponding calculation for the Nexon EV amounts to less than 10 per cent of the petrol version at Rs 61 given the electricity tariff for EV charging at Rs 4.5/kWh.

On the other hand, market information suggests that the approximate maintenance cost of the petrol version is Rs 22,230 while the electric version's service cost amounts to Rs 17,500 over a period of 5 years according to bookyourcar.co.in. The first service of the EV is after 10,000 km which is free of cost. This is only indicative and subject to variation.

E-car has benefits of low operational cost. According to a survey conducted by Feedback Consulting in 2018, 75 per cent[6] of Indian commuters travel less than 1,000 km a month (or roughly less than 35 km a day). A vehicle offering battery range of 100 km can easily last about two days of typical usage and idle drain and cost the user Rs 35 per day to meet travel needs.

The low cost of operations makes EVs a viable option for the commercial segment like ride hailing and taxi aggregators as well. They can break even faster than vehicles in the private segment because of high utilization. All they need is a larger network of charging stations for opportunity charging.

AC vs e-car?

We use more electricity to run our home air conditioner for active cooling than driving a car. According to the 2021 star labelling programme of Bureau of Energy Efficiency and as per its Indian Seasonal Energy Efficiency Ratio (ISEER), a 5 star 1.5 ton AC (if operated for 8 hours a day) consumes about 8 kwh of electricity per day. Similarly, a 3 star 1.5 ton AC (if operated for 8 hours a day), which is also more widely used, will consume about 10 kwh of electricity per day. But a popular e-car model like Tata Nexon EV, which offers ARAI certified range of 312 km on a 30.2 kWh battery, will require only 3.38 kWh of electricity if driven typically for 35 km a day.

What will it cost to replace the batteries?

E-cars currently available in the market offer battery warranty of 3 years or 36,000 km (Mahindra e-Verito and Tata Nexon EV) and 8 years or 1,60,000 kms (for MG ZS EV and Hyundai Kona). Batteries can last longer with the adoption of charging best practices such as reduced fast charging cycles and avoiding complete discharge of the battery before charging.

With multiple charging and discharging cycles, battery capacity degrades over time, reducing range and the time between charge cycles. Vehicles with shorter range that require frequent charging, and hotter operating temperatures such as in the case of DC fast charging, increase depletion rates of the battery.

An electric vehicle battery pack is typically made up of several smaller battery cells working together. Owners have the option of replacing weakened battery cells to optimise battery efficiency. In case the battery stops working or is 'bricked' because of unrecoverable low voltage state the battery has gone into, the battery needs to be replaced.

That can be expensive even though battery costs have reduced in the last decade by more than 85 per cent. An average Li-ion battery pack for vehicles in 2020 was priced at about $137 per kWh[7] or about Rs 10,000. For a 30-kWh battery, that translates to Rs 3 lakhs. But the cost of Li-ion batteries is reducing fast and experts believe that by 2030, a kWh would be below the $100 level. With scale, this is expected to come down further.

5. WHAT INCENTIVES DO I GET FROM MY GOVERNMENT?

E-car purchase attracts incentives under the central government's incentive programme called Faster Adoption and Manufacturing of Electric Vehicles (FAME) as well as state governments' programmes. This defrays the buying cost and cushions the incremental increase while moving from ICE cars to e-cars. Specific car models have been listed under FAME as well as state government policies, like the Delhi government's EV policy which aims for 25 per cent electrification of the new fleet by 2024.

Under the Delhi EV policy, electric four-wheeler models manufactured by Tata Motors and Mahindra are eligible for a flat purchase incentive of Rs 1.5 lakh and 100 per cent exemptions from road and registration taxes in Delhi. The state is providing incentives to three vehicle models (and twelve model variants in total) from these manufacturers—the Tigor EV and Nexon EV from Tata and the e-Verito from Mahindra. However, the incentives only apply for the first 1,000 e-cars bought under the scheme.

