



Whitepaper

# Elevating electric vehicle experience with personalized range prediction

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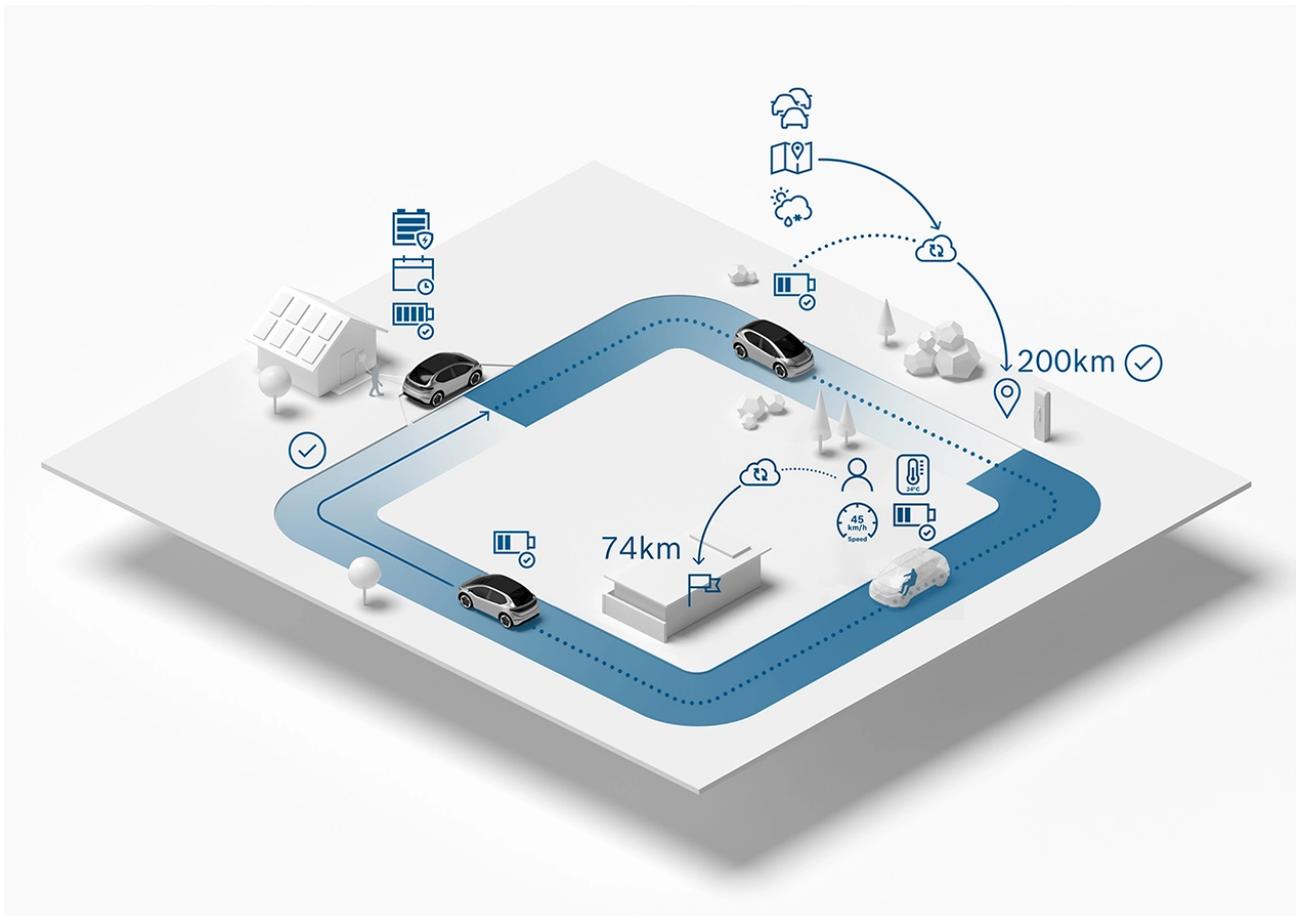
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# 01

## Introduction

The automotive industry is undergoing a significant transformation, shifting from a singular focus on powertrain performance to a holistic emphasis on brand image, seamless integration of digital life, and deep vehicle personalization. In this new era of electrified mobility, connected vehicle energy management plays a central and strategic role, influencing everything from optimal battery sizing and thermal management to robust connectivity. For electric vehicles, a critical aspect of vehicle energy management is range prediction, a feature directly impacting customer satisfaction, trust, and ultimately, brand loyalty.

