





# ENERGY CONTROL AND CYBERSECURITY AC WALLBOXEN

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# **EDITORIAL**

Home charging plays a central role in the transition to electromobility. With a potential of over 7 million charging points in private parking spaces by 2030, charging at home is becoming increasingly important. Wallboxes are being used to establish a comprehensive charging infrastructure in the private sector. While simple devices without digital interfaces were mainly used in the past, the demand for intelligent, networked models is growing. This trend is primarily due to the increased importance of optimized electricity usage, particularly in view of high energy prices. Manufacturers of wallboxes are benefiting greatly from this demand but are facing new challenges following the end of the subsidy measures.

Since the end of the KfW subsidy, competition in the market for private charging equipment has intensified significantly. There are already over 270 providers on the list of eligible charging stations alone, and more are entering the market to take advantage of the industry's growth potential. Software-based companies in particular are gaining market share with user-oriented, intelligent AC Wallboxes against established manufacturers in the electrical industry, who are under strong pressure to expand. The market is also complicated by increasingly complex regulation at regional, national and international level. This diversity of providers, models and requirements often presents both installers and end customers with major challenges when making a selection. Heterogeneous customer profiles, new technologies and digital services make it even more difficult to gain an overview.

As a technology consultancy, P3 has been analyzing the dynamic charging market at various levels of the value chain for years. The P3 Wallbox Benchmark was launched in 2023 to increase supply transparency for the electrical trade and for private and commercial end customers when purchasing AC Wallboxes. In 2024, the



focus is increasingly on the areas of energy control and cybersecurity in addition to the categories already tested. In several test weeks, 8 intelligent AC Wallboxes were evaluated based on 225 customer requirements from the perspective of installers and end customers. Issue 02 | Energy Control & Cybersecurity AC Wallboxes is aimed at private and commercial applications.

The test results provide many exciting findings. It is pleasing to note that all the wallboxes tested were convincing in the basic "charging" requirement. Nevertheless, there is still potential for improvement for many manufacturers, particularly in the core technology of communication and the intelligent control and optimization of charging behavior. Two models stood out in particular and illustrate the key differences between the variants tested.

An important aspect of our analysis was the cybersecurity assessment, which was carried out as part of the Cyber Threat Defense Unit (CTD P3). Most of the issues identified range from informational to medium risks and predominantly affect the mobile applications and web management interfaces of the devices. While some models have welcome features such as preventing unauthorized connections via BLE and secure interfaces, others lack certain functions. If you are interested in a particular product in the future or would like a more comprehensive review, we will be happy to provide you with a detailed audit.

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# EXECUTIVE SUMMARY

The report presents the development, implementation and results of the P3 Wallbox Benchmark 2024 / 2025. As part of the benchmark, the technology experts at P3 developed a holistic test and evaluation concept for AC Wallboxes and tested a total of 8 intelligent AC Wallboxes in the P3 Energy.lab Osnabrück.

## Objective

The P3 Wallbox Benchmark was developed in order to create a transparent and user-related benchmark for the first time, with which Wallboxes can be compared from the perspective of both installers and end customers.

Issue 02 focuses on intelligent energy management for charging battery electric vehicles (BEV) in both the private and commercial sectors. The focus is on energy control functions that dynamically adapt the charging process and cybersecurity.

## Methodology & evaluation

Interviews with experts from the electrical trade and an end customer survey were conducted to validate the key factors from the perspective of installers and end customers.

The P3 Wallbox Benchmark evaluates a wallbox from two different perspectives. The comparison from the installer's perspective is based on the process steps (1) Delivery, (2) Installation, Electrical Connection, Interface Connection and (3) Installer Configuration. From the end customer's perspective, the evaluation is made up of the process steps (4) End Customer Configuration, (5) Charging, (6) Smart Charging, (7) Fleet Management and (8) Technical Details. The overall rating per wallbox is calculated from the average of the installer and end customer 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 test was carried out in Q3/2024 at P3 Energy.lab Osnabrück with 8 intelligent AC Wallboxes using a standardized test catalog with a total of 31 test categories, 115 test cases and the testing of 225 customer requirements from the perspective of installers and end customers.

