



AI predictions of real-world EV DCFC charging profiles and durations

Presented at: *Aachen Automotive Colloquium, 5-7 Oct. 2026*

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Shell’s net-zero emissions target

Shell’s operating plan and outlook are forecasted for a three-year period and ten-year period, respectively, and are updated every year. They reflect the current economic environment and what we can reasonably expect to see over the next three and ten years. Accordingly, the outlook reflects our combined Scope 1 and 2 target, NCI target and our oil products ambition over the next ten years. However, Shell’s operating plan and outlook cannot reflect our 2050 net-zero emissions target, as this target is outside our planning period. Such future operating plans and outlooks could include changes to our portfolio, efficiency improvements and the use of carbon capture and storage and carbon credits. In the future, as society moves towards net-zero emissions, we expect Shell’s operating plans and outlooks to reflect this movement. However, if society is not net zero in 2050, as of today, there would be significant risk that Shell may not meet this target.

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Agenda

01 Introductions

02 DCFC Charging Profiles

03 AI Predicted Charging Profiles

04 Conclusions

Q&A

Back-Up Slides

01. Introductions

Shell's Strategy

Energy Security Scenarios

EV Charging in Shell

Shell Recharge

Differentiation with Interoperability

01.1 Shell's Strategy

Who we are

Shell is a global group of energy and petrochemical companies, employing 85,000 people across more than 70 countries.

Our strategy

Delivering more value, with less emissions.

Our vision

Is to become the world's leading integrated energy company – delivering impact at scale, connecting energy and people, matching supply to demand.

Ref: [Our strategy | Shell Global](#)



01.2 Energy Security Scenarios

In Shell's 2025 Energy Security Scenarios: **Energy and Artificial Intelligence**, we re-imagine our **Archipelagos** and **Horizon** scenarios in the context of a world using AI.

We have also added a third scenario, **Surge**, which explores the prospect of a new wave of economic growth driven by productivity improvements catalysed by AI.

[The 2025 Energy Security Scenarios | Shell Global](#)



01.3 EV Charging in Shell

Growing our public network of EV charging points

We currently have >80,000 public charge points globally at forecourts, on-street, mobility hubs and destinations. As drivers switch to EVs, we expect a shift away from at home charging towards public charging.

Delivering smarter electric fleet solutions

Business travel accounts for roughly 1/3 of all journeys. We help customers electrify their fleets by providing comprehensive charging infrastructure and services.

Shell Recharge Driver Survey 2026 covers China, Europe and North America.



01.4 Shell Recharge

Shell Recharge is the brand name for our EV charging products and services. It is a key part of our strategy: **delivering more value, with less emissions.**

It complements our traditional fuel brands, Shell V-Power and Shell FuelSave – both of which are available for both customers requiring either gasoline and diesel.

These are **differentiated** – both from competitor products (“Super”, “Premium”), and from each other.

Shell
Recharge 

Shell
V-Power 

Shell
FuelSave

01.5 Challenge: Optimise Interoperability

Interoperability works really well in traditional hydrocarbon fuels: if you don't own an F1 car, bring your city car, or moped, or mobile home, or...

Encourages scales - everybody can meet the specifications. It's a very competitive market.

Our AI model is one option Shell has to excel in energy and power management, and to help the customer understand how long the session will take.



02. DCFC Charging Profiles

DCFC Charging Profiles – Basics

DCFC Examples – Ideal Conditions

Real Customer Examples – NON-Ideal

02.1 DCFC Charging Profiles - Basics

DCFC: Direct Current Fast Charging Fits with Shell's E-Mobility strategy.

Charging Profiles: power vs state of charge [SoC]

Very different, EV to EV, due to differences in, e.g.:

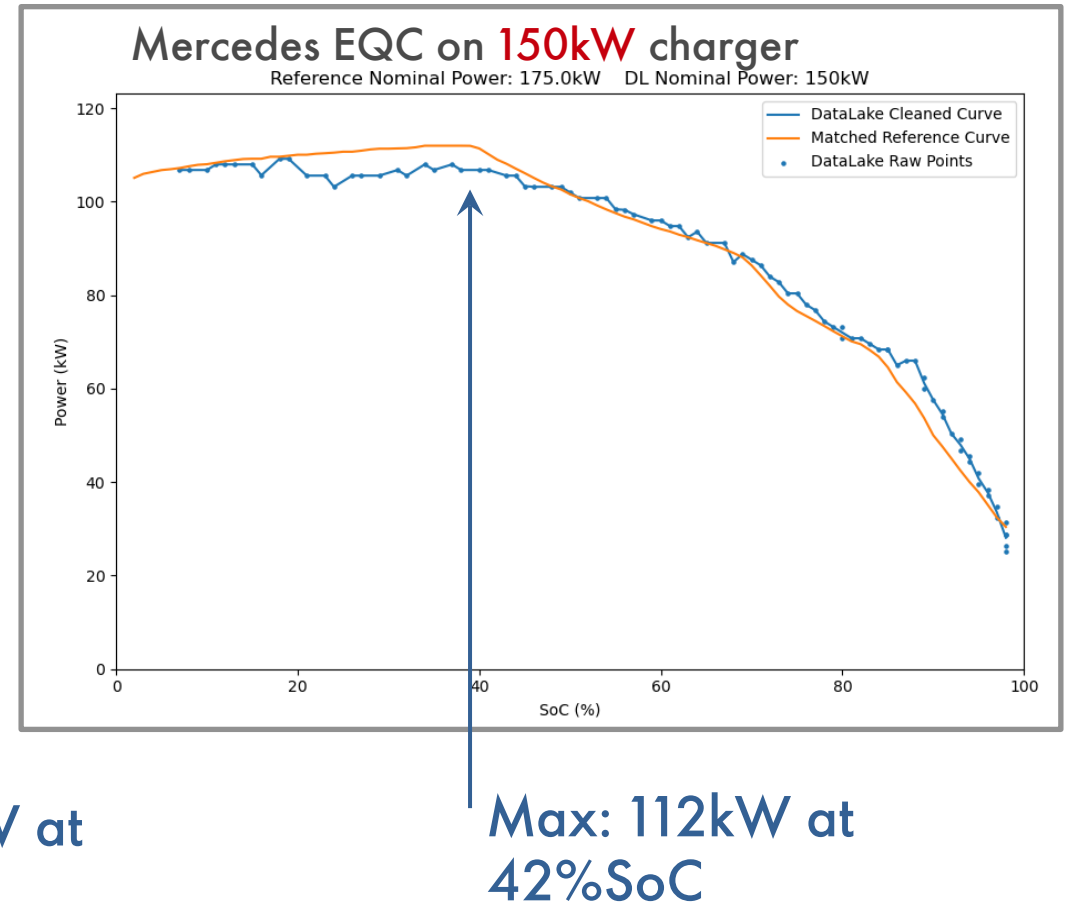
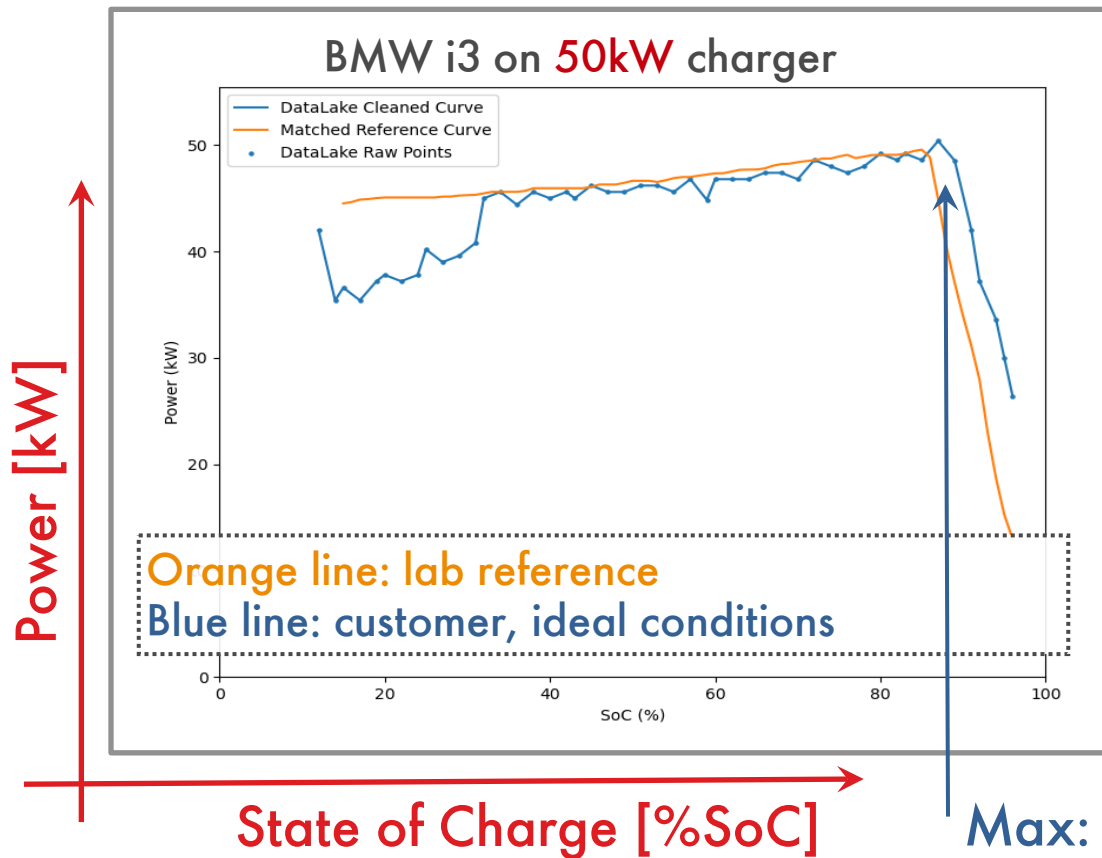
- battery chemistry
- battery management systems (BMS),
- thermal management systems...

Can be **EV Limited** or **Charger Limited**

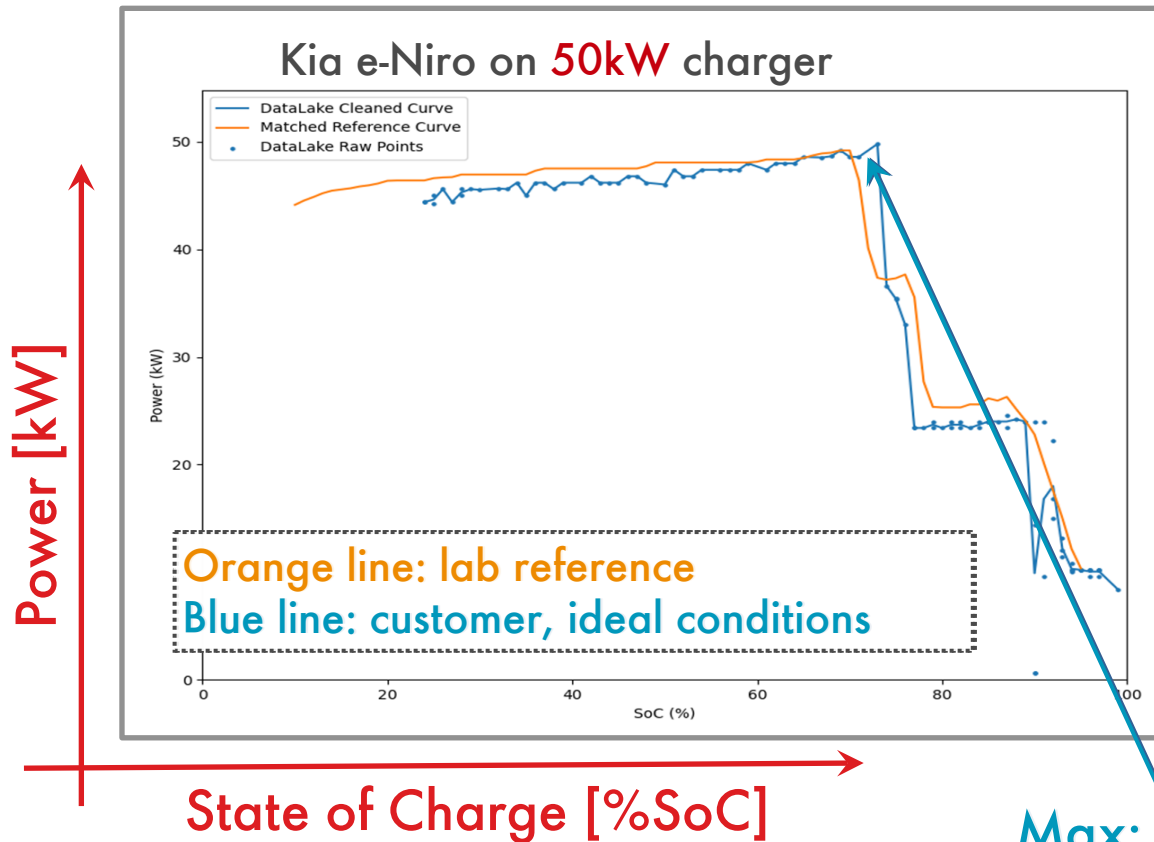
OCPP data – more limited than Chinese equivalent, GB/T 32960

- No vehicle identification no (VIN), no Make & Model identification.

