36th International Electric Vehicle Symposium and Exhibition (EVS36)
Sacramento, California, USA, June 11-14, 2023

Engineering and Operational Excellence for Customer Centric Global Public Charging Networks

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Executive Summary

Operating global public High Power Charging (HPC) networks raises different challenges in terms of interoperability, data quality, KPI consistency, and increasingly, integration with digital products and services beyond EV charging and offering a holistic customer experience at scale. These lead to the importance of introducing Global Network Performance KPIs in order to monitor the reliability and perceived customer experience of the operated HPC charging infrastructure. Furthermore, the massive ramp-up plans for charging infrastructure on a global scale require a multi-system (and/or partner) approach operating multiple HW, CPMS, and digital technology providers at the same time. To strive for engineering & operational excellence in this highly complex and dynamic environment, interoperability and observability is key from an end-to-end perspective including the evolving need for a data standard that enables a "plug & play" integration of new ecosystem elements, and implementing best practices of technology operations at scale.

1 The Status Quo

1.1 Complexity of the Public Charging Ecosystem

The public charging ecosystem is shaped by many stakeholders operating different Hardware and IT systems for charging infrastructure operations and billing and have access to different charging data sources.

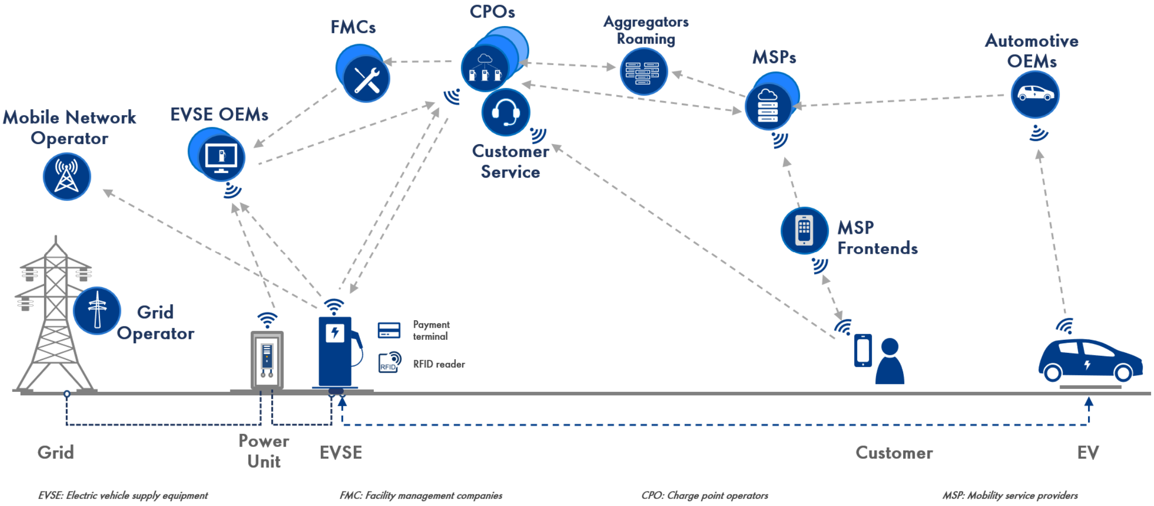

Figure 1: Example overview of a public charging ecosystem

1.2 Status Quo – End to end Interoperability from Engineering Excellence Perspective

Practical experience show that interoperability and data transparency varies across interfaces. OCPP as key enabler for diagnostics & maintenance, but is shows variety of vendor specific implementations.

