LTIMindtree

Whitepaper

# EV Market:
# Challenges, Development, and Solutions

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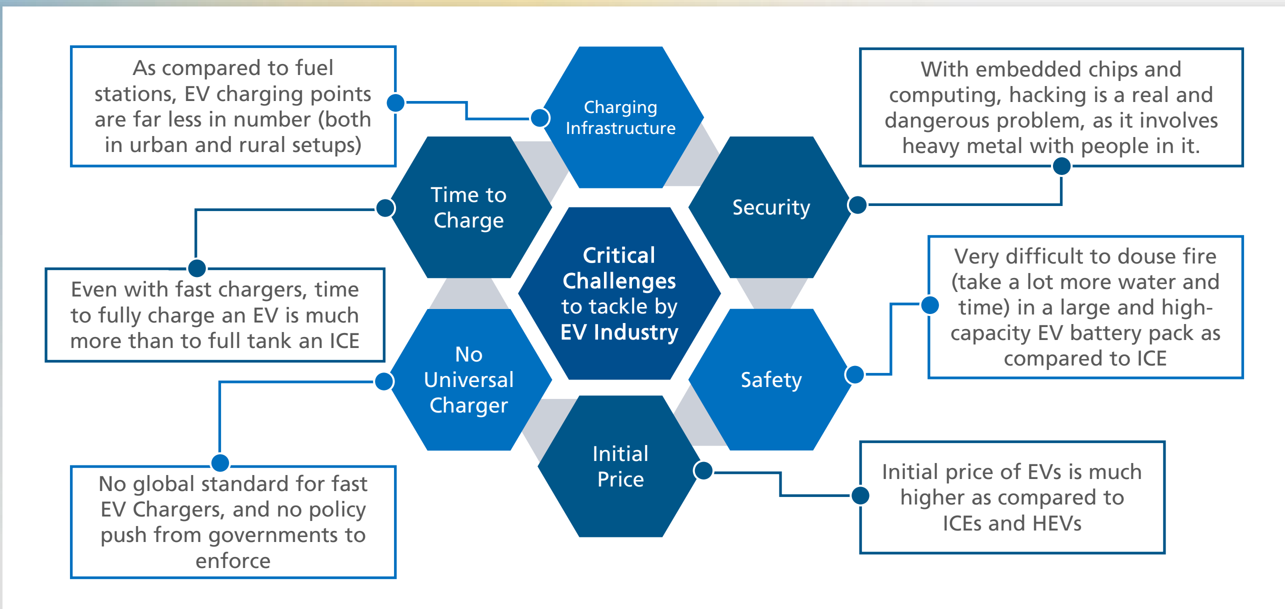
## Introduction

With governments across the globe enacting laws to ban the sale of Internal Combustion Engine (ICE) vehicles starting from a defined year, such as the European Union's announcement of 2035 and the UK's target of 2030, we may be witnessing the potential final phase of ICE vehicle manufacturing. These established cut-off dates have provided clarity for automakers, enabling them to strategize, backtrack, and plan necessary R&D to meet the set deadlines. The most evident alternative to ICE at this point is EV technology, which can be powered by either batteries or fuel cells. This technology has been successfully in use for decades, instilling confidence in its reliability and encouraging its application to help us achieve our climate goals.