CSE conducted a study to understand how the reduced on-road price of the electric vehicle (post subsidy) compares with that of the ICE versions of the same models. This shows the incentives and tax exemptions lead to a decent reduction in the

Table 3: Electric vehicle models eligible for incentives from Delhi state

	EV model name		Range (km)	Purchase cost without state incentives	Purchase incentive (INR)	Exemption in road tax and registration fees	Purchase cost with state incentives	State incentive % on purchase cost
1	Tata Motors	Tigor EV XE	140	13,86,559	1,50,000	1,21,067	11,15,492	19.5%
2		Tigor EV XM	140	14,14,324	1,50,000	1,23,505	11,40,819	19.3%
3		Tigor EV XT	140	14,25,002	1,50,000	1,24,442	11,50,560	19.3%
4		Tigor EV XE+	213	15,21,766	1,50,000	1,32,938	12,38,828	18.6%
5		Tigor EV XM+	213	15,40,780	1,50,000	1,34,607	12,56,173	18.5%
6		Tigor EV XT+	213	15,57,876	1,50,000	1,36,107	12,71,769	18.4%
7		Nexon EV XM	312	16,16,393	1,50,000	1,40,500	13,25,893	18.0%
8		Nexon EV XZ+	312	17,58,946	1,50,000	1,49,900	14,59,046	17.0%
9	Mahindra	E-Verito C2	143	13,94,520	1,50,000	1,26,465	11,18,055	19.8%
10		E-Verito C6	143	14,43,479	1,50,000	1,30,778	11,62,701	19.5%
11		E-Verito D2	181	14,99,273	1,50,000	1,35,693	12,13,580	19.1%
12		E-Verito D6	181	15,29,571	1,50,000	1,38,362	12,41,209	18.9%

Source: CSE analysis

upfront price of the vehicle—approximately 19 per cent on an average vehicle model. Personal cars do not get incentive under central FAME programme. But incentive is available under Delhi government programme. Delhi offers a subsidy of Rs 10,000 per kWh, which is capped at Rs 1,50,000 per vehicle. The subsidy is directly transferred into the buyer's bank account within a week of purchase. In addition, buyers can avail a 'scrapping incentive' if they're switching from ICE vehicles to EV.

To avail of the incentive in Delhi, the buyer has to register with the Delhi Transport Department for processing of the incentives.

Delhi has faced this unique challenge of delisting of Nexon EV model due to buyer complaints over the promised range of the car. However, this may require a more nuanced response. Delhi government should make it mandatory for the automakers to provide more realistic ranges based on improved vehicle testing for certification. In fact, the result of the testing depends on the driving cycle (that approximates the driving pattern on the road) that is used for testing in the laboratory. The current cycle needs to be replaced with the Worldwide Harmonized Light Vehicles Test Cycles (WLTC) as developed by the UN ECE GRPE (Working Party on Pollution

and Energy) group. This is in any case scheduled for introduction in India. This should be advanced and be made mandatory for sale in Delhi.

Otherwise, delisting vehicles can lead to removing one of the few personal segment e-vehicles that are eligible for electric vehicle subsidies under FAME. Delisting could hurt the policy intent to push for larger EV adoption. Though the Delhi High Court has since released a stay order against delisting of the Nexon EV, this requires a regulatory response to tighten the testing parameters for certification of EVs. This has national implications.

The government is also planning non-fiscal incentives that can accelerate demand creation. With fiscal benefits, apart from the purchase incentive, the state government offers exemption from road tax and registration fees, and a reduced tax burden. EVs with batteries are levied Goods and Services Tax (GST) of 5 per cent instead of the 12 per cent earlier.

6. HOW CAN I GET MY E-CAR FINANCED?

In addition to government incentive programmes, other financing is also possible. There is a specialized EV financing product under the Green Car Loan programme by the State Bank of India. The government offers an income tax deduction of Rs1.5 lakh on the interest paid on loans taken to purchase EVs.

