



WALLBOX  
BENCHMARK

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EDITION 01 | HOME CHARGING – INTELLIGENT AC-WALLBOXES

**REPORT**  
**2023**

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## Editorial

Home charging is a key factor for the successful transition to electromobility. With a total potential of more than 7 million charging points in private parking destinations in Germany by 2030, this type of charging is highly important in the transformation of transportation. In the private application areas, wallboxes are key to this transition to a demand-oriented charging infrastructure. While simple devices without a digitized interface have predominantly been installed, the trend in private households has increased towards intelligent and networked models following the successful implementation of the subsidy program by the federal government and the increased demand for holistic optimization of electricity consumption triggered by the energy crisis. Manufacturers of charging hardware, have benefited significantly from the increased demand for intelligent wallboxes in recent years. However, many are now being confronted with changed customer requirements due to the provisional end of the subsidy measures.

Since the end of the subsidy, the competitive situation in the market for private charging facilities has intensified tremendously. In Germany, more than 270 providers have been added to the list of eligible charging stations by the promotional bank *KfW*, and new players continue to enter the market in hopes of profiting from the industry's promising growth potential. Software-driven companies, with a user-oriented product design in the segment of intelligent AC-wallboxes, are recording increased market shares compared to the established manufacturers in the electrical industry, who are under high pressure to expand. As an additional challenge, the framework conditions are also becoming increasingly complex, with regional and national requirements for regulation as well as international requirements for installation and operation. While manufacturers are confronted with this complex market situation in their daily business operations, the variety of offerings often poses challenges for electronic installers and end-users when making investment decisions. In addition to the broad spectrum of suppliers and wallbox models, heterogeneous customers and requirements, as well as new technologies, functionalities, and digital services have made the market overview even more intricate.

P3 has been accompanying and analyzing the extremely dynamic charging market at various levels of the value chain for years. To increase supply chain transparency for the electrical profession, as well as private and commercial end-users when purchasing AC-wallboxes, P3 developed the *P3 Wallbox Benchmark* at the beginning of 2023. In the previous weeks, a total of ten intelligent AC-wallboxes were tested for 185 customer requirements from the installer and end-user perspective. For "*Edition 01 | Home Charging Issue*", the focus is on wallboxes in the private application area.

The test results offered many exciting insights. A key finding we would like to share in advance is that all wallboxes were convincing based on basic charging requirements. However, it became clear that many manufacturers still have room for improvement, particularly in the core technology of communication and the ability to intelligently control and optimize charging behavior. In the end, two models differentiated themselves from the competitive field. The *P3 Wallbox Benchmark* uncovers and shows these differences.



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## Executive Summary

This report presents the development, implementation, and results of the *P3 Wallbox Benchmark 2023*. Within the benchmark's framework, the technology experts of P3 automotive GmbH developed a holistic test and evaluation for AC-wallboxes and tested ten intelligent AC-wallboxes in the *P3 Energy.lab* Osnabrück, Germany.

### Goal

The *P3 Wallbox Benchmark* is one of its first and was developed to provide a transparent and utility-based benchmark to compare wallboxes from both an installer and end-user perspective.

Edition 01 focuses on single or three-phase charging of battery electric vehicles (BEV) with alternating current (AC) via intelligent wallboxes and Type 2 connector in the private application area.

### Methodology & Evaluation Criteria

Interviews with experts from the electrical trade and an end-user survey were conducted to validate the key factors from the installer and end-user perspectives.

The *P3 Wallbox Benchmark* evaluates a wallbox from two perspectives. From the installer's perspective, where the evaluation is based on the following process (1) *Delivery*, (2) *Installation*, (3) *Electrical Connection*, (4) *Interface Connection*, and (5) *Configuration of the Installer*. From the end-user perspective, the evaluation is based on the following process (1) *Configuration end-user*, (2) *Charging* and (3) *Operations & Service*. The overall rating per wallbox is the average of the installer and end-user ratings. In addition, there is also a price-performance rating based on the overall rating in relation to the manufacturer's recommended retail price.

### Testing

The tests were carried out in Q1 2023 at the *P3 Energy.lab* Osnabrück, Germany. The test included ten intelligent AC-wallboxes using a standardized test catalog, with a total of 25 test categories, 93 test cases, and the testing of 185 customer requirements from the installer and end-user perspective.

### Results

The analysis reveals a high level of product quality in the respective field overall. All ten wallboxes tested were particularly convincing in the basic discipline of charging. No charging interruptions occurred during the endurance tests and countless test series.

Nevertheless, the strict test catalog helped identify distinctions in the implementation of the manufacturers, especially in the test cases for intelligent control and adaptation of the charging behavior. In the end, the *EVBox Livo* (overall and end-user test winner) and the *go-e Charger Gemini Flex* (installer and price-performance test winner) were the two models that stood out from the competition.

### P3 Wallbox Benchmark Report 2023

The contents of this publication were developed using scientific quality criteria and correspond to the authors' state of knowledge and opinion at the time of publication.

The report therefore only represents a snapshot of the wallboxes at the time of testing and makes no claim to completeness. All images and information contained in the report are protected by copyright. Reprinting or digital reproduction of the contents is only permitted with the prior consent of P3 automotive GmbH.



For easier reading, functional designations as well as personal nouns are used in this report; the designations apply to all genders without any intention of discrimination.

## P3 Wallbox Benchmark 2023 – Overall Test Winner

First-time tested and overall winner in the *P3 Wallbox Benchmark*: Nearing its market launch, the *EVBox Livo* is nominated for the *P3 Wallbox Benchmark 2023* winning overall and the end-user comparison.

Winner  
Overall

EVBox | Livo



P3 WALLBOX BENCHMARK  
84.1|100

Score

1.3

## Methodology

The *P3 Wallbox Benchmark* was developed to establish a transparent and utility-based benchmark to compare wallboxes from both an installer and end-user perspective. To validate the key factors from the installer and end-user perspectives, interviews with experts from the electrical trade as well as an end-user survey were conducted by the *P3 Charging & Energy Technology Team* in Q1 of 2023.

A total of eight electrical experts were asked for their assessment. In addition to representatives from the trade associations and guilds for electrical engineering and information technology, it was important for us to also obtain the assessments of experts from small and medium-sized installation and electrical companies. Regardless of the size of the company and the number of charging points installed each year, all experts revealed basic key factors and requirements that electrical installers place on a wallbox.

In the end-user survey, more than 100 private individuals and companies were interviewed who had a wallbox or were interested in installing one in the future. The aim of the survey was to determine customer needs for the configuration and use of a wallbox and consequently to identify relevant key factors from the end-user's perspective. Although the end-user survey shows a wider spread of requirements due to the different local conditions and customer profiles, overarching key factors with a high influence on customer satisfaction were evident.