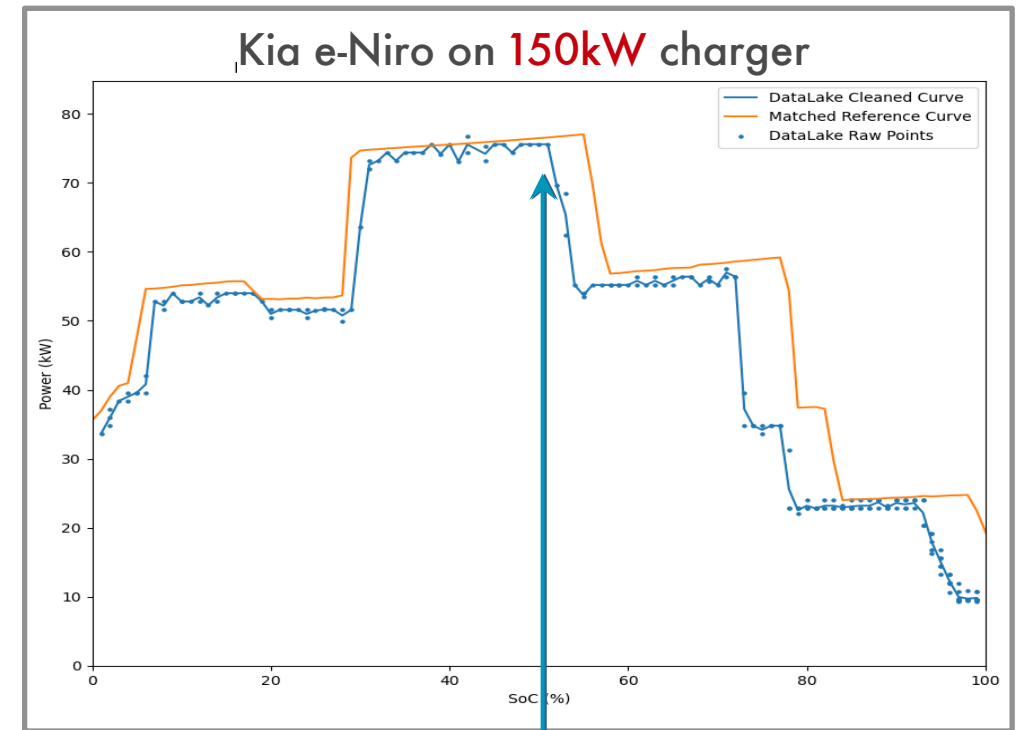
02.2 DCFC Examples – Ideal Conditions



02.1 More Examples – Ideal Conditions



Max: 50kW
at 73%SoC



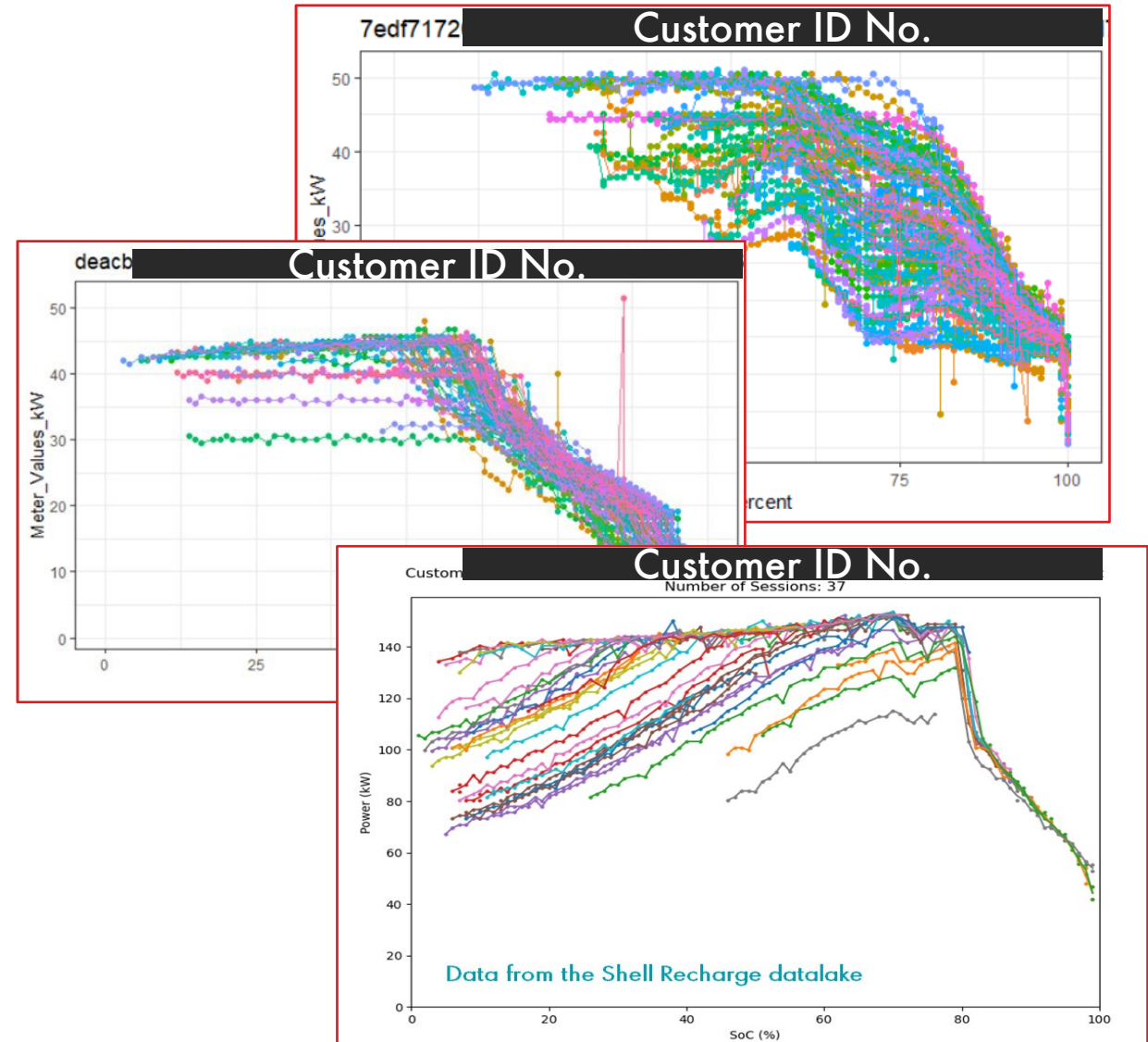
Max: 78kW
at 50%SoC

02.1 Real Customer Examples – NON-Ideal!

Real customers' experience

- Variability in charging performance makes it more difficult to estimate charging duration.
- Power-sharing effects may contribute to additional variability.
- Makes corporate planning and "Smart Charging" hard.

Each graph is for a **SINGLE** customer.
Each line on a graph is a single session.



03. AI Predicted Charging Profiles

Our Publication

Deep Learning

Input Data

Results

03.1 Our Publication

Deep learning predicts real-world electric vehicle direct current charging profiles and durations.