Other banks, however, are reluctant to lend to EV buyers due to lack of awareness about EV technology and its associated risk. As a result, there are very few specialized EV financing options. Interest rates are higher on EVs along with a low loan to value ratio which shows how much value of the vehicle can be financed by the bank loans.

7. WHAT ABOUT CHARGING MY CAR?

One of the biggest deterrents to EV adoption is the unavailability of charging infrastructure and the time it takes to charge. This requires establishment of charging network in cities and making buildings ready for charging.

What are the types of charging?

There are the two types of charging offered in the country—slow charging (AC: 3–4 kW) and fast charging (DC: 50–100 kW). 'DC' refers to direct current, while 'AC' to alternating current. AC is used in chargers fixed in households and is more

Table 4: AC and DC charger technical specifications

	AC I	AC II		AC III	Bharat AC 001
		A	B		
Input voltage (V)	120	230	230	415 or more	415
Output power (kW)	1.4 to 2.4	1.4 to 3.3	3.3 to 7.4	11 to 43	3.3
Charging mode	n/a	Mode 1 or 2	Mode 2 or 3	Mode 3	Mode 3
	DC 1	DC 2		DC III	Bharat DC 001
Input voltage (V)	415	>415		>415	415
Output power (kW)	<50	>50		>150	3.3/10/15
Charging mode	Mode 4	Mode 4		Mode 4	Mode 4

Source: AEEE

Note: Input voltage: As per India's distribution network, service voltage level of 120 V is not applicable, therefore AC Level 1 is not relevant in India. Moreover, single phase AC circuits can provide a maximum power of 230 V and therefore for 415 V and higher, three phase AC circuits are required.

Charging modes: Mode 1 uses a standard household socket in which the charger can be plugged to charge the vehicle. Mode 2 also uses a household socket to charge, but it has inbuilt shock protection against DC currents, and a control device. Mode 3 uses a fixed outlet, usually wall mounted (in less than 0.2 sqm of area), and a tethered cable to communicate with the vehicle while charging. Mode 4 technology is for DC fast charging and is used in public fast chargers.

common in India. The battery uses DC supply, and therefore AC current from the grid must be converted to DC with an AC-DC convertor present either on board the EV during AC charging or as part of the electric vehicle supply equipment (EVSE) for DC charging.

This is also why DC chargers are expensive since they need the convertor as part of the EVSE in addition to other auxiliary equipment. Since DC chargers convert AC power to DC within the charging station and deliver DC power directly to the battery, they charge faster.

Charging equipment installed in buildings and garages are usually slow charging points while public charging stations can have both slow and fast chargers. Even though fast charging takes less time it is not what we want to adopt as the regular charging option. It is important to note that frequent use of DC fast charging can negatively impact battery performance and durability. An electric car's ability to accept higher charge currents is affected by the battery chemistry. It is believed that only fast charging can increase the rate at which an EV's battery capacity will decline. However, a combination of slow and fast charging would make a marginal

difference to the capacity. Fast charging is more appropriate for opportunity charging, that is the short duration top up charging to maximize the range while driving.

Is my home ready to have charging facility?

Manufacturers provide information about vehicle voltage and amperage requirements as part of vehicle technical specifications. A new connection will be required if the load for charging the vehicle is higher than what is already available in the building premises. Typically, Indian households are connected to a 3-4 kV electric connection which is sufficient for slow charging two- and three-wheelers, but for a four-wheeler, owners will have to upgrade to a 5 kV connection. The new connection would mean new wiring and new electricals. The home-based charger offered by Tata costs Rs 12,000 including installation. A few automakers offer the home charger free.

Owners also have the option of creating rooftop solar charging facility at home. Rooftop solar panels can be installed for housing societies and businesses linked together to form a microgrid that can be used to charge EVs.

How much time will it take to charge my e-car?