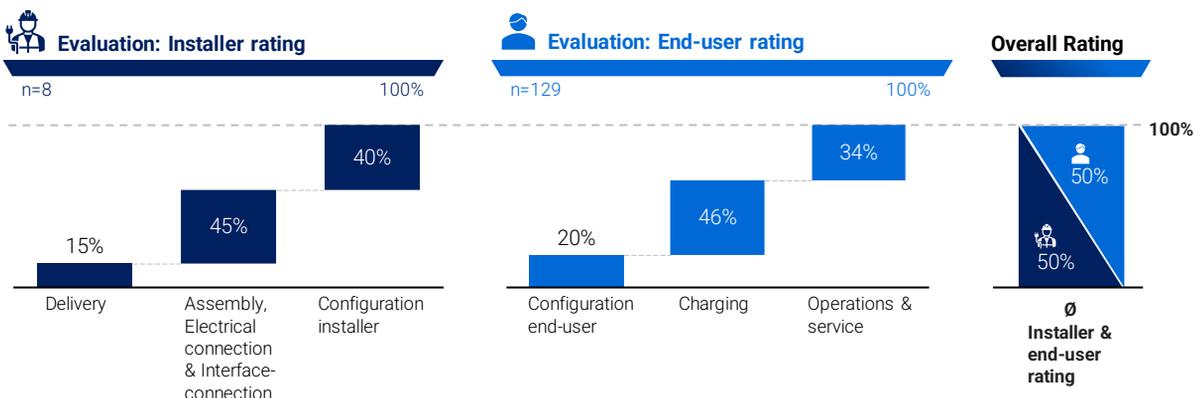
### Test Concept and Evaluation

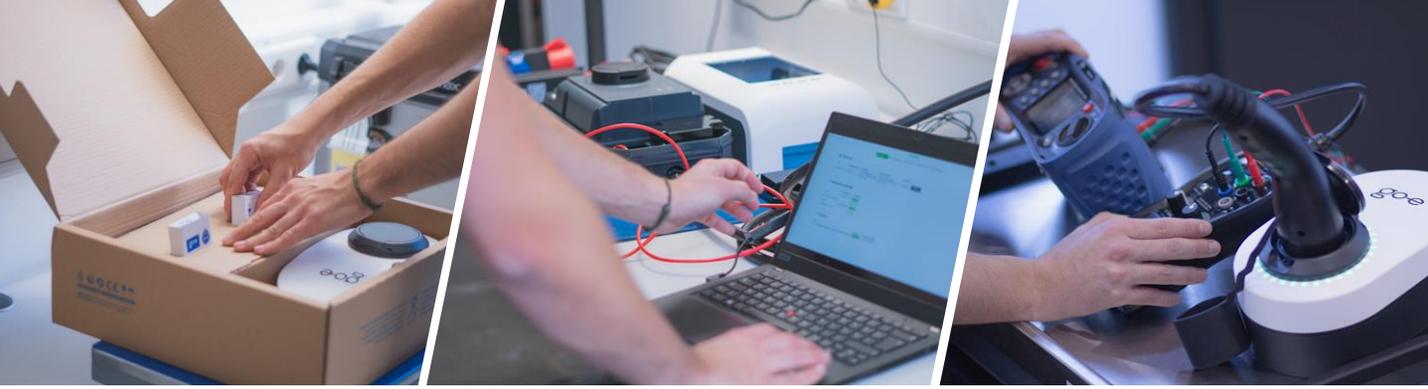
Based on the market validation and key factors identified, the *P3 Charging & Energy Technology Team* was able to design a standardized test catalog including 6 process steps, 25 test categories, 93 test cases, and 185 different customer requirements from an installer and end-user perspective. In addition to quantitative metrics, qualitative criteria was also considered and scaled where necessary.

The customer satisfaction varies based on either being an installer or an end-user, a weighting scale was introduced. For this purpose, the P3 experts assigned a total of three relevant process steps to the installer rating: (1) *Delivery*, (2) *Assembly, Electrical Connection and Interface Connection*, and (3) *Configuration Installer*. For the end-user rating, the following three relevant process steps were defined: (4) *Configuration end-user*, (5) *Charging* and (6) *Operations & Service*. The six life cycle process steps were weighed based on statistical analysis from the expert and end-user surveys. For the installer rating, the surveyed experts stated that *Assembly, Electrical Connection and Interface Connection* was the most relevant part of the life cycle (45%), followed by *Installer Configuration* (40%), and *delivery* (15%). In the end-user evaluation, charging requirements had the highest weighting (46%). High importance was also assigned to the utilization phase under the *Operations & Service* process (34%) while the *Configuration end-user* process step fell slightly behind (20%).

Each of the six process steps considered in the product life cycle of an AC-wallbox was then divided into individual test categories as part of the analysis. Individual test categories were subsequently broken down into one or more test cases. A test case formed the smallest unit of analysis and was evaluated by the P3 experts based on one or more predefined customer requirements. The customer requirements served as a benchmark, representing the current market needs. However, some customer requirements (e.g., network frequency or input voltage) specify basic requirements that are to be met as a standard measure.

### Weighting: Evaluation by installation experts & end-user





To meet the basic quality criteria of the benchmark, a standardized test catalog defines the test concept, the test specification, the measurement and test equipment, as well as the respective degree of criteria fulfillment. It is possible to obtain the detailed results of the individual test catalogs from the respective P3 contact persons.

The selection of the ten wallboxes included in the benchmark report was based on specific product and market premises, pre-defined by P3. Participation in *Edition 01 | Home Charging*, required the complete fulfillment of these selection criteria. The following chapter "Competitive Landscape" will provide an insight in background information and elaborate on the field of participants and the nomination criteria.

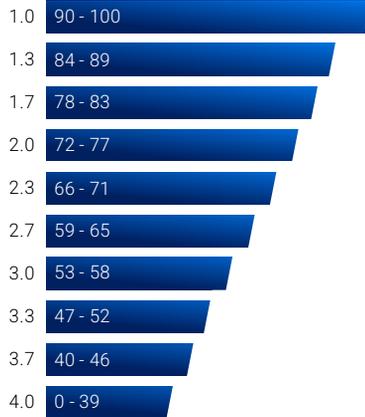
As part of the evaluation, the test results were transferred into a scoring matrix. To determine the individual scores, the score per test case and test category was averaged. The averaged score of the associated test categories represents the ratings of the wallbox throughout its six process steps. Based on the weighting scale results were rated accordingly. The weighted and aggregated score of process steps one to three made up the installer score while process steps four to six made up the end-user score. For better comprehensibility, the result of the two evaluations was scaled to a score of 100 maximum points.

### Rating Keys

In total, a wallbox could achieve 100 points in both evaluations (installer and end-user) across all associated test categories. The overall result per wallbox is the average of these two scores. In addition, the respective overall result is set in relation to the list price (points/price) in order to provide a reliable price-performance assessment. For easier classification, the respective test results were translated into a German school grade logic. Grades vary from 1.0 (very good) to 5.0 (insufficient). The assignment of the school grades to the point results is visualized with the two enclosed rating keys.

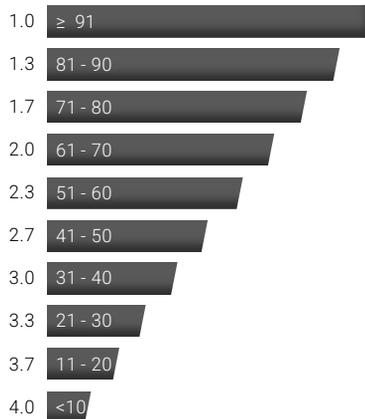
### Rating Key <sup>1</sup>

<sup>1</sup> Overall, installer and end-user rating



### Rating Key <sup>2</sup>

<sup>2</sup> Price-Performance



Not every process step has the same impact on customer satisfaction, depending on being an installer or an end-user. The statistical analysis of the market surveys within the *P3 Wallbox Benchmark* takes these differences into account and ensures a valid weighting of the test results.



P3 Energy.lab Osnabrück, GER  
www.p3-group.com

The tests for the *P3 Wallbox Benchmark* were conducted in the first quarter of 2023 at the *P3 Energy.lab* located in Osnabrück, Germany. The competence center specializes in smart energy and charging technologies and offers comprehensive charging tests on a 7,500 sq. ft. area. In addition to existing test facilities for interoperability tests such as ISO15118, OCPP, or EEBUS implementation, the *P3 Energy.lab* will also provide the necessary test infrastructure for integrating photovoltaic systems and energy management systems in the future.