## Challenges

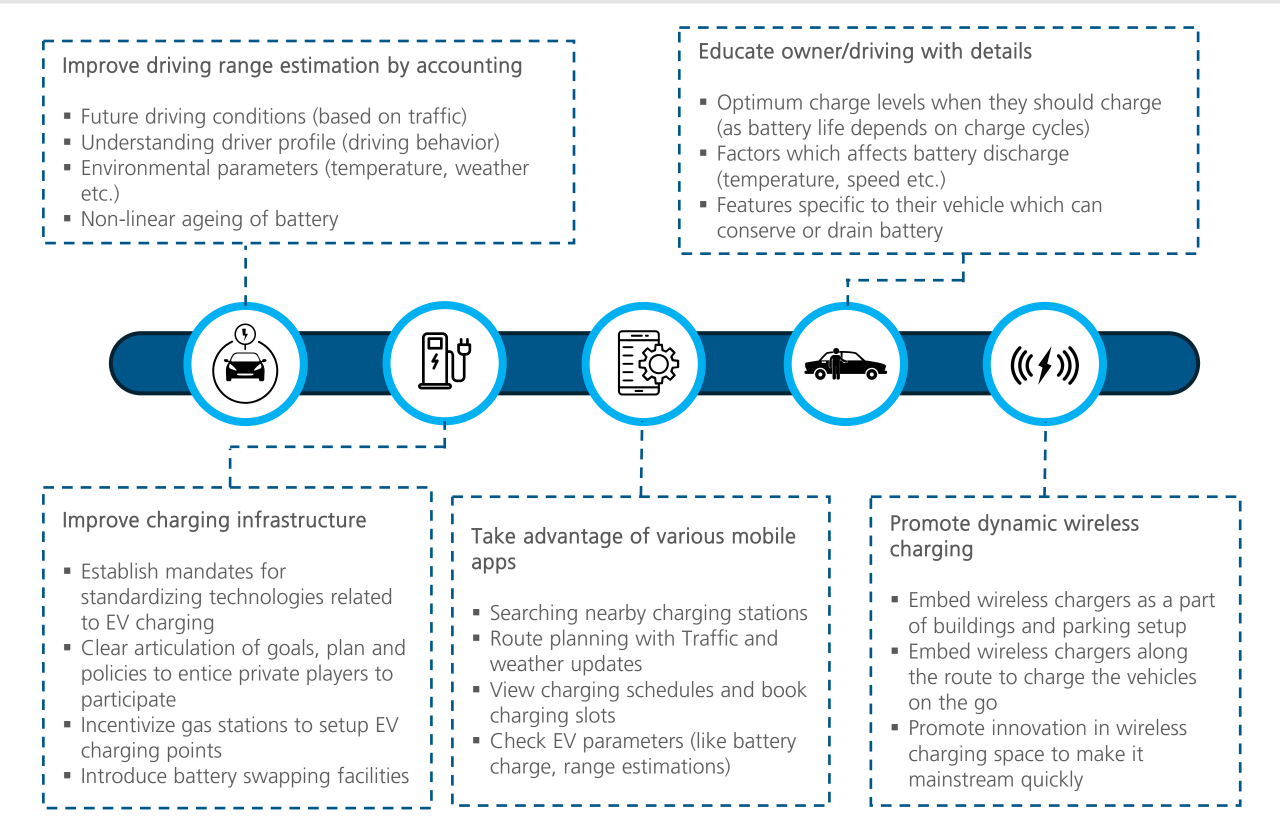
The transition to EVs represents more than a mere technological shift within the existing transportation mode; it's a complete lifestyle change for the owners. It's a complete change in the way of doing business for Original Equipment Manufacturers (OEMs), suppliers, and dealers, and plenty of technical challenges/opportunities for the R&D to conquer. Although the EV landscape is witnessing rapid innovation, there are still some roadblocks in EV adoption, such as higher initial cost of EVs, inadequate availability of charging infrastructure, no standards for universal fast EV chargers, time to charge EVs, accurate range estimations, safety, security, and supply chain disruptions.



## The most prominent hurdle emerges as follows

In contrast to fuel stations, which are present everywhere, across urban and rural settings, the current state of EV charging infrastructure remains scarce. Due to this lack of a ubiquitous charging network, owners depend heavily on a feature that tells them about the range (the distance the vehicle can travel with the current battery charge). The other issue is the long time it takes to charge an EV vehicle. Range anxiety combined with charge anxiety is one of the most prominent hurdles for an EV transition. It's a complete lifestyle change to switch to an EV in the current times. For example, if we plan to travel, it's not like we just punch in the destination on the GPS and drive; with EVs, we will have to plan it in such a way that we are not stranded on a deserted road due to dead batteries or stuck in long queues for hours to recharge our vehicles.

Addressing range and charging anxiety demands the implementation of a multitude of solutions.




Among the array of proposed solutions, two readily attainable measures stand out as having the potential to alleviate range anxiety swiftly: improved range estimation and the utilization of mobile apps for effective trip planning. In the context of this discussion, let's dig into the subject of range estimation, bearing in mind that mobile apps constitute a dynamic field where personal preferences influence feature significance.