## Results

The analysis shows an overall high level of performance in the competitive environment examined. All wallboxes tested were particularly impressive in the basic discipline of charging. There were no charging interruptions during the endurance tests and numerous test series.



However, the strict test catalog revealed subtle differences in implementation, particularly in the test cases for smart charging and cybersecurity. The Elli Charger Pro 2 (overall winner and winner in the end customer category) and the Zaptec Go (winner in the installer and price-performance rating) were therefore able to clearly set themselves apart from the competition.

# P3 Wallbox Benchmark Report 2024 / 2025

The contents of this publication were developed using scientific quality criteria and reflect 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 the test was carried out and makes no claim to completeness.

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For reasons of easier readability, only the masculine form is used in this report for personal and functional designations and personal nouns; the designations apply to all genders without any intention of discrimination.



# Elli | Charger Pro 2

Test premiere and direct overall winner in the P3 Wallbox Benchmark: Almost at the same time as its market launch, the Elli Charger Pro 2 is nominated for the P3 Wallbox Benchmark 2024 / 2025 and wins both the overall ranking and the end customer comparison.



#Osnabrück



# **FOCUS TOPICS**

## 1. Energy Control

As the number of electric vehicles continues to rise, intelligent charging is becoming increasingly important. Wallboxes with energy control functions dynamically adapt the charging process to factors such as available grid capacity, energy prices or own energy generation. This helps to reduce electricity costs, avoid grid overloads and maximize self-consumption of solar energy, for example. Such functions are crucial for an efficient, sustainable and user-friendly charging infrastructure in the age of electromobility.

## Energy Control-Funktionen – At a glance

- **Intelligent load management:** The wallbox adapts the charging power to the available grid capacity to avoid overloads. In a network of wallboxes, the energy is efficiently distributed to the charging points.
- Integration of energy management systems (EMS): Seamless integration of energy meters and home energy management systems. This enables flexible control of energy consumption in real time, tailored to current demand and PV generation, in order to maximize efficiency and self-consumption.
- Dynamical electricity tariffs: Automatic adaptation of the charging process to variable electricity tariffs.
   The wallbox selects cost-optimized charging times to reduce energy costs while responding to the availability of cheap or renewable electricity.
- **Phase switching:** The wallbox automatically switches between 1-phase and 3-phase operation depending on the available PV power.
- **Real-time reporting and analysis:** The user can call up the charging status, charging speed, power consumption and charging time remotely in real time via an app or website. The wallbox sends a signal or alarm when charging is complete or if faults occur.





# 2. Cybersecurity

Cybersecurity is becoming increasingly important in e-mobility, especially for wallboxes, which are vulnerable to cyberattacks due to their networking. In the P3 Wallbox Benchmark 02, our Cyber Threat Defense Unit (CTD P3) integrates comprehensive security checks to identify vulnerabilities and increase resistance to threats. Through measures such as encrypted communication and basic authentication, we ensure the highest security standards and provide a holistic assessment of wallboxes in terms of performance and security.



## Why cybersecurity is crucial for wallboxes

- **Networked systems:** Modern wallboxes are part of a complex, networked system. They communicate with electric vehicles, the power grid, payment systems and mobile devices. These interactions make them potential gateways for cyberattacks.
- **Data protection:** Wallboxes process a wide range of data from personal information and payment details to usage habits. Protecting this data is critical to maintaining user trust and meeting legal requirements.
- **Grid integrity:** As wallboxes are directly connected to the power grid, security vulnerabilities could potentially lead to disruptions in grid operations. This could range from localized power outages to large-scale instability.
- Availability and reliability: Cyberattacks could affect the availability of charging stations, causing not only inconvenience to users but also financial losses for operators. Reliable operability is therefore essential.
- **Reputation and financial risks:** Security incidents can cause significant financial losses and damage the operator's image in the long term.

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# METHODOLOGY

WALLBOX BENCHMARK

With the P3 Wallbox Benchmark, P3 has developed a comparison methodology that offers electricians as well as private and commercial customers a well-founded decision-making aid in the purchasing process for intelligent AC wallboxes. In order to identify key factors from the installer and end customer perspective, the P3 Charging & Energy Technology team conducted interviews with experts and an end customer survey in Q1/2024.