Nature Communications 16, 10921 (2025).

<https://doi.org/10.1038/s41467-025-65970-y>

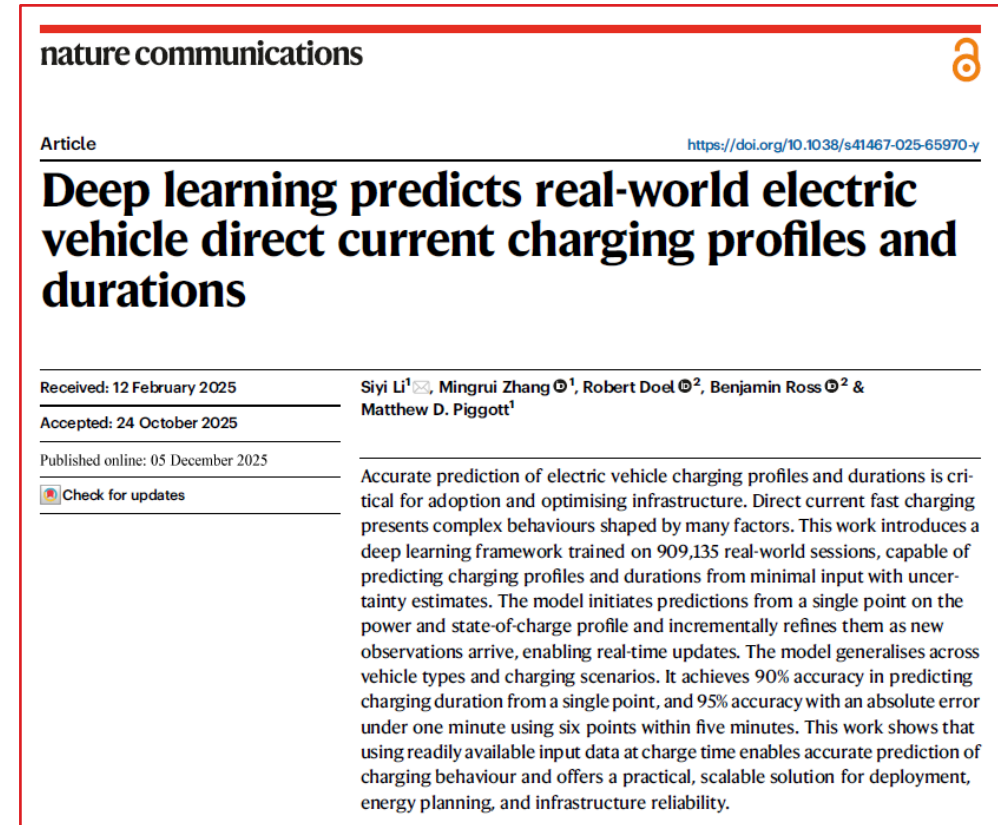
Acknowledge co-workers:

Prof. Matthew Piggott: Professor of Computational Geoscience & Engineering, Imperial College London, UK.

Mr. Siyi Li: PhD Candidate under Prof. Piggott.

Dr. Mingrui Zhang: Post doc under Prof. Piggott.

Mr. Ben Ross: Intern student at Shell, from Bath Uni.



03.2 Deep Learning

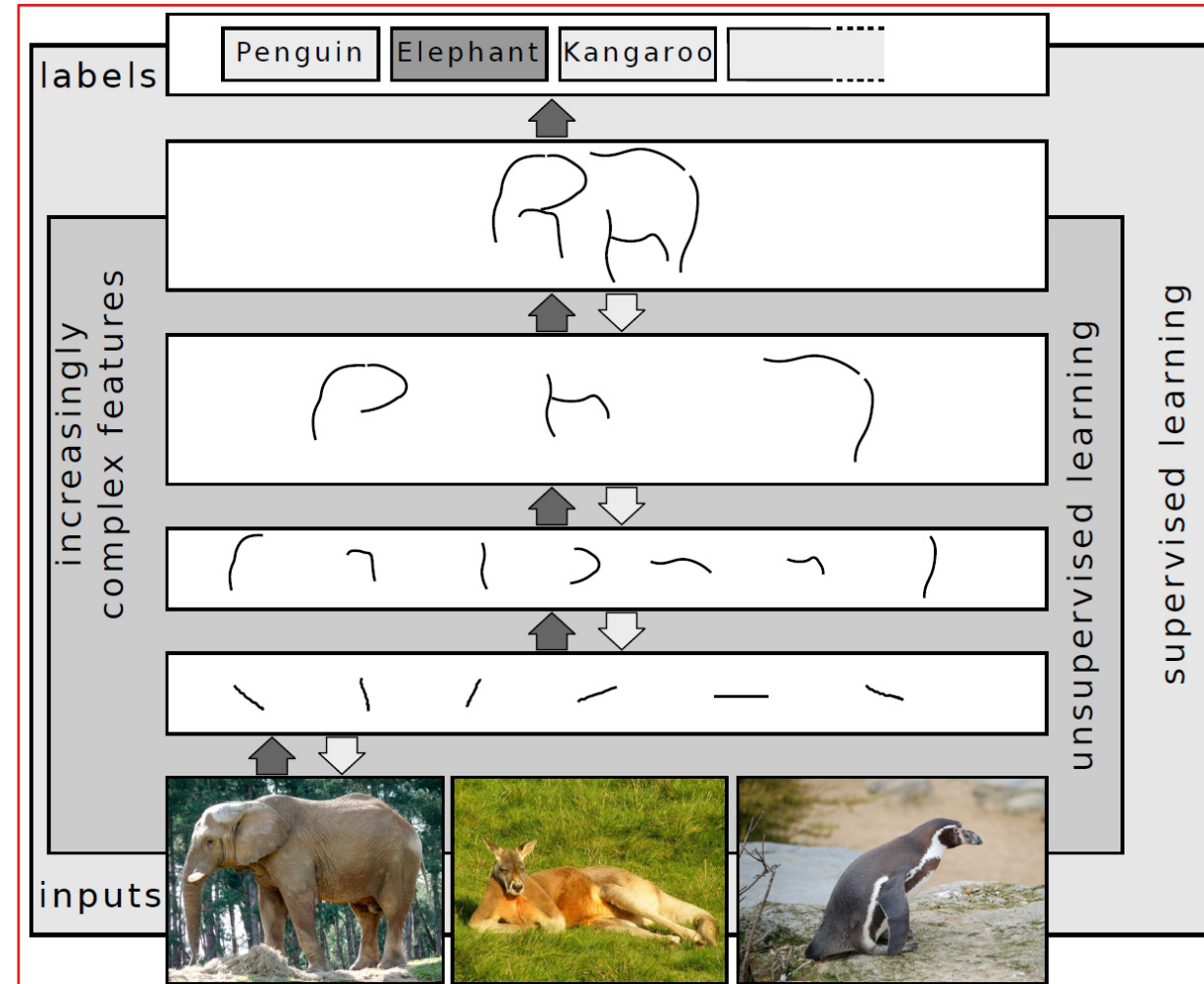
Wikipedia tells me: **Deep learning (DL)** stacks multi-layered neural networks and “trains” them to process data to perform tasks, e.g., classification and representation learning.