## Driving range estimations, complexity, and solutions

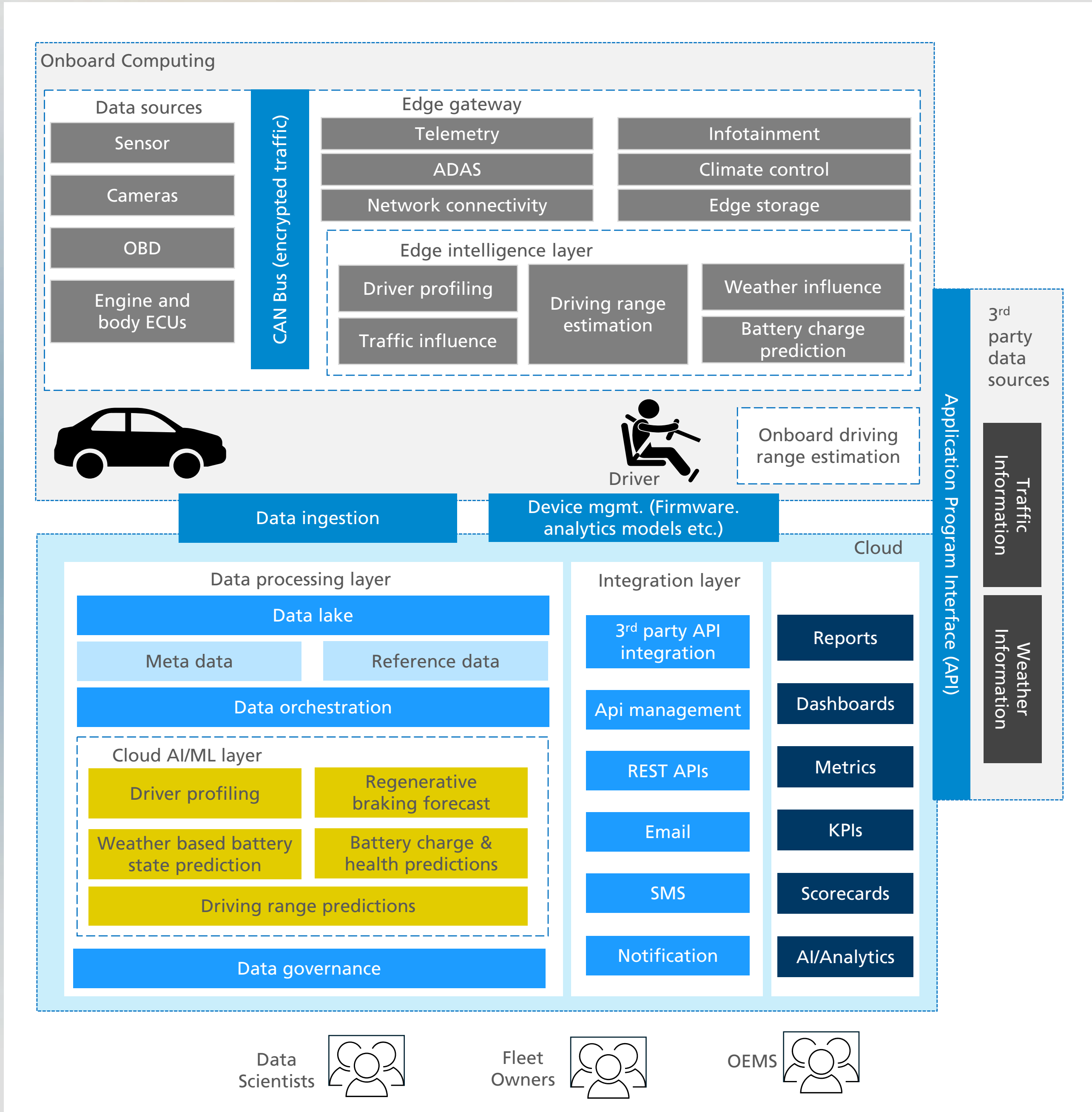
A range advertised for an EV is one of the crucial decision factors for purchasing a particular EV brand and model. The significance of precise range estimation became evident through recent events, exemplified by Tesla's confrontation with a California class action lawsuit pertaining to its range assertions. Furthermore, the observation is that in almost all cases, the actual range achieved by an EV rarely aligns with the advertised or runtime-projected range.