This whitepaper explores how an advanced, personalized range prediction system can fundamentally enhance the driving experience with electric vehicles. By moving beyond traditional, average-based estimations, we can provide drivers with accurate, reliable, and confidence-inspiring range information, intelligently tailored to their individual driving styles, preferences, and the dynamic environmental context.



## 02

# The limitations of traditional range prediction

Conventional range prediction methods typically rely on the average energy consumption of the vehicle over a recent historical period (e.g., the last 200-400 kilometers). While a foundational step, this approach presents several critical limitations for the modern electric vehicle driver:

### **Ignores individual driving styles**

Averaging data across a generic vehicle usage profile fails to account for the specific energy consumption patterns of individual drivers. A “sporty” driver’s energy consumption will differ significantly from an “economical” one, leading to frustrating inaccuracies, a problem amplified in shared vehicles.

### **Neglects dynamic environmental context**

Traditional methods often fail to consider dynamic conditions such as real-time

traffic, road type (highway vs. city), terrain (uphill/downhill sections), and weather forecasts. These factors profoundly impact energy consumption. For instance, a drive at night on a wet highway at  $-10^{\circ}\text{C}$  has vastly different energy demands than a sunny daytime drive at  $+20^{\circ}\text{C}$  on the same route.

### **Lacks adaptability and foresight**

Static estimations do not adjust proactively to changing conditions or evolving driver behavior during a journey. This lack of foresight is a direct cause of “range anxiety”, which in turn erodes driver confidence and the perceived reliability of the vehicle.

## 03

# The power of personalized range prediction

Personalized range prediction addresses these shortcomings by incorporating a rich array of real-time, predictive, and historical data points to create a highly accurate and individualized estimation that is truly relevant to the driver's specific situation. This advanced approach significantly enhances the driver's peace of mind and overall experience:

### Driver behavior analysis

By continuously learning and adapting to individual driving styles, the system can predict energy consumption based on how a specific driver typically accelerates, brakes, and maintains speed in various situations. This intelligence extends to understanding preferences, such as how much thermal comfort a driver typically demands.

### Environmental context awareness

The system considers and predicts factors such as current and forecasted weather conditions (temperature, precipitation, wind), road type and conditions, and even the time of day to refine the range prediction.

### Proactive route prediction and optimization

Integrating navigation data allows the system to anticipate upcoming road characteristics (e.g., elevation changes, speed

limits, traffic congestion) and potential charging stops. This enables not only precise prediction but also proactive optimization suggestions.

### Holistic system integration

Personalized range prediction isn't a standalone function. It's deeply embedded within a comprehensive personalization ecosystem. This integration extends across different domains, enabling the insights gathered to enhance not only Bosch features but also those from vehicle manufacturers. Moreover, this personalized prediction is a core component of Bosch's broader vehicle energy management strategy, providing the foundation for activating customized energy-saving measures, optimizing vehicle settings, and ensuring a smooth, uninterrupted journey.

This advanced personalization approach leverages a sophisticated combination of:

- Pattern logic modules: that dynamically match identified usage patterns to function-specific parameters.
- Hyperpersonalization data model: to build rich, individual driver profiles that capture nuanced preferences and habits.
- AI learning algorithms: to continuously refine predictions, adapt to new data, and evolve with the driver's changing needs and external conditions.

# 04

## Strategic advantages for vehicle manufacturers

Implementing personalized range prediction offers several profound strategic advantages for vehicle manufacturers in the competitive electric vehicle market:

### **Elevated customer experience**

Accurate and reliable range predictions significantly reduce range anxiety and increase driver confidence. This translates directly into greater satisfaction, trust in the vehicle, and stronger brand loyalty – a true “peace of mind” driving experience.

### **Decisive competitive differentiation**

Offering a highly personalized and intelligent driving experience sets manufacturers apart. This isn't just about features; it's about delivering a superior, intuitive, and reassuring user interaction that competitors struggle to match.