For the *P3 Wallbox Benchmark*, each nominated wallbox underwent a comprehensive series of tests. The safety components, including DC fault current detection, were examined, along with the charging behavior in 11kW endurance tests and self-consumption in standby mode. However, the investigation did not include an overall examination of the CE declaration. All charging tests were conducted with an Audi e-tron 55 quattro 300 (M1J) and BMW i4 M50 (MJ 2023) / G26 BEV. Compatibility tests with other manufacturers and models were only conducted if anomalies occurred.

**185** CUSTOMER REQUIREMENTS  
**93** TEST CASES  
**25** TEST CATEGORIES

**10** INTELLIGENT AC WALLBOXES  
**6** PROCESS STEPS  
**1** OVERALL WINNER



The *P3 Wallbox Benchmark* looks at the end-to-end process of delivery, installation, configuration and use of an intelligent AC-wallbox using a 360° analysis.

The overall score includes a total of 185 customer requirements, which are divided into 93 test cases and a total of 25 test categories. The results of the first eight test categories are included in the installer score, while test categories 9 to 25 are included in the end-user score.

The diagram visualizes the distribution of customer requirements among the individual test categories.

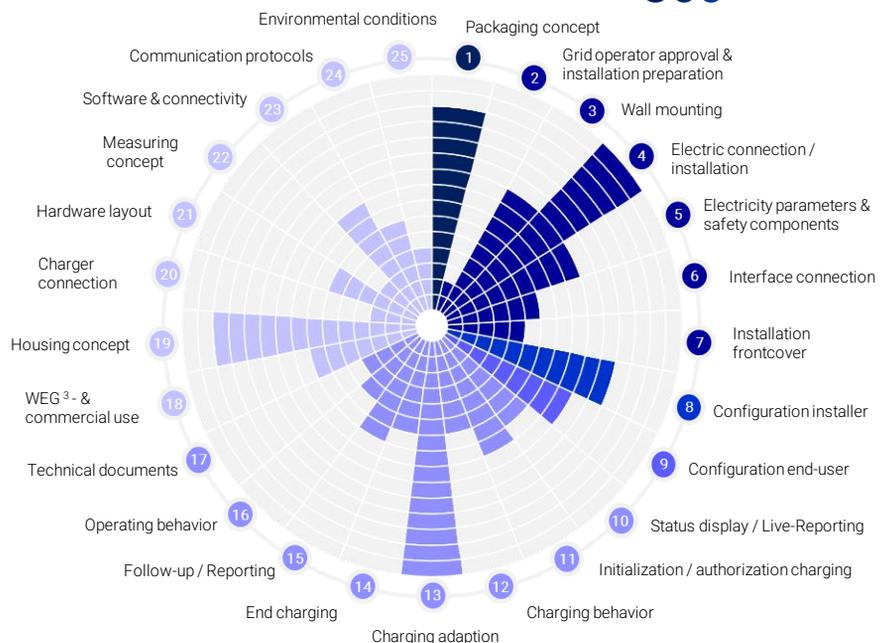
**Installer rating**

- Delivery
- Assembly, electric & interface connection
- Configuration installer

**End-user rating**

- Configuration end-user
- Charging
- Operations & Service

**360°**



<sup>3</sup> Multi-unit residential dwelling

## Competitive Landscape

The P3 experts selected and defined the product and market conditions for the initial release of the *P3 Wallbox Benchmark*, all of which can be traced back to the orientation of the benchmark edition, *01 | Home Charging*. A wallbox' nomination necessitates the complete fulfillment of these selection criteria. Furthermore, the pre-selection of wallboxes was validated by P3's internal market analysis, thereby reflecting a broad spectrum of national and international market participants.

### Product premises

- Home Charging, max. 22 kW charging performance (1 charging point)
- Backend-connectivity (through OCPP, at least OCPP 1.6j)
- Regulatory requirements profile: low voltage
- Load management & energy management
- Multiple authentication & individual configuration

### Market premises

- Different price segments: 600 – 1.800€ (gross)
- Highest possible market penetration in the region of Germany, Austria and Switzerland<sup>4</sup>
- Product offering for end-user
- Product availability (common distribution channels)
- Sustainable product portfolio by manufacturer

### Test objects

Ten models were nominated for participation in the *P3 Wallbox Benchmark* based on these selection premises.

All manufacturers were informed of their nomination before product testing commenced. Furthermore, the manufacturers were requested to provide feedback on product-specific content. In cases where no feedback was received, the tests were carried out using the model and firmware status at the time of purchase by P3.

## Test objects A-Z

**Alfen | Eve Single Pro-line**

Type	NG910-60023		
Firmware	5.8.1-4123		
Price	1.125,00 €		1

**Charge Amps | Halo**

Type	100308		
Firmware	N/A		
Price	1.014,00 €		2

**EVBox | Livo**

Type	L33262EUC00		
Firmware	5.14.1		
Price	795,00 €		3

**go-e | Charger Gemini Flex**

Type	GM-10-223121		
Firmware	055.0		
Price	689,00 €		4

**KEBA | KeContact P30 x-series (Green Edition)**

Type	24077194		
Firmware	1.15.0		
Price	1.731,45 €		5

**Mennekes | Amtron Charge Control C2**

Type	1349201.21742		
Firmware	5.22.3-13380		
Price	1.352,00 €		6

**myenergi | zappi**

Type	20370619		
Firmware	v4.122		
Price	1.397,00 €		7

**VW | ID. Charger Pro**

Type	22-03-A1X-SSF		
Firmware	V2.14.4		
Price	1.095,00 €		8

**Wallbox | Copper SB**

Type	CPB1-S-2-4-8-002		
Firmware	v.5.13.17		
Price	949,00 €		9

**Webasto | Next**

Type	NEXT-WS106204		
Firmware	3.1.4		
Price	959,00 €		10

Type 2-Plug-in Fixed installed charging cable

<sup>4</sup> Based on internal market analysis by P3



The price level (gross) refers to stated RRP in the case of direct sales by the manufacturer and to standard retail prices in the case of a multi-stage sales concept.



## P3 Wallbox Benchmark Winner 2023

### Winner Overall

EVBox | Livo



### Winner Installer rating

go-e | Charger Gemini Flex



### Winner End-user rating

EVBox | Livo



### Winner Price-Performance

go-e | Charger Gemini Flex



## Results

All 10 wallboxes that participated in the *P3 Wallbox Benchmark* study were successful in the charging tests. There were no charging interruptions observed in the 11kW endurance tests conducted under laboratory conditions, as well as in numerous test series with shorter charging processes. Furthermore, no abnormalities were detected during the safety tests as per the *E-Check E-Mobility* of the ZVEH<sup>5</sup> or in the testing of the operating behavior. Especially the models with displays showed marginal differences in a year-on-year comparison, with consumption measured between 3W and 5.2W (standby). With an 11kW load at 16A 3-phase, and a measuring distance of 1m to the housing, the noise emissions in the charging tests were also less than 40 dB (A), corresponding to the background noise in the test lab. During power failure simulations, all restarted wallboxes resumed charging within a short time, although most models required deactivation of the authorization function.

In *Edition 01 | Home Charging*, intelligent communication and control functions were two additional focus areas beyond the charging tests. Among the participating models, the *EVBox Livo* and the *go-e Charger Gemini Flex* were able to differentiate themselves from the competition. The *EVBox Livo* emerged as the winner with a narrow lead of 1.3 points overall. The latest model on the market also secured first place in the end-user ranking. The Austrian manufacturer *go-e* received praise for its simple and intuitive installation concept, earning them first place in the installer rating as well as the winner for its combination of favorable price and feature range.

