

Smart Charging Testing

Technical verification of Machine to
Machine (M2M) communication between
vehicles and charging stations

The logo for Elaadnl is contained within a white circular bubble. It features the text 'Elaadnl' in a blue, sans-serif font, with a yellow lightning bolt graphic positioned below the letters 'adnl'.

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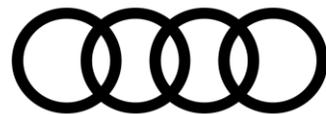
Project storyline



- Project commissioned by Dutch ministry of Infrastructure and water management
- Set up together with partners RAI (vehicle manufacturers/importers association) and DOET (charging infrastructure association)
- Preparation phase; sept 2023 – April 2024;
- Joint test protocol established, based on;
 - Standards
 - Everyday scenarios
 - Extreme scenarios, to test boundaries
- Selection of charging stations based on common presence in NL or abnormal mode 3 communication
- May 2024; start of the testing
- April 2025; all vehicles tested 114 BEV & 28 PHEV, Total market share tested: 77,1%

Overview tested brands

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CITROËN



CUPRA



DACIA



HONDA



HYUNDAI



Jeep



KGM



KIA

LANCIA



LEAPMOTOR



MAXUS



MAZDA



JAGUAR



LAND-ROVER



MITSUBISHI
MOTORS
Drive your Ambition



NISSAN



smart



SUZUKI



PORSCHE



SEAT

SERES



smart



SUBARU



SUZUKI



TESLA



VOLVO



ZEEKR



Test procedure

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Test protocol focus



Customer perspective tests

- Test 1 - Interoperability & Smart Charging
- Test 2 – Smart Charging profile/ compliance to basic mode 3 charging
- Test 3 - Low speed charging capability
- Test 4 - Response to charging pauses
- Test 5 - Response to increasing charging speed after 3 hours constant charging speed
- Test 6 - User notifications via vehicle app



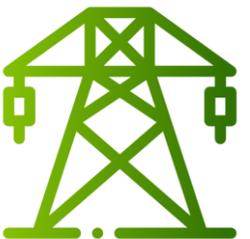
Grid perspective tests

PQ Immunity:

- Test 7 - Voltage deviations
- Test 8 - Harmonic distortions
- Test 9 - Phase switching
- Test 10 - Voltage on non-powered phases

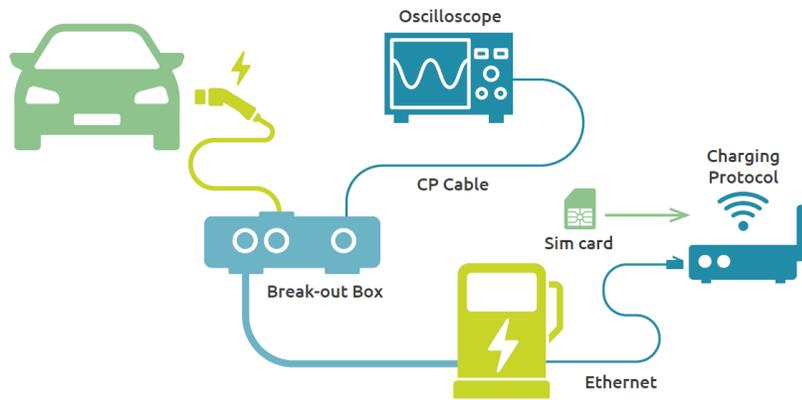
PQ Emissions:

- Test 11 - Harmonic emissions
- Test 12 - Supraharmonic emissions
- Test 13 - Power Factor