### **Data-driven insights for innovation**

The rich data collected through personalized range prediction provides invaluable insights into real-world energy usage, driver behavior, and system performance. This intelligence can be leveraged to further optimize vehicle design, enhance strategies, and inform future product development cycles.

### **Extensibility and scalability**

A modular software platform ensures that personalized range prediction can be easily integrated into various vehicle architectures and quickly adapted or expanded with new features and functionalities as market demands evolve.

## 05

# Our modular building block kit: Accelerating your development

To facilitate the rapid and robust implementation of personalized range prediction and advanced vehicle energy management we offer a comprehensive building block kit. This modular platform empowers manufacturers to select, integrate, and customize specific features based on their unique product strategies and priorities. This kit comprises three key, interconnected layers:

**01** State-of-the-art features (foundational layer): This robust toolbox covers all required domains to guarantee a functional, reliable, and compliant user journey. It provides the core algorithms and interfaces for basic energy management, battery state estimation, and standard range calculations, ensuring a solid, safe, and stable base for further development.

**02** Advanced features (predictive layer): This layer enriches the foundational capabilities with sophisticated predictive intelligence. It employs advanced software functions for real-time optimization of energy consumption based on current conditions and upcoming route data. This includes considering navigation, traffic, and dynamic environmental factors to achieve up to 10% higher precision in range prediction and enable optimization for either time savings (up to 13%) or range extension (up to 10%).

**03** Personalization (hyper-intelligence layer): This uppermost layer integrates deep personalization by incorporating dynamic driver behavior profiles, individual preferences, and comprehensive environmental context. Leveraging AI learning algorithms, a hyperpersonalization data model, and the pattern logic modules, this layer ensures that all vehicle energy management decisions and range predictions are uniquely tailored to the specific driver, providing an unparalleled level of accuracy and comfort.

Ultimately, this modular approach not only significantly speeds up your development cycles but also provides a safe and stable foundation for continuous innovation and feature expansion, ensuring your vehicles remain at the forefront of the market.

- 10% higher in precision in range prediction
- Up to 13% time savings or up to 10% range extension

## 06

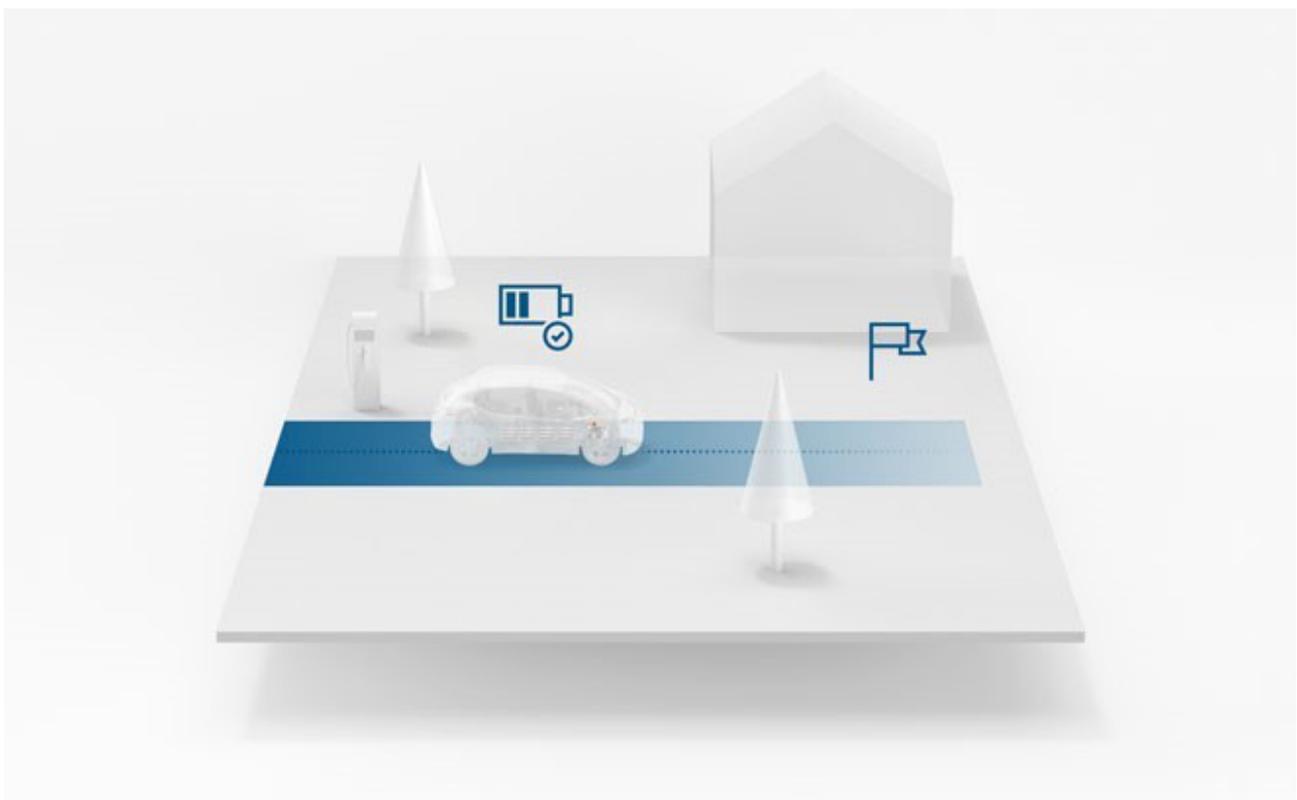
# “Get home” mode and intelligent energy-saving measures