However, towards the end of the test weeks, some gaps and blind spots were identified, especially in terms of the possibilities for intelligent control and adaptation of charging

behavior, where manufacturers are likely still in the early stages of research and development. The 'Smart Charging' functions such as CO<sub>2</sub>, photovoltaic-, price-optimized or grid-optimized dynamic charging current regulation via connected apps or backends are only partially available in the wallboxes tested and require a high level of implementation effort. Furthermore, only one wallbox in the test, the *Mennekes Amtron Charge Control C2*, enables the connection of an energy management system via an EEBUS interface. Additionally, the *EVBox Livo* is the only model in the test to support vehicle communication in accordance with ISO 15118, but the Plug & Charge authentication function is yet to be implemented. However, the *myenergi zappi* stood out in the test as it implemented dynamic charging current regulation by taking into account the total real-time consumption in the *P3 Energy.lab* via the CT coils (measuring units) supplied.

When it comes to the perspective of the installer, the value chain from product delivery to handover to the end-user yielded varying results. Some models required plug-and-play installation, while others necessitated several hours of assembly and configuration. The models with a multi-stage and service-friendly housing concept were the most convincing when it came to wall mounting and electrical connection. Regarding the configuration process, the software-driven manufacturers in particular offered a simple and intuitive configuration concept.

Further elaboration on the subtle differences in the performance of each wallbox can be found in the following pages.



With a narrow lead, the Dutch manufacturer *EVBox* secures the overall victory in the *P3 Wallbox Benchmark 2023* with the wallbox *Livo*.

## Test Winner Edition 01 | Home Charging

### EVBox | Livo

Almost in conjunction with its market launch, the Livo was nominated by P3 for the *Wallbox Benchmark* and, at the test premiere, it won not only the overall ranking but also from the end-user perspective. The winner's scores were partly due to its simple and intelligent charging management via the *Everon* management system. The housing of the *Livo* housing is made with sustainable polycarbonate and still meets the competitive IP and IK protection classes for external influences. The passive cooling concept with aluminum core is particularly effective in the 11kW endurance tests.

#### Installer Score

Wall mounting only requires a few installation steps using a separate wall bracket with which the housing is snapped and screwed into place. Inside the housing, a protected cable management system supports the cable feed (in the outdoor area from below), the electrical connection, and the interface connection. The user information is clear and concise (including the Quick Guide as part of the delivery) which considerably reduces the time required for installation. For the initial configuration, the *EVBox Install App* is available, which is connected via a local WiFi hotspot of the wallbox. Overall, the app's configuration guides the user intuitively through the installation with a step-by-step structure.

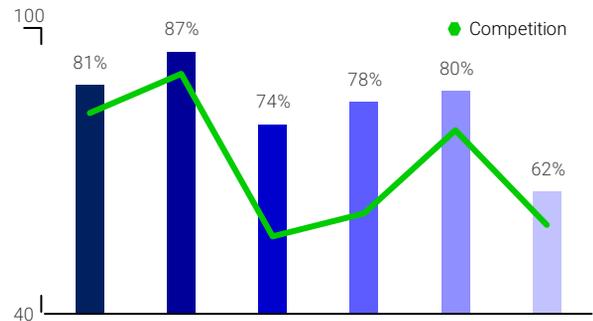
#### End-user Score

For user interaction, the operating status is visualized via an LED display in the front cover. The *Everon App* is also available for controlling and adjusting the charging behavior (including remote start/stop) and also offers the possibility to export data for billing purposes. However, the integrated measurement device is not yet MID-compliant. With the retrofitting of an additional control unit (*Dynamic Load Balancing Kit*), the *Livo* enables and regulates a dynamic charging current. As the only wallbox in the test, the *Livo* implemented the backend communication protocol OCPP 2.0.1. Up to now, *EVBox* refrains from open interfaces for third-party providers and instead relies on the manufacturer-specific *Everon* backend. With the hardware preparation already adhering to ISO 15118, the *Livo* has theoretically laid the foundations for Plug & Charge, although the function is not yet visible in the authorization options.

**Score**  
**1.3**  
Price-Performance Score 1.0

EVBox | Livo

**Installer Score** 88.7|100  
**End-user Score** 79.4|100

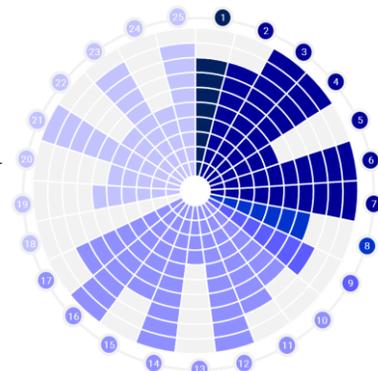


#### Installer Score

- Delivery
- Assembly, electric- & interface connection
- Configuration installer

#### End-user Score

- Configuration end-user
- Charging
- Operations & service





## Alfen | Eve Single Pro-line

As one of only a few wallboxes in the test, the *Eve Single Pro-line* from Dutch manufacturer *Alfen* offers a 3.5" color display with clear information and instructions for user interaction for home use. However, in the overall rating it only achieves 68.9 out of 100 points.

### Installer Score

The *Eve Single Pro-line* initially impresses with its multi-level housing concept, which enables intuitive installation and simple connection via tension clamps. The cable feed into the housing can only be done from below. For the initial configuration, *the ACE Service Installer* software must be installed first, then the access data must be requested from *Alfen Service*. The request when testing took only a few minutes but it may take up to several working days. With an Ethernet connection to the wallbox, the software provides comprehensive configuration options.

### End-user Score

Although the *MyEve* app has recently been made available to end-users, it only reflects the contents of the installer software, limiting it for everyday use. However, *Alfen* scores more points in WEG and commercial use (including integration in system networks, connection of third-party backends). Additional functions to adjust the loading behavior can be acquired via licenses.



## Charge Amps | Halo

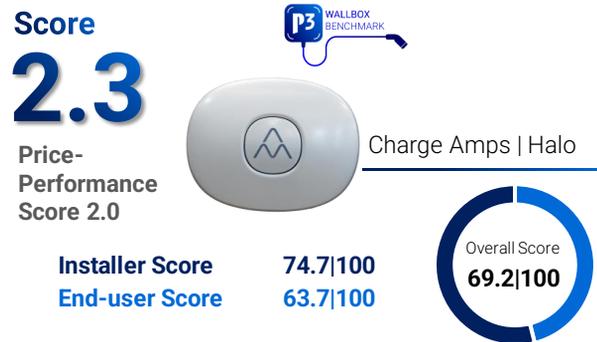
'*Halo*' from the Swedish manufacturer *Charge Amps* stands out with its futuristic design and a recycled aluminum housing. While the overall score is only 69.2 points, a new model from Charge Amps, the '*Dawn*', has already been launched.

### Installer Score

While the special housing design is appealing from the end-user's perspective, it comes with certain impairments for wall mounting and electrical connection. This causes the installation to require increased amounts of time and effort. The supply line is always fed in via the underside of the housing. *Charge Amps* recommends using sealant for outdoor installation, but no further information is specified in the installation guide. In terms of configuration, the *Halo* scores higher with a simple onboarding process via a local hotspot.

### End-user Score

The intuitive and clear *Charge Amps* app is available for end-user configuration (including LED lighting, RFID authorization, charging current limitation) as well as live reporting and statistics. With the retrofitting of the external *Amp Guard* control unit, it has the option to control the charging current and connection of a photovoltaic system. However, *Charge Amps* scored lower in the area of Operations & Service and other categories due to the lack of interfaces to connect external control units via Modbus or EEBUS.