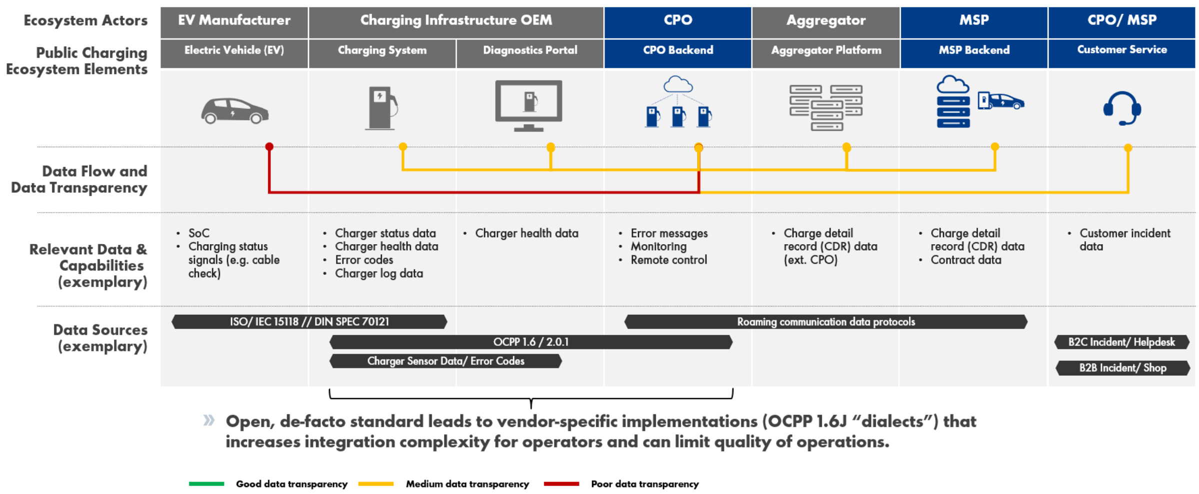

Figure 2: Quality of data transparency across the ecosystem interfaces

1.3 Status Quo – Vendor Error Codes as an example for Data quality and Data Consistency

Vendor Error Code Analysis showing large differences between equipment manufacturers. At the same time they are key for smart maintenance.

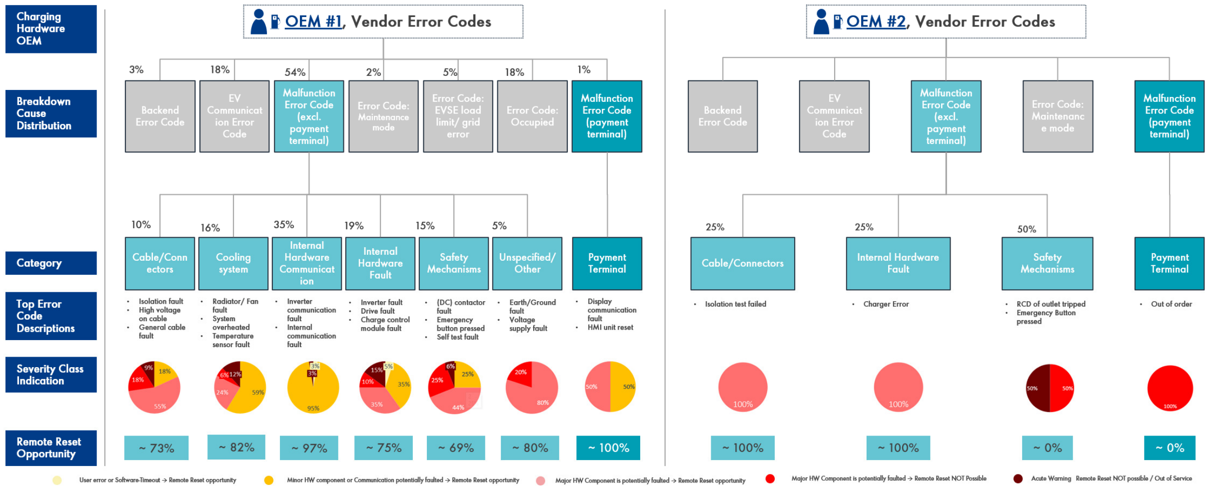

Figure 3: Distribution of Breakdown Causes, Malfunction Categories, Top Errors incl. Severity Class & Remote Reset Opportunity. Deeper colors indicate greater severity of errors.

2 The Challenge and Opportunity Ahead

In order to provide a compelling customer value proposition the EV Charging Services must be reliable, every transaction should be successful, and the services should offer a seamless customer experience alongside other offerings. We see the following areas as a challenge and an opportunity:

2.1 Uptime & Customers Charging Success as key elements for EV charging network operating reliably

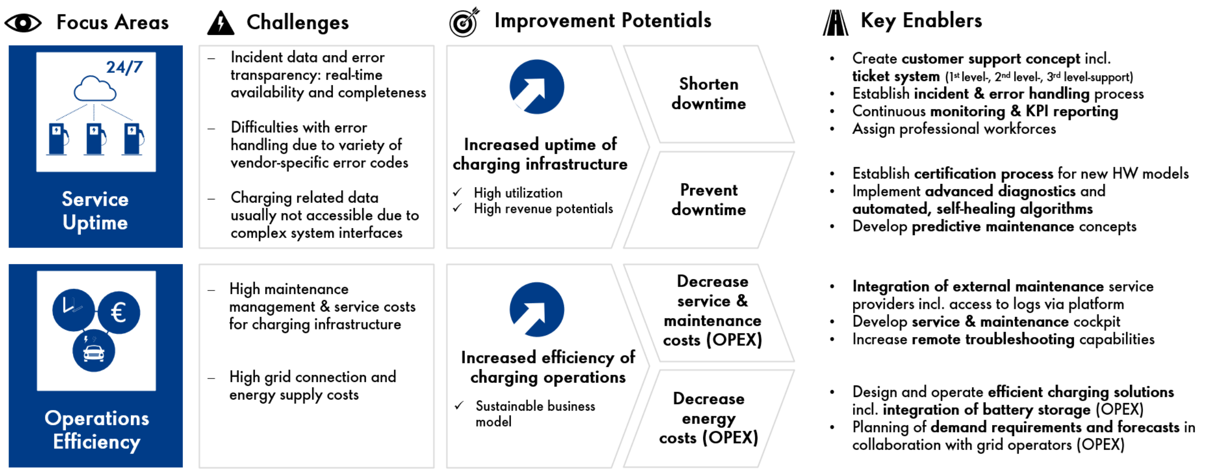

Figure 4 Focus areas, challenges, the potential of improvement, and the key enablers

2.2 Importance of Maintenance and Diagnostics Concepts on Uptime & Customers Charging Success

Maintenance and diagnostics concepts have a major impact on operating hours and resistance to error of charging hardware: 'Condition-based Maintenance' towards 'Predictive Maintenance' as key concepts for successful operations.

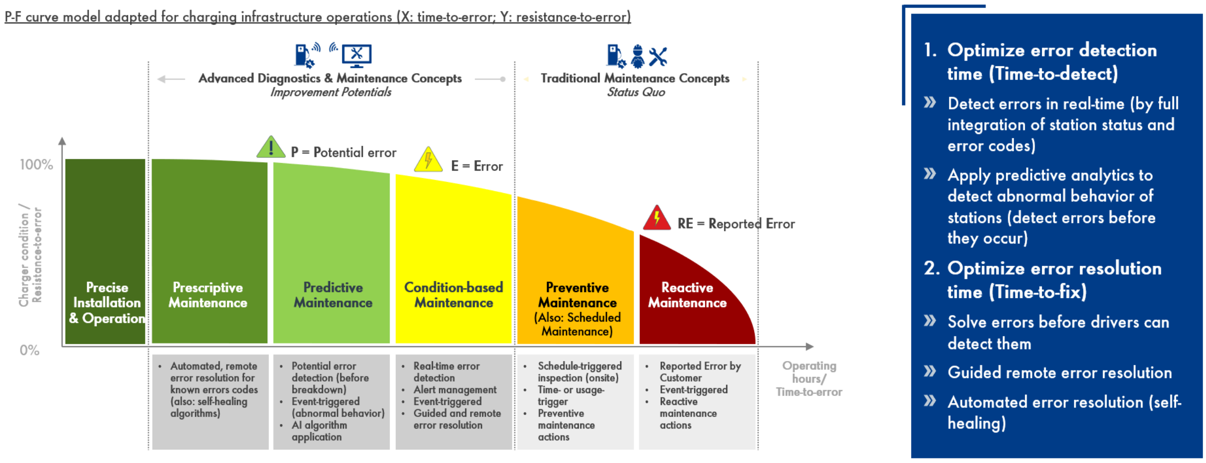

Figure 5: P-F curve model adapted for charging infrastructure operations (X: time-to-error; Y: resistance-to-error)

2.3 Customer demand for differentiated and integrated offerings

Within the Shell business context, the EV charging offering is not standalone, but part of a differentiated and integrated offering, across all EV charging use cases and integrated with other offerings such as convenience retailing. Therefore the EV charging technology solution will be integrated across new and legacy digital products and thus require integrated observability and maintenance approaches.