Currently, most range estimations are based on mathematical models that predominantly leverage historical data. These models utilize two primary inputs: the current battery State of Charge (SoC), indicating the battery's current charge level, and the State of Health (SoH), reflecting the battery's current age (not measured in years but in charge cycles). This algorithm operates under the assumption that immediate future energy consumption. Thus, range will mirror recent energy usage. This presumption lies at the core of the accuracy challenges these models face, given the substantial energy consumption fluctuations encountered in real-world driving conditions.

Multiple factors impact the range calculations, or to be precise, battery energy consumption. For example, EVs, for that matter, even Hybrid Electric Vehicles (HEVs) as well, use something called regenerative braking, which primarily converts the kinetic energy of the vehicle during braking or deceleration into electric energy and then used for charging the batteries. Another factor that affects a battery's capacity to hold charge is temperature. Temperature plays a major role in battery life, its ability to hold charge and performance. Chemical activity happening inside a battery is more at higher temperatures than at lower temperatures. At 0 degree Celsius, the capacity of the battery drops by 20%. So, for us to predict the driving range more accurately, we will have to add the complexities of predicting the uncertainties in the driving conditions and the environmental conditions, along with the battery state.

To predict the driving range of a vehicle more accurately, we need to consider all factors influencing battery energy consumption. To predict the effect of driving conditions on a battery charge, we will have to first integrate with third-party Application Programming Interfaces (APIs) (like Google Maps, MapQuest, Here, etc.), to fetch the real-time traffic details of the entire route. Additionally, by analyzing the driver's current driving style (harsh braking, accelerations, sharp turns, etc.), we can forecast the driving pattern based on existing traffic conditions. Combining these two insights, we can derive accelerations and decelerations and predict the battery charge state while factoring in regenerative braking.

Likewise, to predict the effect of environmental factors on the battery charge, we will have to first fetch the weather conditions (rain, wind, ambient temperature, etc.), from third-party sources like (WeatherAPI, AccuWeather, etc.), and then apply predictive models to forecast the battery charge state though out the route. The nonlinearity of SOH degradation (age of battery) is a solved problem and is already used in current range estimation models. All three of these inferences, based on driving conditions, environmental factors, and battery state, need to be calculated in real-time and then merged to predict the driving range accurately. This complexity renders the entire process computationally demanding.



There exist two deployment options, namely edge and cloud. Each possesses distinct advantages. Edge over the cloud has the advantage of having minimum latency to sensor data and video feeds, while cloud computing provides the elasticity of both computation and storage to perform big data analytics with ease. The solution, therefore, should be developed to leverage the strength of both, with the analytical models running on the edge and interacting with third-party data sources to provide real-time range estimations to the drivers. At the same time, the cloud part should analyze the data from different vehicles to provide insights for the OEMs to improve the design, provide a holistic view of the fleet for the fleet owners, and provide inputs for the data scientist to tune the analytical models (which can then be pushed to the edge).

# Conclusion

In conclusion, although EV users currently face several challenges, the industry is swiftly devising multiple solutions to address them. Undoubtedly, the primary concern shared by both existing and potential EV buyers is range anxiety. Various stakeholders within the ecosystem, including governmental bodies, car manufacturers, dealerships, etc., are dedicating significant efforts to tackle this pivotal user issue. At dealerships, sales representatives are actively educating potential EV owners about factors influencing vehicle range. These encompass elements such as the impact of weather and temperature on battery performance, as well as features like regenerative braking that can enhance range. Simultaneously, governmental authorities are implementing policies to standardize fast chargers while also investing in establishing widespread EV charging infrastructure similar to conventional fuel stations. EV manufacturers are also contributing to the solution space by introducing innovations.

These innovations encompass more accurate range prediction mechanisms, integrated climate control systems to mitigate range reduction during extreme temperatures, advancements in battery technology for increased capacity and faster recharge rates, and reduced battery degradation. These combined efforts aim to enable EVs to cover longer distances without inducing range anxiety.

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# Author Profiles


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NRK Rao has a proven track record in consulting, architecting, and building innovative technical solutions for customers, enabling them in their IoT journey. With over two decades of industry experience in telecom, mobility, and product engineering, he has garnered the skills to define scalable enterprise solutions. He is also part of the Industry 4.0 CoE team and is instrumental in defining solution frameworks, the creation of accelerators, and the technical enablement of the team.