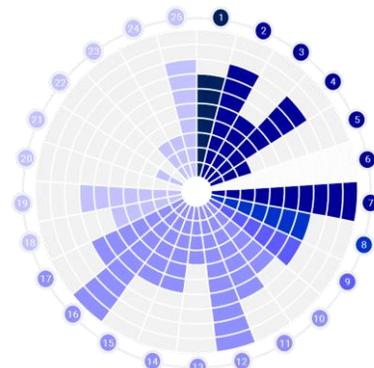


### Installer Score

- Delivery
- Assembly, electric- & interface connection
- Configuration installer

### End-user Score

- Configuration end-user
- Charging
- Operations & service





go-e |  
Charger Gemini  
Flex



Score  
**1.7**

Price-Performance  
Score 1.0

Installer Score **89.2|100**  
End-user Score **76.4|100**



## go-e | Charger Gemini Flex

With the predecessor model *go-e Charger Home* wooing the press with its price-performance ratio, the *go-e Charger Gemini* is just as convincing in the *P3 Wallbox Benchmark* placing second overall. In addition, *go-e* wins the price-performance rating with the highest score of 1.0. In the *Flex* specification (fixed 16A CEE plug), *go-e* is the only manufacturer in the test with installation and commissioning using the plug-and-play principle.

### Installer Score

The company from Austria (AT) relies on a sealed housing for installation, and the house connection is made either via a permanently attached cable (*Gemini*) or a CEE plug (*Gemini Flex*). For initial configuration via the *go-e Charger app*, the *Gemini Flex* establishes a local WiFi hotspot. Although the installer and end-user share the same app interface for configuration and operation, system-critical parameters can be protected by a technician password.

### End-user Score

Intuitive, simple, and with a clear user guide, the *Charger Gemini Flex* has rightfully secured a top place in the end-user category due to the charging usability test cases. An intelligent charging ecosystem can also be completed with the *go-e Controller*, which is available as an accessory. Although *go-e* does not yet offer its own backend, it successfully enables remote access in the test via the P3 backend (OCPP 1.6J).



The *go-e Charger app* offers versatile communication and control options, including configuration of the LED status display on the housing. Although it is also possible to export data for billing purposes, the integrated measurement concept of the *Charger Gemini* is not yet MID-compliant.

## KEBA | KeContact P30 x-series (Green Edition)

With the *x-series*, the *KeContact P30* from the Austrian technology company *KEBA* gives a solid score of 72.8 in the overall evaluation. The MID-compliant *x-series* includes a SIM slot for mobile data connection (SIM card not included).

### Installer Score

For wall mounting, the *KeContact P30 x-series* offers many cable feed options and a drilling template but requires several time-consuming installation steps. The calibration of various settings (including network parameters) is done via dip switches in the casing and requires familiarization with the extensive installation manual. One positive is that the communication interfaces are accessible without opening covers with live components. In addition, a separate interface for the installer is available with the initial configuration via the *KEBA WebUI* (web interface accessible via local WiFi hotspot).

### End-user Score

While the *KEBA eMobility App* scores lower in usability compared to the top competition, the *KeContact P30 x-series* is convincing with a high compatibility and integration flexibility. In addition to external control units for regulating dynamic charging currents and PV optimization, the P3 backend also successfully connected in the test. Up to now, *KEBA* has not provided its own backend.

Score  
**2.0**

Price-Performance  
Score 2.7

Installer Score **73.5|100**  
End-user Score **72.1|100**



KEBA | KeContact  
P30 x-series  
(Green Edition)

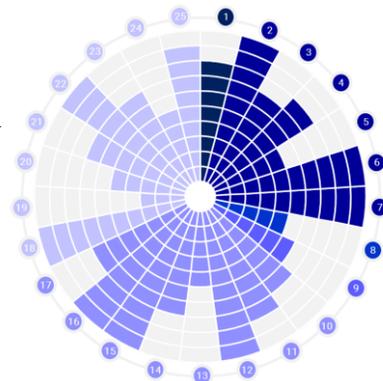


### Installer Score

- Delivery
- Assembly, electric- & interface connection
- Configuration installer

### End-user Score

- Configuration end-user
- Charging
- Operations & service





## Mennekes | Amtron Charge Control C2

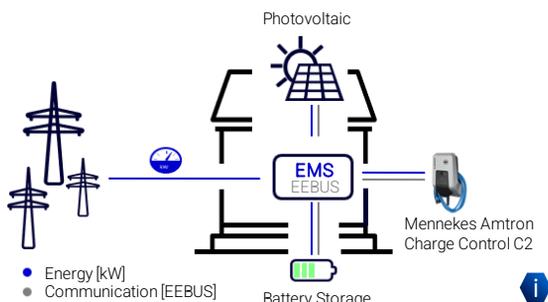
From *Mennekes'* comprehensive product range of charging hardware, the *Amtron Charge Control C2* for private application is included in the *P3 Wallbox Benchmark*. However, the somewhat technical commissioning and operation can be a challenge for installers and end-users without prior knowledge. In the end, the test resulted in a score of 2.3.

### Installer Score

The *Amtron Charge Control C2* already attracts attention with large packaging upon delivery, making a 1-person installation rather difficult. *Mennekes* is convincing overall with high quality craftsmanship but doesn't come with a multi-level concept for the housing which might affect cable routing and wall mounting. Initial configuration is done via laptop using a USB interface with special access for installers. Overall, installation and configuration require intensive familiarization with the product and usage information.

### End-user Score

The frontcover of the *Amtron Charge Control C2* visualizes the current operating status via LED pictograms, and the *Mennekes Charge App* is currently only available for the *Xtra* and *Premium* models. For company car expenses, the *Charge Control* provides a MID-compliant metering concept, which can be read locally if required. In the case of WEG or commercial use, *Mennekes* charging stations can be combined in a system network, which can also manage local load balancing.



For dynamic charging current control, connection of a photovoltaic system or an energy management system, the *Charge Control* offers a high degree of compatibility and integration flexibility for third-party systems; the wallbox is already one of the few models that can be controlled via an EEBUS interface.

## myenergi | zappi

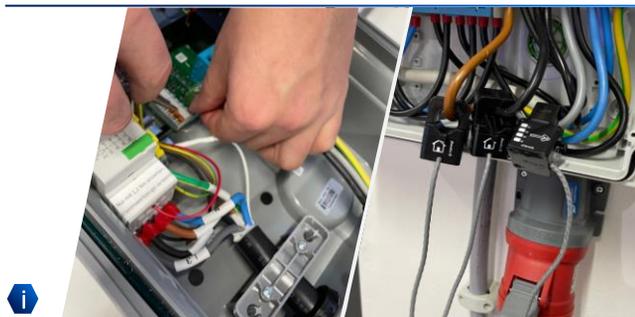
While the other competitors had a higher overall score in the installer rating compared to the end-user rating, it was the opposite for the wallbox from the UK. One of the highlights was the informative LCD display in the frontcover with control buttons for local user interaction.

### Installer Score

The wall mounting of the *zappi* is done directly through the housing, with a drilling template and mounting kit with screws and plugs included in the delivery. Interestingly, the housing offers various positions for cable feed (surface and flush-mounted), however the housing opening must be drilled by the user without pre-stamping. Further, an additional cable gland (IP65) is required. Initial configuration (including charging current control and phase assignment) is quick and easy via the display, and a password protects safety-relevant parameters.