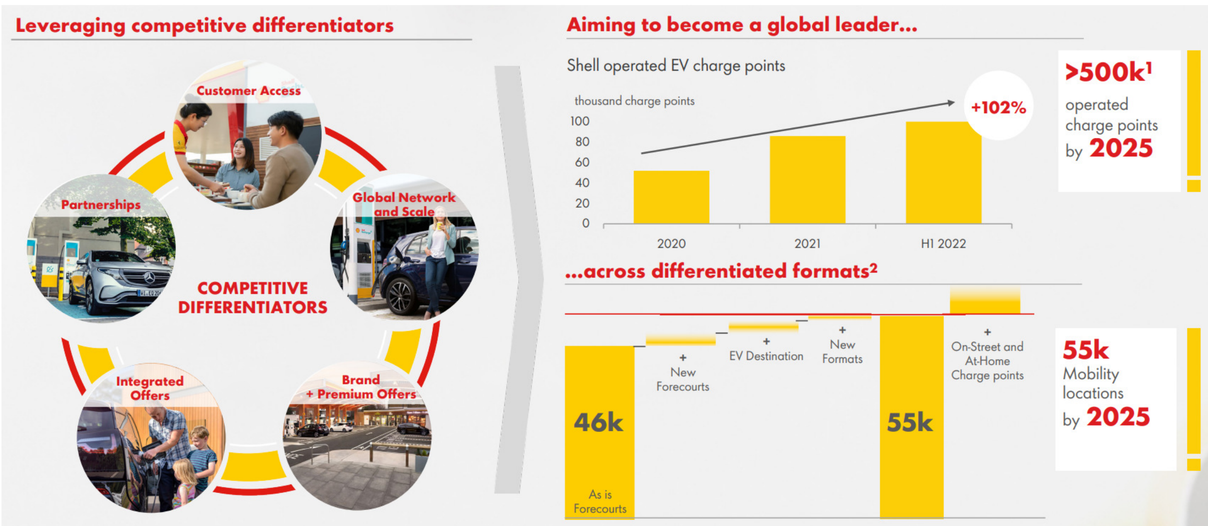

Figure 6: Shell Mobility EV Charging – Building the Mobility offer of the future by leveraging differentiators. 1. Includes charge points at Shell forecourts and new locations as well as operated charge points owned by customers and third parties 2. On-street and at-home charge points will be additional to the 55K mobility locations. Growth levers in waterfall indicative and not to scale ©Shell Plc

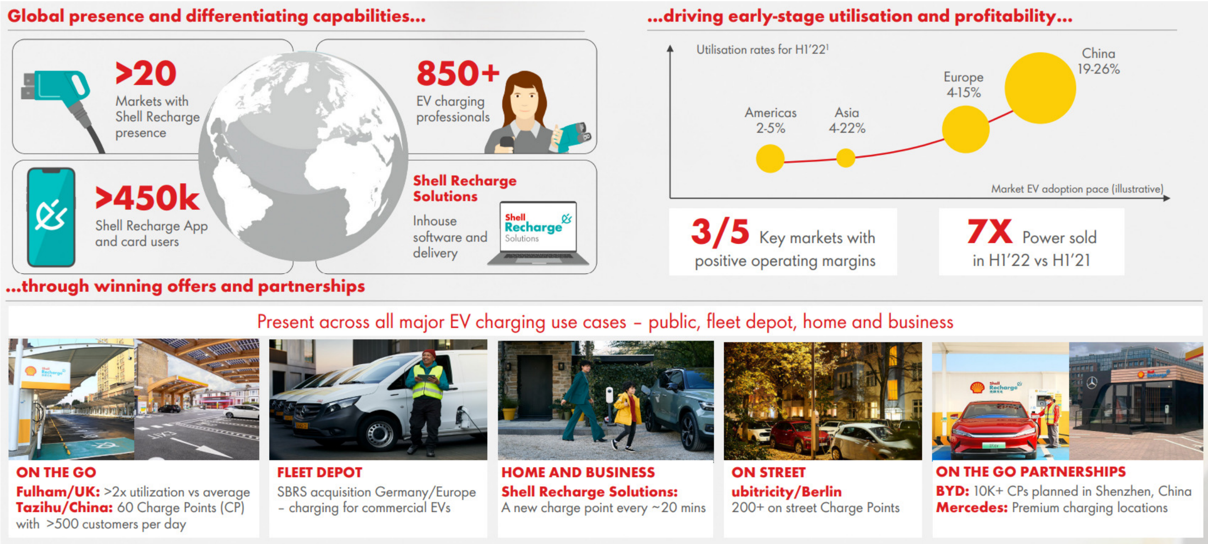

Figure 7: Shell Mobility EV Charging – Global presence and capabilities driving growth across all major EV charging use cases ©Shell Plc

3 Potential Approaches – Dialogue Invitation

3.1 Introducing Global Network Performance KPIs..

..in order to monitor the reliability and perceived customer experience of the operated HPC charging infrastructure demand for differentiated and integrated offerings.