One of the factors on which the charging time depends is the quality of electricity being fed by the grid. Households and offices, for example, use stabilizers to maintain a consistent supply at the required voltage. While companies like NTPC are managing to maintain a 98 per cent efficiency rate at stations, state owned utilities fail to maintain even 50 per cent efficiency rates.[8] This variability will have to be addressed.

Charging times also depend on the power output of the charger. For example, Hyundai Kona takes six hours to charge using a 7.4 kW wall mounted charger, but with a domestic socket, which is typically a 15 ampere plug, it takes 19 hours for a full charge. The Nexon typically takes about six to eight hours to charge when using a slow charger and between an hour and ninety minutes with a fast charger.

Electric cars charge at different rates depending on the state of charge of the battery. It charges faster up to 50 per cent and then the charging speed continues to decrease as the state of charge (SOC) increases, reducing to 'trickle charging' during the last 10–20 per cent of charging. This mechanism ensures enhanced battery life over several charging cycles. This is also why charging the battery takes longer than what a theoretical time of charging formula prescribes (Battery Capacity / Charger Power Output).

A 12 kWh battery, for instance, can get charged in about 4 hours by a 3 kW power output according to the formula. However, it takes somewhere between 5 and 6 hours. Typically, automakers offer information on charging time for 0–80 per cent, because trickle charging can increase the charging time for 80–100 per cent to larger numbers. Charging time also depends on various other factors, such as the temperature at which the battery is charging and the state of health of the battery.

Where can I charge?

For personal vehicles, residential and office buildings will have to be made ready as discussed below. Cars are parked at home and offices the most. Individually owned houses will have to check their connected load as well as internal wiring and plug points to meet the charging requirements. Also, collective public parking spaces would need to create charging facilities for the residents. Charging solutions can be a challenge for EV owners in high-rise buildings.

Charging service providers therefore have begun to coordinate with resident welfare associations (RWAs) in apartment complexes to set up those systems as well as operate them. For such cases, charging service providers such as Tata Power, Volttic and BrightBlu provide charging solutions at designated parking spaces. OEMs provide wall mounted chargers when Mode 3 charging technology is available in the vehicle.

Besides, parking areas in apartment blocks, offices, recreational and commercial places are now legally required to provide facility for charging. In 2019 the Ministry of Housing of Urban Affairs amended the Model Building Byelaws (2016) to include a provision for electric vehicle charging infrastructure within building premises. According to the amendment, 20 per cent of the total parking capacity in a building needs to be dedicated to charging infrastructure. And the building should have separate power input equal to the power required by all the chargers being operated simultaneously.[9]

Several states including Uttar Pradesh, Tamil Nadu, Delhi, Karnataka, Maharashtra, Andhra Pradesh and Telangana have prepared electric vehicle policies which include amendment to building codes and zoning laws to integrate electric mobility in shared spaces. To enable shared charging facilities for residents, RWAs and charging infrastructure service providers look at utilization potential before setting up public chargers. In potentially high utilization scenarios, stakeholders can work out a mutual arrangement regarding ownership of the charging equipment hardware and the fee plan, be it on the spot or as part of the maintenance fee (if the RWA owns the hardware). There has to be popular

pressure on the RWAs and institutions to speed up the implementation of these facilities. This can further stimulate demand.

What about public charging?

While home and office-based charging will meet the bulk of the charging requirements, availability of public charging facilities will be critical to build public confidence and reduce range anxiety. Public charging most of the time is used as a top up and not for full charging of personal cars.

With public charging, EV owners have to use a charger provided by the automaker or one that aligns with the connector protocol that their vehicle is designed to accept. Public chargers in India typically offer one or more or any combination of the chargers (see *Table 5: Charging standards used in India*).