### End-user Score

The *zappi* scores particularly well in the end-user rating with the usability test cases for charging. The displayed user guidance is convincing, and the visual preparation of the charging data, the house consumption (optional), or the PV generation power (optional) is also very appealing. The intuitive *myenergi app* is also available for controlling and adjusting the charging behavior. In the end, the *zappi* rightfully made second place in the end-user rating.



**P3 Wallbox Benchmark highlight:** As the only wallbox in the test, the *zappi* enables control of the dynamic charging current and regulates the charging current with the installation of CT coils (measuring units, included in delivery) based on the real-time consumption of *P3 Energy.lab*. With the retrofitting of the external sensor *harvi*, the data of the measured consumption can also be transmitted wirelessly.



## VW | ID. Charger Pro

The *ID. Charger Pro* shows to be in the middle of the benchmark with 69 total points. Especially in the software & connectivity categories, a better result was within reach.

### Installer Score

At the beginning of the test, we noticed that the compartmentalized kit of the *ID. Charger Pro* contained one Torx-screw less than planned in the delivery, but installation was still possible. The housing offers the option of surface and flush-mounting the supply line via the wall mounting knockout tabs. Although the *ID. Charger Pro* comes without a multi-level housing, the connection is solid and offers sufficient scope for higher cross-sections. However, the initial configuration is tricky due to several different QR and pairing codes.

### End-user Score

For end-user interaction, the front glass cover offers colored LED pictograms and the *We Connect ID. App*. The app offers the possibility to control the charging process remotely. Control of the dynamic charging current is only possible via the installation of external CT coils (measuring units). The *ID. Charger Pro* also offers the possibility of connecting an energy management system via the EEBUS communication protocol. However, deductions were made due to a lack of compatibility and integration information.



Although the *WeConnect ID. App* offers the possibility to register the vehicle for the use of the Plug & Charge function, the *ID. Charger Pro* does not yet support vehicle communication according to ISO 15118. Thus, the function is currently not available at your own wallbox.

## Wallbox | Copper SB

The *Copper SB* wallbox received a visual facelift in Q1 2023 with a new matte black front cover. For its first test, it received an overall score of 2.3.

### Installer Score

While some manufacturers provide a separate mounting plate for wall mounting, the *Copper SB* is mounted to the wall directly and the cables are fed through the housing. Cable entry from below is possible, but there is little slack for flush-mounting and larger cross-sections. Weighing only 2.3 kg, handling is easy and convenient. The calibration of the network parameters is done via a small rotary wheel on the circuit board. The installer and end-user only have a common interface for the initial configuration, but the connection in the *myWallbox app* is convenient via QR code scan.

### End-user Score

For controlling and adjusting the charging behavior, Wallbox relies on the simple Wallbox app and offers users several communication interfaces to connect to the App and Cloud including wifi, 4G, Ethernet and Bluetooth. The extensive *myWallbox portal* is available for management and control. The wallbox from Barcelona (ES) also offers open interfaces for third-party backends via OCPP 1.6J. Via the retrofitting of proprietary measuring devices (e.g. *wallbox power meters*), the charging power can also dynamically adapt to the total consumption or photovoltaic power.



Wallbox | Copper SB

**Installer Score**  
**End-user Score**

**71.9|100**  
**62.5|100**



Wallbox does not use any plastics, composites or high-gloss coated cardboard boxes in its deliveries, and instead relies on the use of recycled materials.

**Score**  
**2.3**

Webasto | Next

**Price-Performance Grade 1.7**

**Installer Score** 81.8|100  
**End-user Score** 61.5|100

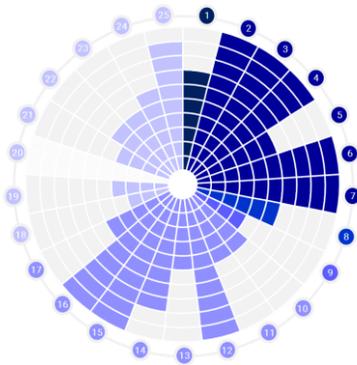


**Installer Score**

- Delivery
- Assembly, electric- & interface connection
- Configuration installer

**End-user Score**

- Configuration end-user
- Charging
- Operations & service



**Webasto | Next**

Webasto has its headquarters in Munich (GER) and provides a diverse range of applications for its *Webasto Next* wallbox, as well as a web interface and connection to the Webasto backend *ChargeConnect*. However, it can be difficult to keep track of the various frontends. Despite this, the test result is still good with an overall grade of 2.3.

**Installer Score**

The difference of 20 rating points between installer and end-user clearly highlights the strengths of the wallbox. The *Next* allows for quick and easy wall mounting with very good and simple preparation of the few assembly steps. In the sealed housing, only the connection block is accessible, and supply and connection of a 10mm<sup>2</sup> supply line can be done without any issues. The *Charger Setup app*, which is linked to the wallbox via a local WiFi hotspot, is used for the initial configuration.

**End-user Score**

The front cover of the *Next* is slightly scratch-sensitive but features an LED bar to visualize the operating status. Additionally, users can interact with the *ChargeConnect app*, which offers features such as a dashboard with live data, authorization, and data export. However, compared to the top competition, the app falls short in terms of functionality and user-friendliness. For dynamic charging current regulation (by retrofitting an external control unit) and connection to an energy management system, *Webasto* demonstrates a high level of compatibility and integration flexibility.



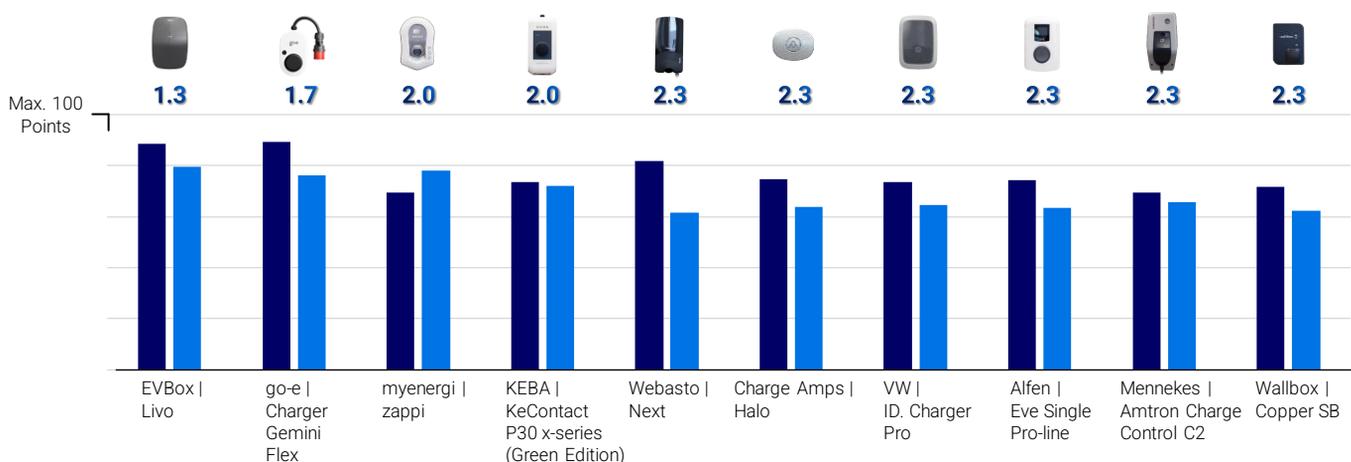
# Edition 01 | Home Charging – At a glance