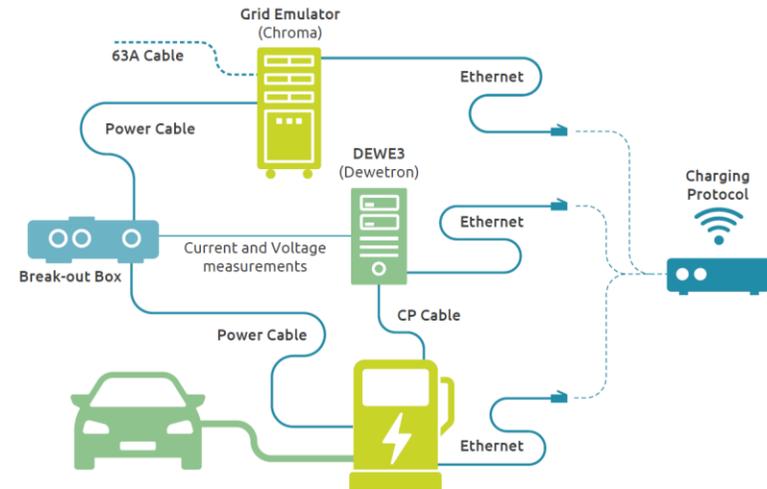


Test setups

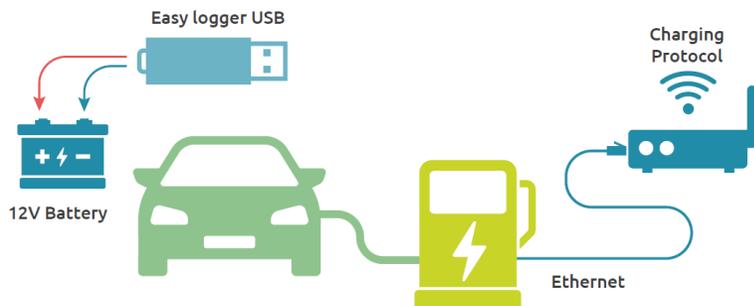
1. Interoperability and smart charging



2. Smart charging scenarios and Power Quality



3. Overnight test



4. App behaviour



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A background image of an electric vehicle (EV) charging station. A person's hand is shown holding a charging cable handle, which is connected to the charging port of a white car. The scene is overlaid with a green-to-blue gradient.

Conclusion,
recommendations
and follow up

Conclusion



Customer perspective

- 99,96% of the vehicle/charging station combinations able to charge, 97,1% able to smart charge.
- Most tests had >95% success rate based on market share.
- Some results (close to) 100% success rate; 6 hours delayed and paused, charging speed change after 3 hours, ability to switch between 1 and 3 phase charging.
- Intermittent charging had a slightly lower score (90%).
- There are vehicles on the market (2%) that do not effectively charge <8A.
- Connecting charging Apps proved challenging and in a lot of cases did not provide (consistent) charging information.

Grid perspective

- Low charging speeds do not lead to a significant increase of PQ emissions or lower PF.
- The highest SH emission limit was not crossed by ~78% (1ph) and ~75% (3ph) of the vehicles.
- Almost all vehicles were immune to PQ distortions. Only harmonics had a significant impact (86,1% success), mostly due to current increasing over station limit (13.2%).



Recommendations

Vehicle manufacturers

- Test your vehicles on real life smart charging scenarios.
- Resolve found issues using firmware updates. If not possible, inform drivers and charge point operators about the vehicle's behaviour.
- Pay special attention to the >50V on inactive phases issue, as this forms a safety risk.
- Test whether the vehicle drains the 12V battery over long periods (week) while connected to a charging station and if so, charge them via the high-voltage battery.
- The vehicle's Apps should be easy to install and have the ability to easily set the amount and type of notifications and mute them for a time period.

Charge Point Operators

- Keep in mind there are vehicles (2% market share) that can not effectively charge < 8A. Recommendation; smart charge (always or for the specific vehicles) at a minimum of 8A.
- Voltage and harmonic issues might lead to overcurrent and stopped transactions. If this happens often at a specific location, setting the limits less strict in the charger might help.



Recommendations

Grid operators

- Smart charging using basic mode 3 communication is a feasible way to perform “grid aware charging”.
- Research the emission and impact of Supraharmonic distortions on the grid and on consumer devices and use this to set emission limit standards.

Overall

- To make sure smart charging will work 100% of the time, the OEMs, CPOs, DSOs and other relevant stakeholders should better define smart charging scenarios and possible limits, like number of pauses in a given time period.
- This should result in a test procedure and possibly an obligatory test of stations and vehicles. Vehicles for instance by including smart charging tests in the Type Approval tests from the UN ECE.
- In the meantime; test your stations and vehicles at the Elaad Testlab on smart and bidirectional charging, ISO 15118-20 interoperability, DC charging, cyber security, etc.



Final report

Report Smart Charging for all Test Results

Location: <https://elaad.nl/en/publications/>

https://elaad.nl/wp-content/uploads/downloads/25_008_ELA.001-Smart-Charging-Testing.pdf