Table 5: Charging standards used in India

Charger type	Sr. no.	Connector type	Vehicle type	Output voltage (V)
Fast	1	CCS (min 50 kW)	4W	200 to 750 or higher
	2	CHAdeMO (min 25 kW)	4W	200 to 500 or higher
	3	Type 2 AC (min 22 kW)	4W, 3W, 2W	380 – 415
Slow/Moderate	4	Bharat DC 001 (15 kW)	4W, 3W, 2W	48
	5	Bharat DC 001 (15 kW)	4W	72 or higher
	6	Bharat AC 001 (10kW)	4W, 3W, 2W	230

Source: Ministry of Power

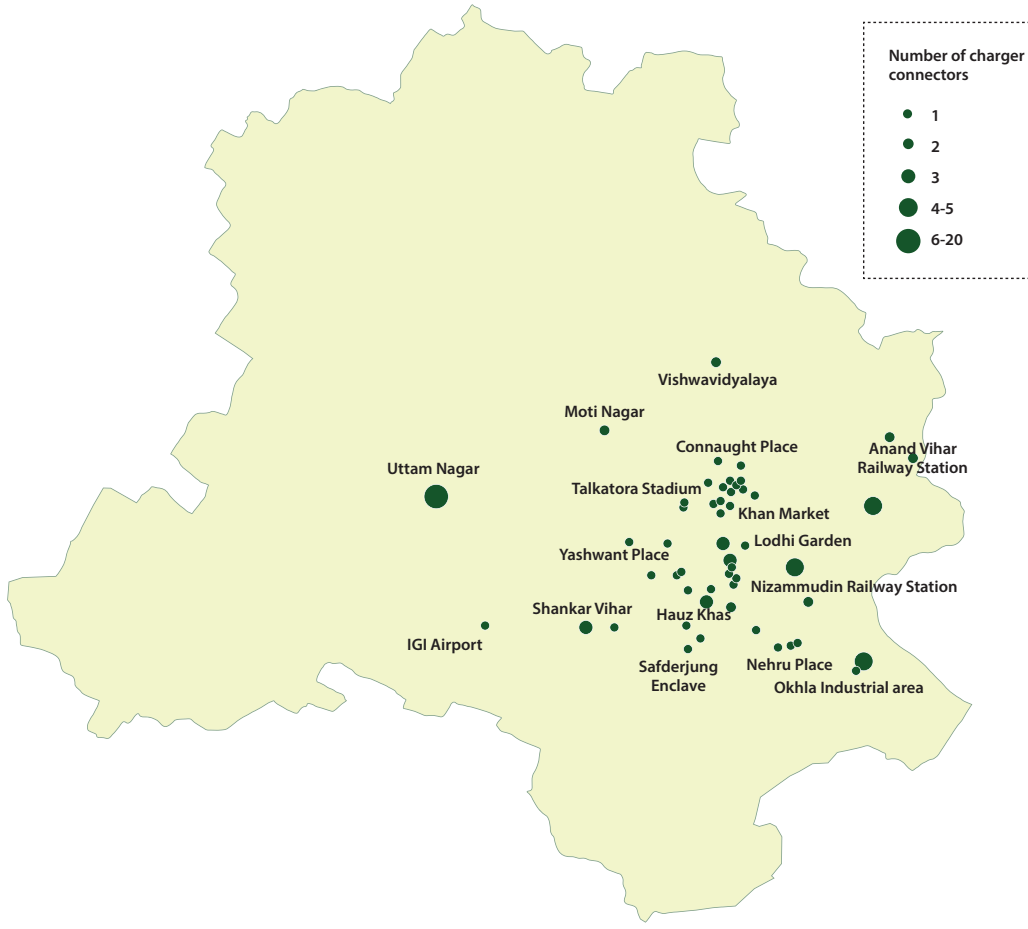
Four-wheelers in India use one of these connector standards. For example, Hyundai Kona, Tata Nexon EV, and MG ZS EV use CCS 2 for DC fast charging. EV owners can use publicly available charging locator applications for information on the type of connector available at a station.