A compelling application of personalized range prediction is the “get home” mode. More than a simple manually activated function, this feature intelligently selects the most appropriate energy-saving measures to reach a destination by leveraging personalized data, including:

- Driver and passenger preferences: understanding desired levels of comfort.
- Learned driving style: adapting to the driver’s typical habits.

- Thermal comfort requirements: proactively managing climate control needs.
- Environmental context: optimizing for external conditions (adapting the driving style based on the weather, e.g., if heavy rain is predicted).

This ensures that energy-saving measures are not only highly effective but also minimally intrusive, preserving the driving experience while making sure that the target destination can be reached with the given battery state of charge. The system dynamically balances efficiency with user comfort.



## The future of personalization: Beyond range prediction

Personalized range prediction is merely the initial step in a much broader journey. The ability to capture, analyze, and intelligently act upon driver and vehicle data opens the door to a wide array of personalized features and services that can redefine the entire vehicle ownership experience:



### Adaptive vehicle settings

Automatically adjusting seat positions, mirror settings, climate control, lighting, and infotainment preferences based on driver recognition and historical usage patterns.



### Predictive maintenance

Anticipating potential maintenance needs based on individual driving patterns, load profiles, and vehicle usage, proactively scheduling service when most convenient.



### Personalized safety features

Tailoring the sensitivity and response of advanced driver-assistance systems (ADAS) to individual driving habits and preferences, enhancing both safety and driver confidence.



### Integrated home energy management

Seamlessly connecting the vehicle's charging and discharge cycles with smart home energy systems for optimal cost and sustainability.

By embracing this comprehensive vision of personalization, vehicle manufacturers can transform electric vehicles from mere transportation devices into intelligent, adaptive assistants that cater intimately to the unique needs and preferences of every driver. This fosters stronger customer relationships and cultivates enduring brand loyalty.

## 07

# Conclusion

Personalized range prediction is a crucial step towards enhancing the driving experience with electric vehicles. By moving beyond generic estimations and embracing deep individualization and contextual awareness, manufacturers can significantly mitigate range anxiety, dramatically increase customer satisfaction, and powerfully differentiate themselves in an increasingly competitive market. Our modular building block kit provides a flexible, scalable, and robust solution for implementing personalized range prediction, unlocking

the full potential of advanced vehicle energy management, and accelerating your path to innovation.

Investing in software-driven personalization allows vehicle manufacturers to transform electric vehicles from mere transportation devices into intelligent, adaptive companions that learn, anticipate, and cater to the unique needs and preferences of every driver, securing a leadership position in the future of mobility.

## Contact us now

Do you have any questions, comments or business inquiries?

Please do not hesitate to get in touch.

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