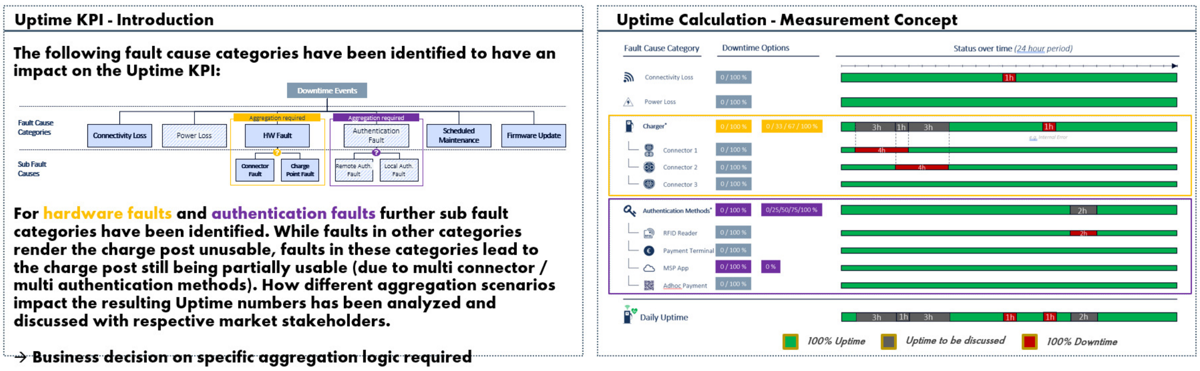

Figure 8: Defining the KPIs and Measurement Concepts for HPC Charging Infrastructure

3.2 From Insight To Action

We marry the feedstock of KPI definition and methodologies with the best practices and platforms from enterprise Information Technology Operations – in order to arm frontline technicians with the tools to

- diagnose and actuate change through remedial or proactive action
- integrate end to end with legacy and digital platforms
- deliver a picture of the customer experience and business outcomes
- automate for reliability, uptime, efficiency, and customer satisfaction
- and as a methodology to track maturity of operations.

The key opportunity to manage complex ecosystems is understand the technical detail and establish intelligent operations solutions. We aim to deploy "deep" & "wide" monitoring mapped to customer journeys, augmented by AI, enabling immediate and proactive action. In doing so, progressively advance the maturity of EV charging technology operations in line with (IT) industry recognised maturity models, and delivering the value therein.