Besides, automakers offer charging locators and organizations such as PlugShare and OpenChargeMaps provide free, open databases of charging stations. Cities like Delhi have also started updating their own list of locations. Delhi has listed 72 charging stations, with their exact locations, operational across the city on its state electric vehicle website portal.

Charging network in my city?

Close to a dozen state governments have framed their respective electric vehicle policies to promote EVs. They include plans for setting up public charging infrastructure. This will have to be implemented quickly and widely.

Map 1: Distribution of charging stations and number of connectors at the stations in Delhi



Source: CSE analysis

Delhi has the most ambitious plan aiming for 25 per cent electrification by 2024 and has accordingly planned the charging infrastructure. As per Delhi's EV policy notified in August 2020, the city should have at least one charging station in every 3x3 grid in the city. A quick spatial analysis suggests that this policy statement translates to around 200 stations across Delhi. Currently, there are 72 stations located in Delhi, as per the official Delhi EV website.

Most stations are closely located, within 200–400 mts of each other and 61 out of the 72 have only one charger connector at the station. The current distribution also has potential for last mile connectivity using electric vehicles around Metro stations as 89 per cent of the chargers, or 64 of them, are located within 500 meters of a Metro station. All chargers are also located within 500 meters of the major

arterial and sub arterial roads in Delhi, making them accessible to both highway and city commuters.

Further analysis of the land use around these stations reveals that, other than stations at the IGI airport and the Talkatora Garden, all stations are located in either residential areas or commercial / mixed use land. This siting strategy makes sense especially during the early stages of the EV market. Commuters would look for charging infrastructure around residential colonies and recreational areas and market places to charge their vehicle when they are busy with day-to-day activities.

What will it cost to charge my car?

This will depend on the respective tariff policies in different states. Let us take the example of Delhi. The Delhi EV policy supports home charging and the EV charging tariff is set at Rs 4.60 ($0.061), one of the lowest in India. It is designed to encourage the adoption of standardized charging equipment since the commercial electricity tariff is as much as twice the EV tariff. Gujarat offers a 100 per cent exemption from electricity duty for EV charging stations and a 50 per cent exemption on motor vehicle tax.

8. HOW DO I MAINTAIN MY E-CAR?

In contrast to ICE vehicles that need a ton of maintenance services, including oil changes, transmission fluid change, spark plug replacement and mechanical tune-ups for several moving parts, EVs do not require much maintenance. For one, there are way less moving parts in the vehicle. Most of the maintenance work needed in EVs does not need to be repeated for months. The vehicle is usually required to be checked visually for leaks, suspension, brakes and steering. The only fluids required to be changed (every 5 years) are the vehicle coolant circuits and brake fluid.

These periodic maintenance services can be availed at the OEM / dealership service centres and are important to keep the warranty of the vehicle and battery in effect. Some things such as checking tyre pressure and wear-tear every month, and ensuring a ready supply of windshield washer fluid can be done by the owner.

9. HOW UNFOUNDED IS MY ANXIETY?

What if the car gets stalled in the middle of the road?

Typically, vehicle models available in India have a State of Charge (SoC) monitoring unit built into the dashboard of the vehicle, where the driver can monitor the

discharging and recharging of the battery. OEMs also offer mobile applications, such as the Z-Connect by Tata Motors for Nexon EV, with which the user can view detailed information from trip origin and destination to charge consumed during the trip.

If, for some reason, the driver misses all of this information, OEMs also provide roadside assistance in the case of breakdowns, accidents and if the vehicle runs out of charge. Delhi government offers support for mobile on-road assistance providers. The roadside assistance team will help to take the vehicle to the nearest charging station. This involves charging the vehicle just enough so the customer can drive to a station. Getting the vehicle towed by a third-party service provider may not be the ideal method to transport an EV since it can damage the tractor motors that generate electricity through regenerative braking or even the battery of the vehicle.