Installer Score

End-user Score

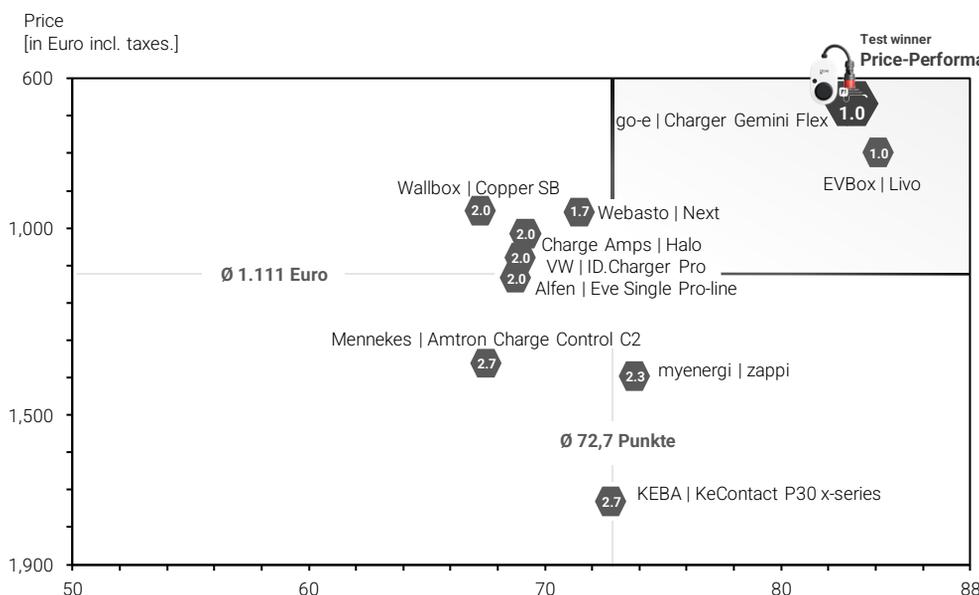
## Overall Rating

All ten wallboxes that were tested received good ratings from both installers and end-users perspective. However, two of the wallboxes - the *EVBox Livo* (which was the overall test winner and also received the highest end-user rating) and the *go-e Charger Gemini Flex* (which was the top choice for installer rating) - were able to distinguish themselves from the other products in the market.



## Price-performance-ratio

The two models that won the overall rating are *EVBox Livo* and *go-e Charger Gemini flex*, and surprisingly, they are also the two cheapest models in the test. This demonstrates that intelligent wallboxes, priced at well under 1,000 Euros, provide a broad range of services for end-users while also impressing installers with their simple installation and configuration concept.



**Test winner Price-Performance**

The price level (gross) refers to the reported RRP for direct sales by the manufacturer and to standard prices for a multi-level sales concept.

The exact product specification of the tested models about the Type 2 charger connection can be found in the competitive landscape chapter.

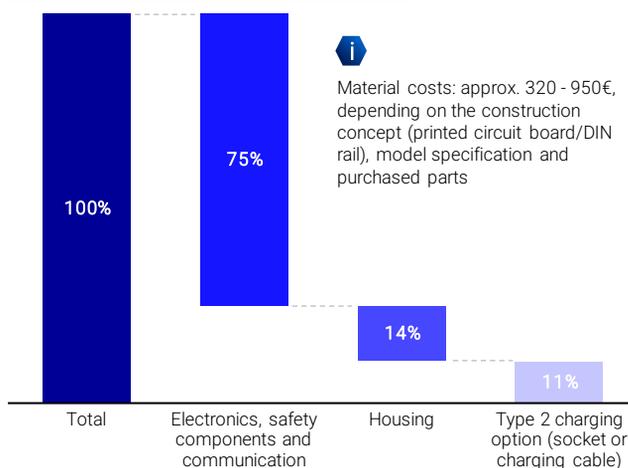
Overall rating [in Points]

### Background

In order to further promote the widespread adoption of electric vehicles, the transition to electrification must include more than just the vehicles themselves. A mature charging infrastructure is a crucial factor and a fundamental prerequisite for user satisfaction and acceptance of electric vehicles. In addition to public charging stations, the private sector also plays a crucial role in the charging infrastructure as vehicles are parked for longer periods, and the extended charging time has little effect on the users compared to traditional refueling processes of combustion engine vehicles. As a result, wallboxes have emerged as a special type of AC charging station for the private sector. Wallboxes are designed to compress the required hardware and firmware into a compact combination of mounting plate, electronics unit, and housing or frontcover depending on the specific requirements and specifications.

Different wallboxes offer different functionalities and control options for the user. Basic wallboxes without a digitized interface have limited functionality and are designed only to charge a vehicle. Intelligent wallboxes, on the other hand, are networked with other electronic control units or connected to the Internet through various interfaces. Intelligent wallboxes use different communication standards, interfaces, and protocols to allow real-time charging data to be retrieved or control commands to be executed, for example via an app or web server. Some of the important remote features of intelligent wallboxes include status queries, starting or ending a charging process, adjusting the current charging current, or performing a software update. Additionally, intelligent wallboxes can connect to local measuring or control units such as photovoltaic systems, battery storage or local energy management systems. As a result, charging processes can be dynamically adapted to the free connection capacity or available photovoltaic power, optimized in terms of time and price. While some intelligent models are now available for several hundred euros, the price level is generally significantly higher than that of simple counterparts due to the additional material and development costs for the control and communication functions. The higher acquisition costs of an intelligent wallbox compared to a simple device without intelligence may pay off over the entire product life cycle of the wall box, under certain conditions, due to the price-optimized charging control.

Material cost structure intelligent AC wallbox ( $\leq 22\text{kW}$ )



There are many different manufacturers in the market for AC-wallboxes, and the *KfW* (German promotional bank) list of eligible wallboxes alone includes over 270 different suppliers.



**Software-driven manufacturers have enormously increased the competitive pressure on the established brands from the electronics industry**

The market for private charging hardware has been experiencing significant growth with potential for further expansion in recent years, thanks to increasing sales figures of plug-in hybrids and battery-electric vehicles as well as government support measures for the purchase and installation of private charging equipment. However, this growth has resulted in an increasingly complex sales and service business for those involved in the market. With the end of the subsidy, electrical experts surveyed as part of the *P3 Wallbox Benchmark* have noted a significant drop in inquiries and sales for installation services. The subsidy was a

decisive factor in the investment decision of many private households and homeowners' associations, and its funding ensured the expansion of private charging infrastructure. However, many planned investments were brought forward, resulting in a temporary market downturn. Until the increasing number of new registrations of electric vehicles is reflected in demand for wallboxes once again, manufacturers will have to address the increasingly heterogeneous requirement profiles of end-users, including both end-users and intermediary installers.

In Germany, electrical experts play a vital role in the value chain of charging infrastructure. While manufacturers may sell the charging hardware directly to end-users, a trained electrician must make the initial connection. Therefore, manufacturers also rely on sales to electrical experts and wholesalers as an important sales channel, along with direct sales and an increasing retail presence. In practice, installers not only provide installation services, but also offer important advice on product selection. However, electrical experts have been facing a new development on the customer side for the past few months. According to interviews conducted by P3, installation companies report a paradigm shift in the role of the installer. While electrical experts typically offer a complete package of hardware sales, installation, and commissioning, increasingly only the connection and acceptance of the wallbox is commissioned. The end-user survey as part of the *P3 Wallbox Benchmark* also reflects this trend, with only about a third of households surveyed stating that both the purchase and installation were carried out by their local electrician. The main reasons for this change include sales campaigns by car manufacturers and the entry of stationary retailers into the market. Discounters and hardware stores now offer wallboxes as take-away goods at attractive prices. The experts interviewed view this development critically from various perspectives. On the one hand, installers do not receive a share of the hardware sale in addition to their hourly wage. On the other hand, the installation of a wallbox provided by the customer requires significant knowledge about the various manufacturers and models on the market. While installation companies can train their employees to become experts on their own range of products, an unfamiliar wallbox from a customer often poses a challenge for installers due to the large variety of products available. The problem of installation has not been significant until now, especially when installing models without communication or control functions. However, as the market penetration of intelligent wallboxes increases and the overall systems become more complex, it will be increasingly important for the wallbox to provide the simplest possible installation and configuration concept to support the installer.