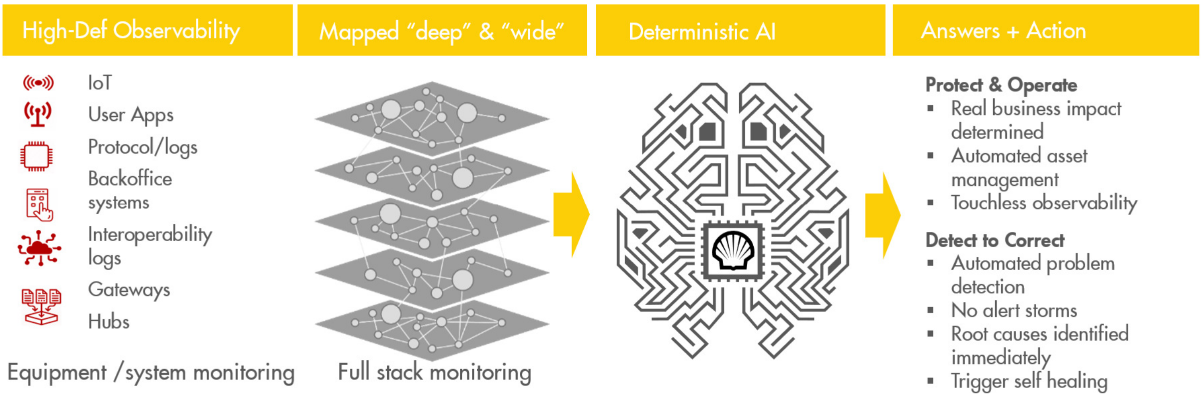

Figure 9: From Insight to Action, transforming our KPIs into actionable outcomes

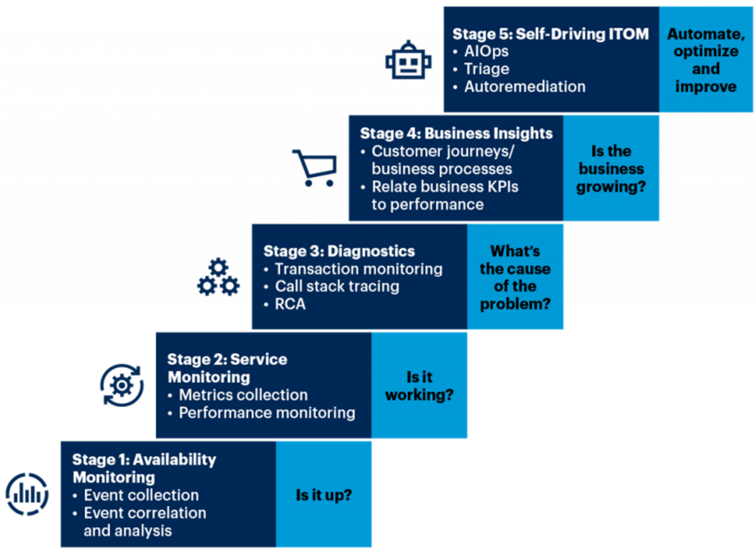

Figure 10: Evolution of IT Operations Monitoring Maturity and the progressive value of each stage of maturity. [1] referenced diagram source © Gartner

4 Takeaways for Discussion

- Today's diagnostics and maintenance concepts (error detection incl. root cause & error resolution) in the EV charging market mainly focus on reactive approaches. Reactive approaches include corrective maintenance (based on reported customer errors) and preventive maintenance (based on historical data and OEM specific maintenance schedules).
- A global analysis of breakdown classes for EV charging (AC + DC) shows significant improvement potential (~ 50 % of charging attempts fail). Major breakdown classes are "EVCommunicationError" and "BackendCommunicationError" (> 50% of all derived error causes) followed by "Occupied" and "Out of Order/ Maintenance Mode". Further breakdown classes "Malfunction" and "Restricted Access" show low overall share.
- An analysis of error codes across different charging hardware OEMs shows that OCPP standard error codes "EVCommunicationError" are widely supported and further developed into vendor-specific

Error Codes with focus on “EVCommunicationError”. Furthermore, error codes are not standardized and can differ across charging hardware OEMs in quantity and quality (e.g. DC: from 30-200 error codes; AC: ~ 20-25 error codes).

- Remote error resolution options in the EV charging market mainly focus on soft resets or hard resets. Charging hardware OEMs provide guidelines for (remote) error resolutions. Error resolution guidelines are usually linked to OEM-specific error codes and therefore are not standardized.
- Data and insights must not only be formed for the EV charging solution but across all integrated offerings that a company aims to deliver for a seamless customer experience. For example, via a unified digital app.
- Once the KPIs, data, and insights foundation is formed, these then need to be translated into actionable outcomes.
- Frontline technology operations need to be enabled with the right tools and practices at scale in order to effectively actuate the changes needed to improve reliability and charging success.
- Implementing the the best practices, platforms, and capabilities of enterprise Information Technology may be effective in achieving these goals.

References

[1] Evolution of IT Monitoring Strategy, Gartner IT Infrastructure, Cloud, and Operations Strategies Conference, 2019, Las Vegas

Presenter Biographies

Anke Freitag is part of the global Mobility Engineering Solutions Leadership team in Shell, with it’s EV charger network of >8000 charge posts and a growth ambition of 30000 charge posts by 2025 across Americas, Europe and Asia. She is responsible for setting up smart, safe and fit for future Engineering processes and tools to affordably grow and operate the Shell Mobility network.

Her expertise lays in bridging between Commercial and Engineering disciplines with a focus on digitalisation and lean processes. She looks back at 23 years working experience in manufacturing, logistics, trading, fast consumer goods sales and global account management as well as Aviation and eMobility Operations and Engieering. In the past years EV charger network operations and performance management of the E2E ecosystem has become her prime priority.

Mrs Freitag holds an Industrial Engineering Diploma from Nordakademie in Hamburg (2003), studied in Salamanca/Spain and worked in India, besides living in Hamburg/Germany. She is member of the international Scrum Alliance and Shell.ai community and is a certified Lean Six Sigma Black Belt.