In addition, to avoid running out of charge, vehicles offer solutions that help improve the range on a low battery to complete the journey. The vehicle may suggest navigating to the nearest charging station or go into a low performance mode as part of which the motor performance is reduced, and top speed is limited. It may even suggest turning off high energy consuming features such as the air conditioner or heater.

Will driving through water logged areas be unsafe?

A common belief about electric cars is that they get damaged easily during the monsoon or when wading through water logged areas due to the large amount of electronics installed in it. All modern EV models come with an IP67 rating for the battery, which means that the vehicle can be submerged in water up to a depth of 1 meter for 30 minutes without any damage. Manoeuvring though an average 300 mm of water logging on the road should therefore not be a problem. In addition, the battery has multiple layers of protection around its different systems to cut off power as soon as it detects entry of water into the system.

How does my driving impact my e-car?

To get the maximum range, experts suggest smooth driving instead of lead footed driving to increase battery performance. Low speeds and reduced usage in sport mode (if the car comes with a sport mode) can also help extend life of the battery.

Maximum use of the regenerative braking mechanism and maintaining tire pressure can help with achieving optimum range. Minimal use of air conditioning or heater and pre-cooling the vehicle while charging just before starting a trip can

save battery juice. If the vehicle offers seat and steering wheel warmers, use that instead. Try and heat before starting the trip, while the vehicle is charging.

Exterior accessories and loading can cause aerodynamic drag at higher speeds that reduces the efficiency of motors and increases energy consumption to maintain that speed. It pays to plan more efficient routes. A route with steady slow speeds can help maximize operating range compared to a high-speed route such as an expressway. For long-distance travel, route planning will have to include stops for top-up charging, so that the SoC does not drop to dangerously low levels.

Timing a charge is also important. After charging, the battery starts to discharge automatically even when idling, however small that discharge may be.

How will congestion and frequent ascent on flyovers affect performance of my e-car?

Even if climatic conditions, terrain typology and temperature have a bearing on the fuel consumption of ICE vehicles it does not cause driver anxiety because fuel is available easily and also requires a lot less top-up time for refuelling. On the other hand, as the range is limited for EVs, any fluctuations due to driving conditions are widely observable. This matters to the users.

We know that driver behaviour helps in increasing fuel efficiency in ICE vehicle and a lot of awareness campaigns are designed around that. Even in EVs, driving behaviour matters and if driven in an ideal driving condition it can provide better range. EV motors have an additional advantage; they are capable of generating energy through regenerative braking—although only a few per cent of overall energy, it can have an impact on overall vehicle range.

For a similar distance of journey, the same EV would consume energy at different rates and their range will be different. Ideally, free flow traffic that allows an even optimum speed during the journey works best for fuel efficiency and battery range. But in high-speed highway conditions, acceleration depletes the battery faster. Inside the city, traffic congestion, undulating road with frequent flyovers will also deplete battery. In slow moving traffic, regenerative braking is not that effective. Energy consumption would be lowest in case of free-flow traffic and highest in congested city streets. Whereas, an undulating road with frequent flyovers may help the vehicle to generate some energy due to regenerative braking while descending and keep the consumption level moderate.

Electric motors are famous for instant acceleration. While resisting the temptation for accelerating vehicles after a halt or slow down can be a challenge, it is a much-needed measure for maintaining battery life and range of the vehicle. This does not mean that driving slow is the only way to go for EVs, but rather that accelerating the vehicle slowly and progressively is healthier for the battery. Indian roads can be challenging for electric vehicles due to frequent traffic bottlenecks, especially in denser cities. However, smooth driving can be learnt on the go. Strategies such as route planning to avoid over-congested routes and avoiding peak hours to drive can help.

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Should we buy an electric car? New technologies often tend to get mired in a web of misinformation and myths due to an information deficit environment. In this publication, Centre for Science and Environment (CSE) answers questions about the electric car that is used for personal mobility, in the hope that this information will dispel myths and encourage consumers to buy more e-cars.

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