P3's tear-down projects involving systematic product disassembly and analysis have revealed that manufacturers have different approaches to the basic product conception. While some manufacturers still provide their wallboxes based

on modular installation devices and DIN rails, software-driven models with highly complex printed circuit board production now enable installation according to the plug & play principle.

## Construction concept Alfen | Eve Single Pro-line



**The conceptual differences are also apparent in the assembly and connection concept. With the design and conception of smaller and smaller housings, flexible cable routing, sufficient space, and bending radius for large cable cross-sections are important quality features of a wallbox that make manual work easier.**

The conceptual differences are also evident in the assembly and connection concept. With the design and conception of smaller and smaller housings, flexible cable routing and sufficient space and bending radius for large cable cross-sections are important quality features of a wall box and makes manual work easier.

The configuration interface also includes physical communication interfaces and the connection of external control units, which may require manufacturer-specific data lines or crimped connection cables. Alternatively, some models provide a local WiFi hotspot and a QR code for direct access to the configuration interface, eliminating the need for time-consuming login or registration processes.

Installers have varying preferences and opinions regarding the configuration interface. While some appreciate the intuitive and structured configuration via their own installer app, the variety of smartphone apps can have negative effects. Many installers prefer the easy access via web interface. However, they agree on the requirements for the configuration menu, which should not require registration or access data. Also, configuration content for installers and end-users should be clearly separated, and system-critical content should be protected by separate access or disclaimer.

While the end-user may not be aware of these installation challenges, other quality features become apparent during the configuration and use phase. Until now, customer focus was on a simple central requirement: Charging. But what does the future hold? A digitized interface is becoming increasingly important as consumers demand network-friendly control of charging behavior and sustainable optimization of their charging ecosystem. The central requirement of a wallbox charging will continue, but a digitized interface is crucial for future success.

Many end-users are increasingly prioritizing intelligent and networked wallboxes, especially since the public funding guidelines (KfW subsidy). These devices offer various communication and control options for optimized charging behavior, in addition to safely and easily charging a vehicle.

However, implementing these intelligent functions, new communication standards, integration of third-party systems, and fulfilling complex regulatory requirements pose significant challenges for manufacturers, but also offer enormous potential for differentiation. Customers are driving the industry to meet requirements such as dynamic load management, photovoltaic surplus charging, backend-controlled dynamic charging current regulation, or Plug & Charge, both on the hardware and software side. Although many manufacturers have integrated appropriate interfaces and communication protocols, such as ISO 15118 or EEBUS, into their products, installers and end-users are often left alone with implementing the necessary control units and functions.

The *P3 Wallbox Benchmark* focuses on these possibilities for intelligent control and optimization of charging behavior, in addition to the basic disciplines related to simple charging. In addition, Report Edition 01's end-user survey showed that topics outside the actual charging process significantly impact customer satisfaction. Therefore, the test catalog also focuses on operating behavior, housing and charging connection, hardware layout, measurement concept for any company car billing, and the possibility of connecting the wallbox to a system network, among other things.

Merely a distant vision of the future: In the test, no manufacturer enabled a comprehensive Smart Charging approach <sup>6</sup> via the connection to a manufacturer-specific backend or app.

<sup>6</sup> Software-controlled, intelligent charging current regulation based on parameters set via OCPP in a connected backend (central system), e.g., CO<sub>2</sub>-optimized charging based on market data, price-optimized charging via flexible electricity tariffs, time-optimized photovoltaic excess charging via the connection to weather data



## Conclusion and outlook

The *P3 Wallbox Benchmark's* first edition provides a detailed analysis of the market for intelligent AC-wallboxes. The report offers an initial orientation and supports the individual purchasing decision with an independent and benefit-focused comparison of the different models from the perspective of the installer and the end-user. The process chain from delivery to use is analyzed, and 10 intelligent AC-wallboxes for home use are subjected to an extensive test concept of 185 customer requirements.

The overall ranking of the first is decided by a narrow lead of just 1.3 points. Nevertheless, the *EVBox Livo* is still the well-deserved test winner. Although the two test winners, *EVBox Livo* and *go-e Charger Gemini Flex*, were able to differentiate themselves from the competition, the overall conclusion of the test is that all 10 tested wallboxes are at a high overall level. Important point differences in the strict test catalogue are due to slight differences in quality and different functional scopes of the individual models. In a tight competitive field, just a few points can decide several positions in the overall standings.

While the benchmark's conception already considered many criteria from the perspectives of both the installer and end-user, the report acknowledges that it is not exhaustive.

The assessment of a wallbox is impacted by other factors throughout its entire product life cycle that were not considered in this analysis due to capacity limitations. The report only represents the authors' knowledge and opinion at the time of the test. However, choosing the appropriate wallbox for a specific application depends heavily on the respective requirements and customer profile.

The market for charging infrastructure will continue to grow rapidly, particularly for charging hardware manufacturers. With the EU's decision to impose restrictions on combustion engines by 2035, the stage is set for growth. However, the market environment is highly competitive and diverse, and players are under tremendous pressure to expand. It is probable that the market will consolidate in the coming years. We will continue to monitor this development and provide our wide-ranging technological expertise as a partner. *Edition 01 | Home Charging* lays the groundwork for additional subject-specific reports, and planning for *edition 02* is already underway.

Still have questions? Feel free to contact us.

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Osnabrück, 04 | 13 | 2023

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## Business as unusual

Breaking new ground with a wide range of skills is our strength.

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- Market & Competitor Analysis
- Market modelling & business cases
- Market strategies & business model development
- Standardization & technical project management
- Technical specifications
- Interoperability assurance & OCPP integration testing
- Technical Due Diligence & M&A Advisory

The charging infrastructure is a central component of the e-mobility market which has great potential, but even greater challenges. The market was barely in existence ten years ago, the field is currently being approached and built up from all sides. Car manufacturers, energy suppliers, mineral oil companies, gas station operators, and the public sector are all involved in this market. Even insurance companies and banks must deal with it – with a market that is still not quite transparent and where standards and technologies are developing at a great pace every day.

At P3, we take a holistic approach to the topic. We have been accompanying and analyzing the highly dynamic charging market in detail for years and have an overview not only of technologies, but also of key players and value chains. In addition, we are in demand as partners in the standardization of the numerous product and service offerings in the field of charging infrastructure. Whether it's about the optimal business model and market entry or hardware and IT solutions, we not only develop the concepts but also provide support in product development and implementation.

We place the power supply of e-mobility in the overall system – from the vehicle to the charging infrastructure to the energy grid. In this context, we rely on our network of experts and bring the appropriate consultants into the project for you, from mechanical engineers to electrical engineers and IT specialists to business economists.

Our advisory is based on our broad technological expertise and strategic vision. For example, our charging tests, which have now been carried out more than 6,000 times worldwide, allow us to make recommendations on typical interoperability problems and numerous other challenges.

Whether it's about the optimal business model and market entry, cooperation partners and funding, or hardware and IT solutions, we not only advise, but also develop concepts and support you all the way through to the implementation of your project.

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