Takes inspiration from biological neuroscience.

‘Deep’ refers to multiple layers in the network.

Can be supervised, semi-supervised, self-supervised or unsupervised.

See back-up slide for details of our approach.



03.3 Input Data

Time series data: Power and %SoC

Static co-variables:

Site Ref. No.

Charger Ref. No.

Connector Ref. No.

Customer ID: For this R&D paper, withheld for privacy. Estimated battery capacity at 100%SoC used as a proxy.

Temperature: Ambient air temperature added from EU database

Coverage: 2021 to early-2024 from GB, NL and DE

After removing sessions with insufficient data: 909,135 sessions, out of the original 1,601,116.

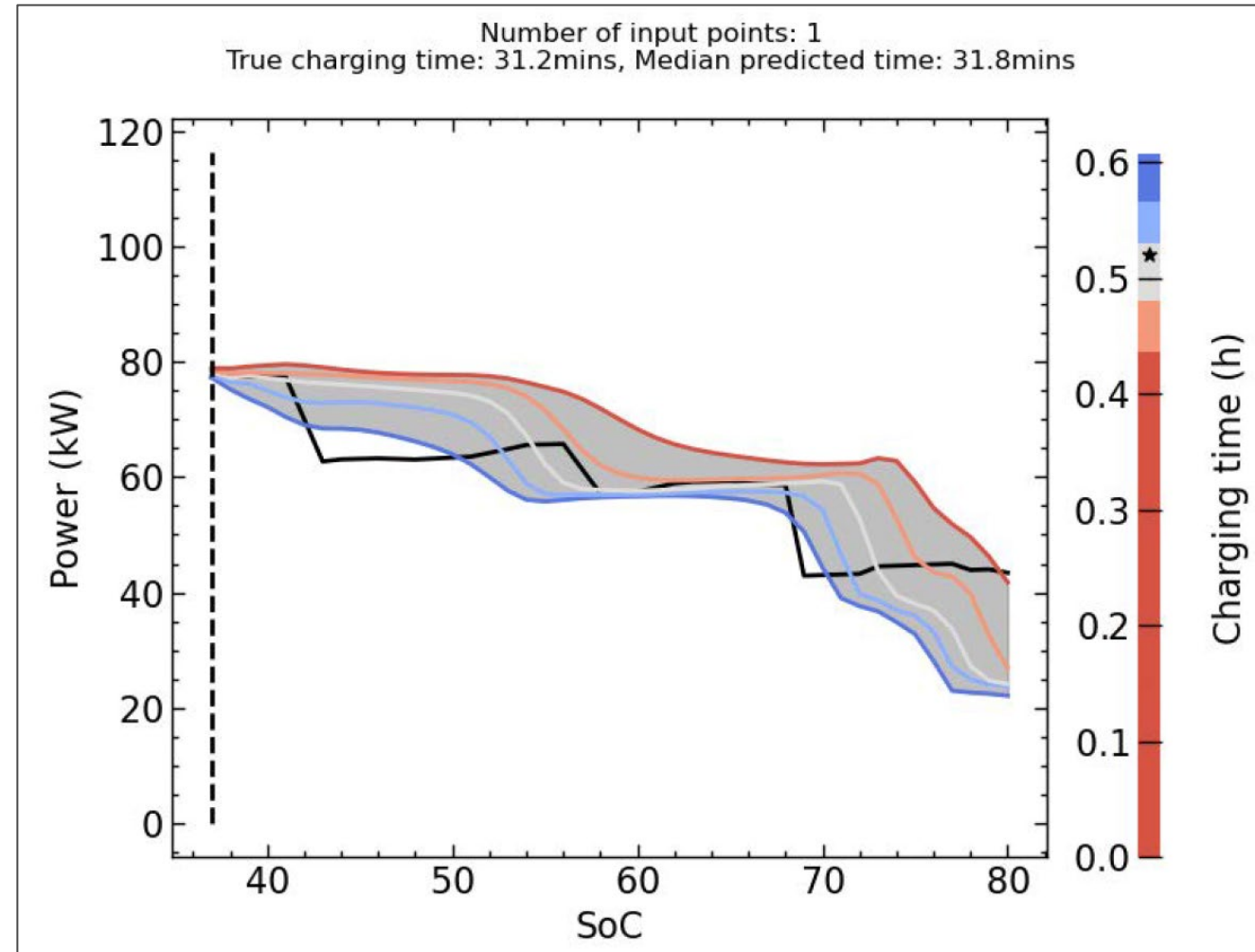
03.4 Results

Predictions for a particular charging curve.

The solid black line is the actual power as a function of state of charge for a session.

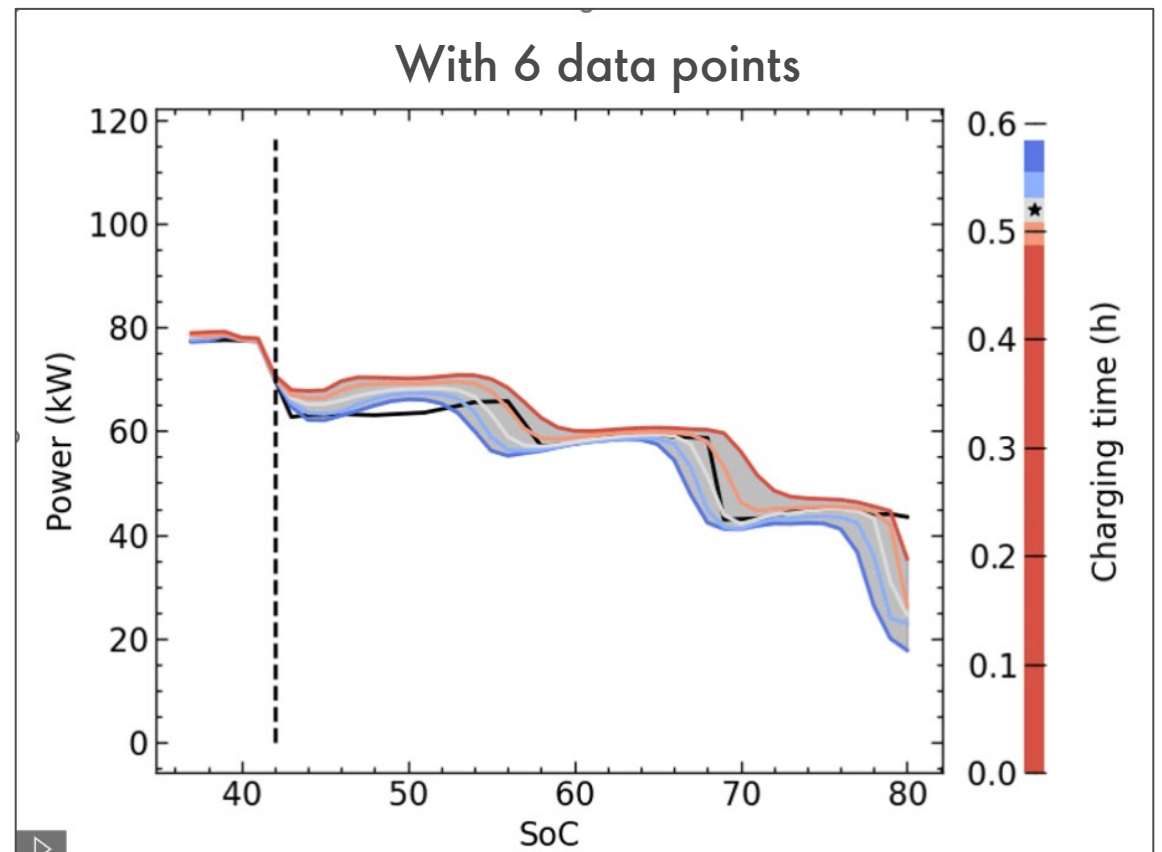
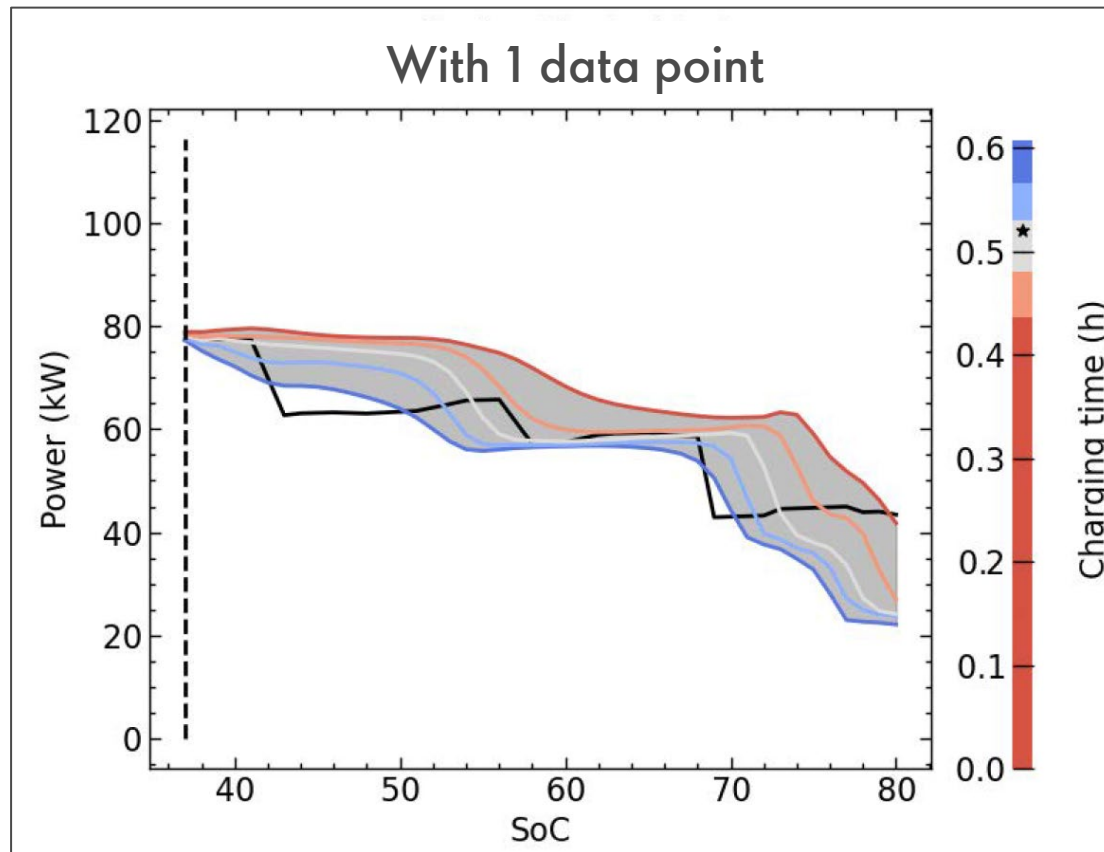
The dashed black line shows amount of charging data available at any moment: here, the 1st. point only: 79kW at 37%SoC.

The shaded area is the range of predictions:
dark red line: 90th %ile;
pale red: 75th %ile; grey: median;
pale blue: 25th %ile; dark blue 10th %ile.



03.4 Results

The shaded area quickly collapses as the model recognises the charging profile.
The algorithm runs **fast enough for real-time** updates.



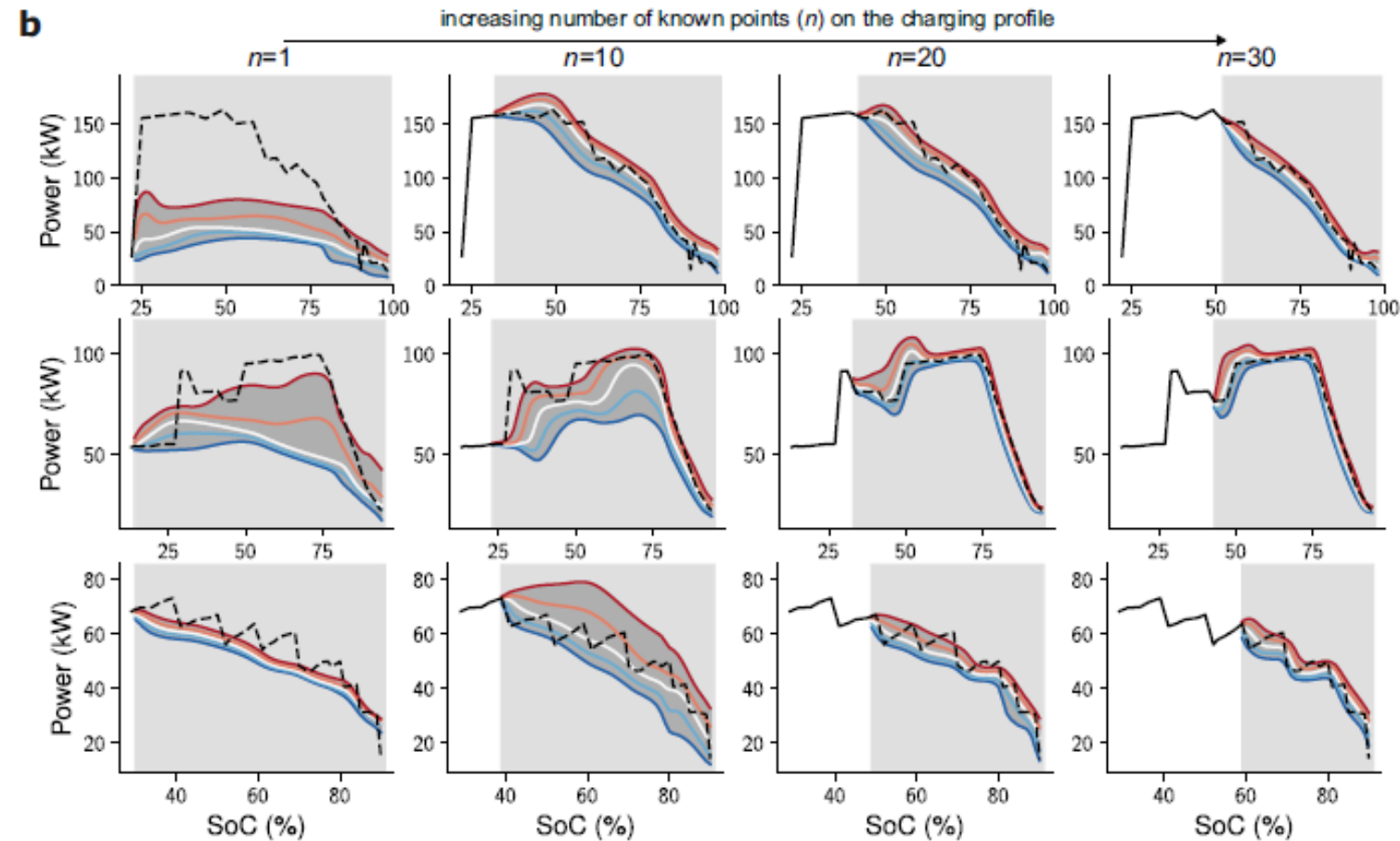
03.4 Results

A series of predictions for 3 different sessions (top, middle, bottom), showing how the model copes with 3 difficult cases.

Ref: fig. 3b of the article.

The algorithm runs **fast enough for real-time** updates.

Very bad cases are still useful:
they indicate EV or CP faults.



03.4 Results

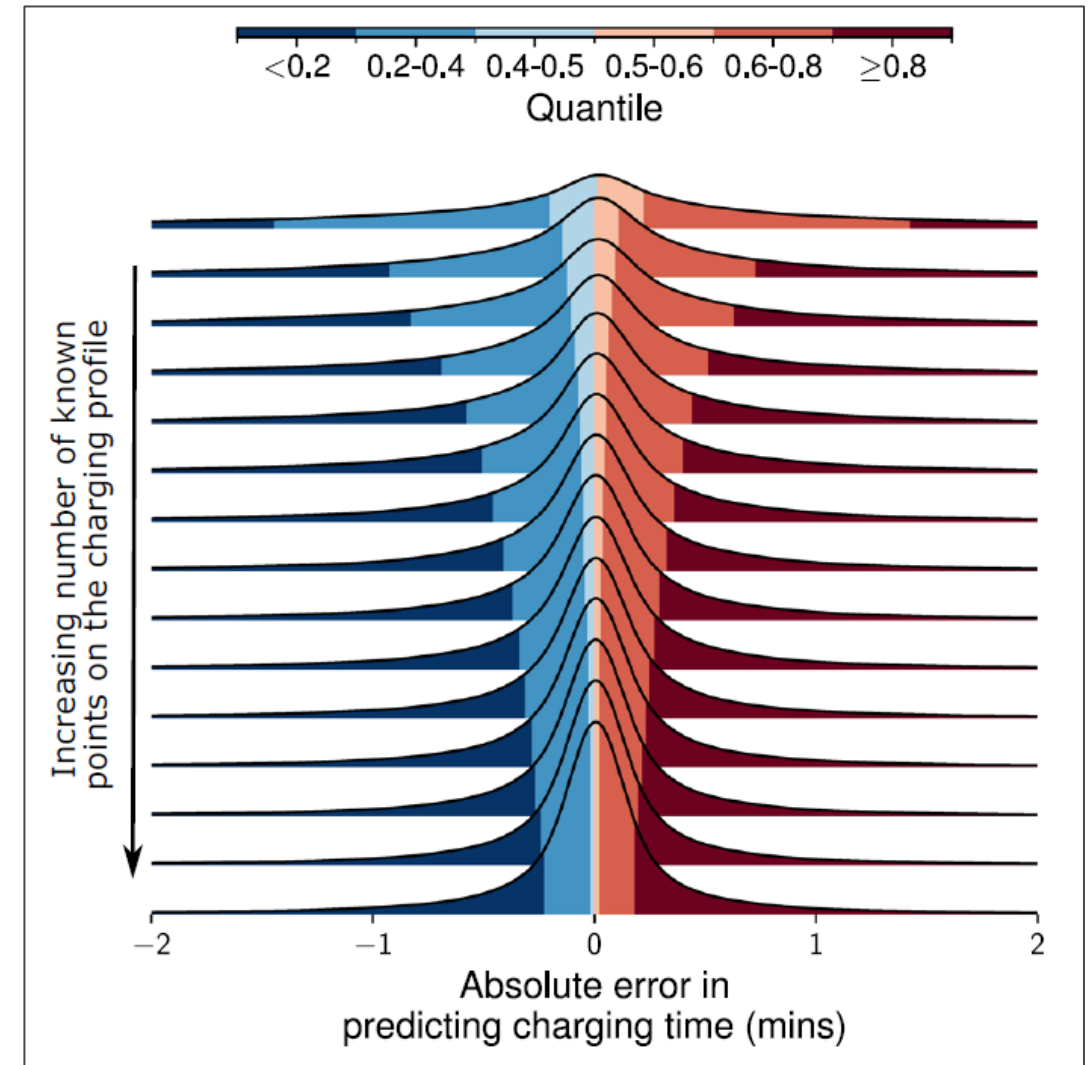
Distribution of error in predicted time to 80%SoC.

Furtherest away Gaussian is with one data point.
Already quite good.

Seccussive Gaussians are for 2, 3, 4, ...15 data points.

With two values, the 20th %-ile and 80th %-ile errors are already less than 1 minute; with 6 values, that value drops to less than 30 seconds.

Ref: fig. 5f of the article.



04. Conclusions

04.1 Conclusions

Method achieves 90% accuracy in predicting charging duration [to 80%SoC] from a single point, and 95% accuracy with an absolute error under one minute using six points within five minutes.

Clear case for developing to a tool, for both private motorists and commercial use-cases.



Q&A

Back-Up Slides

Abstract from Paper

Accurate prediction of electric vehicle charging profiles and durations is critical for adoption and optimising infrastructure. Direct current fast charging presents complex behaviours shaped by many factors. This work introduces a deep learning framework trained on 909,135 real-world sessions, capable of predicting charging profiles and durations from minimal input with uncertainty estimates.

The model initiates predictions from a single point on the power and state-of-charge profile and incrementally refines them as new observations arrive, enabling real-time updates. The model generalises across vehicle types and charging scenarios. It achieves 90% accuracy in predicting charging duration [to 80%SoC] from a single point, and 95% accuracy with an absolute error under one minute using six points within five minutes.

This work shows that using readily available input data at charge time enables accurate prediction of charging behaviour and offers a practical, scalable solution for deployment, energy planning, and infrastructure reliability.

The Deep Learning Framework Ref: Fig 3 of the paper

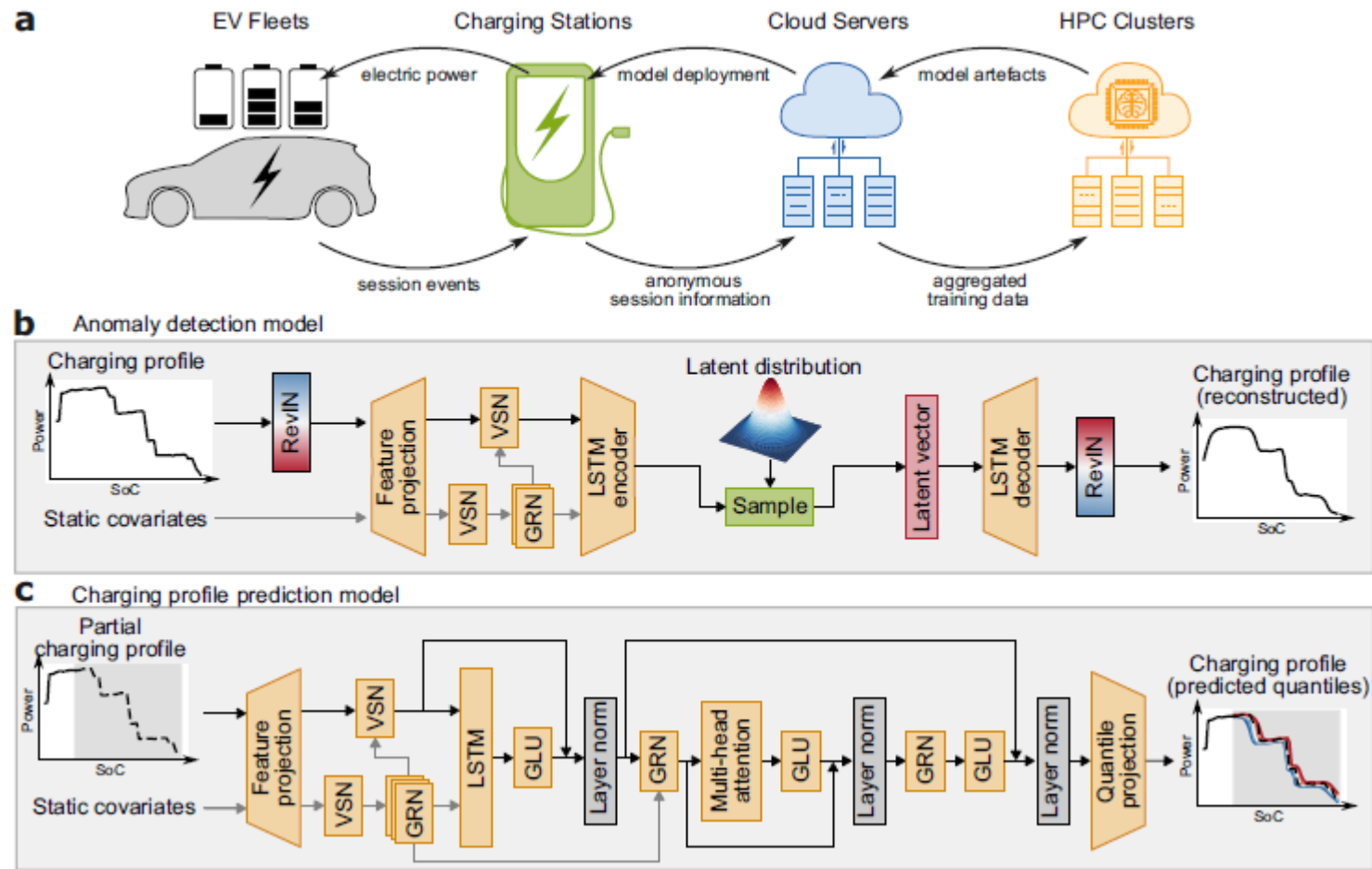


Fig. 3 Overview of the developed deep learning framework. **a** A high-level illustration of the AI-based system for direct current fast charging. Charging session data are continuously collected from charging stations, aggregated on cloud servers, and delivered to high-performance computing platforms for large-scale model training. The resulting trained models are deployed via cloud servers to provide real-time charging profile and time predictions, together with anomaly detection. **b** A schematic of the beta-variational autoencoder-based anomaly detection model, which identifies irregularities in charging sessions by reconstructing the original power/state-of-charge charging profile and evaluating the associated reconstruction error. ReVIN denotes reversible instance normalisation, and long short-term memory (LSTM) is used for sequence modelling. **c** A schematic of the probabilistic charging profile prediction model, which predicts the quantiles of a full charging profile from partial inputs. Gated linear unit (GLU), gated residual network (GRN) and variable selection network (VSN), are key architectural components of the anomaly detection and charging profile prediction models, with additional details provided in Supplementary Fig. 1.

Robert Doel, Principal Scientist, E-Mobility R&D

Robert Doel has worked for Shell for over 30 years. Early in his career he was a member of the R&D teams removing lead from gasoline and sulfur from diesel. He then became Fuels Chemist for Shell's Formula 1 activities – Ferrari and Michael Schumacher won their first Grand Prix together, in a car running on Rob's fuel. ("My 2nd best ever job.") After short stints in Business Development and Knowledge Management (where he gained an MBA), he returned to R&D to manage Shell's fuels patents portfolio.

In the early 2010's he got the chance to look at "fuel" for electric vehicles and has enjoyed himself enormously as the technology has developed rapidly and in multiple directions. Until recently, he was Project Lead for Shell R&D's Disruptive Technology in E-mobility program, which led him to look at Megawatt Charging Systems (MCS) for e-trucks, Extreme MCS (X-MCS) for mining haul trucks, Automatic Charging Devices (ACDs) and Wireless Power Transfer (WPT).

He now concentrates on fast charging technologies for vehicles of all sizes, particularly maximising the understanding we can gain from charging data – the topic of his presentation at this conference.

Before joining Shell, Rob obtained a PhD in Astro-Chemistry, a subject he wishes he had more time to keep up with.