A total of 8 experts from the electrical trade were asked for their assessment. In addition to representatives from the trade associations and guilds for electrical and information technology, it was also important for us to obtain the opinions of experts from small and medium-sized installation and electrical companies. Irrespective of the size of the company and the number of charging points installed each year, all the experts identified the key factors and requirements that electrical installers place on a wallbox.

In the end customer survey, over 100 private individuals and companies with wallboxes already available or interested in a future installation were surveyed. The aim of the survey was to determine customer needs when configuring and using a wallbox and consequently to identify relevant key factors from the end customer's perspective. Although the end customer survey shows a broader spread of requirements due to the different local conditions and customer profiles, overarching key factors with a high influence on customer satisfaction are also evident here.

Tests with smart meters were carried out, but these are not supplied with the wallboxes tested. The costs for wallboxes and smart meters are listed transparently for each test object

## Test concept and evaluation

Based on the market validation and identified key factors, the P3 Charging & Energy Technology team was able to design a standardized test catalog with a total of 8 process steps, 31 test categories, 115 test cases and 225 different customer requirements from the installer and end customer perspective.

In addition to quantitative metrics, qualitative criteria were also taken into account and scaled where necessary.

As not every process step has the same impact on the customer satisfaction of the installer and end customer, a weighting scheme was introduced. The P3 experts assigned a total of three relevant process steps to the installer evaluation: (1) Delivery, (2) Installation, Electrical Connection and Interface Connection and (3) Installer Configuration. Three relevant process steps were also defined for the end customer evaluation: (4) End Customer Configuration, (5) Charging, (6) Smart Charging, (7) Fleet Management and (8) Technical Details.



The six process steps were weighted on the basis of statistical analyses of the surveys of experts from the electrical trade and end customers. For the installer evaluation, the surveyed experts assigned the greatest relevance to the Installer Configuration process step (50%), closely followed by Installation, Electrical Connection and Interface Connection (40%). Delivery only accounted for 10%. In the end customer evaluation, the requirements relating to Smart Charging were given the highest weighting (30%). Followed by Charging with 25%. The configuration phase was also assigned high importance by end customers under the Configuration End Customer process (20%). Followed by the Technical Details with 15%. The Fleet Management process step, on the other hand, falls slightly behind at 10%.

Each of the 8 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 even more finely into one or more test cases. A test case thus formed the smallest unit of analysis and was evaluated by the P3 experts on the basis of one or more predefined customer requirements. The customer requirements represent the current reference solution on the market and therefore always represent the benchmark. However, some customer requirements (e.g. mains frequency or input voltage) only specify basic requirements that should be met as a standard measure.



#### Weighting scheme for installer and end customer evaluation

In order to meet the basic quality criteria of the benchmark when assessing the individual test cases and testing the defined customer requirements, a standardized test catalog defines the test concept, the test specification, the measurement and test equipment as well as the respective degree of fulfilment. If interested, it is possible to obtain the detailed results of the individual test catalogs from the P3 contacts.

The 8 selected wallboxes were nominated on the basis of specific product and market premises defined by P3 in advance. Participation in Issue 02 | Energy Control & Cybersecurity required the complete fulfillment of these selection premises. Further background information on the field of participants and the nomination criteria is explained in the following section on the competitive environment.



As part of the evaluation, the test results were then converted into an evaluation matrix. To determine the individual scores, the test score was averaged for each test case and test category. The averaged score of the associated test categories thus represents the result of a wallbox in the six process steps. These results were then weighted on the basis of the weighting scheme. The weighted and aggregated score of process steps one to three thus formed the installer rating. Similarly, the end customer score was calculated from the weighted and aggregated score of process steps four to six. For better comprehensibility, the result of the two evaluations was scaled to a score of 100 maximum points.

## Scoring key

In total, 100 points were achieved in each of the two evaluations (installer and end customer) 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 make a reliable price-performance assessment. For easier classification, the respective test results were translated into a school grade logic. The assignment of the school grades to the point results is visualized with the enclosed scoring key.

The test was carried out in the third quarter of 2024 at the P3 Energy.lab in Osnabrück. The P3 competence center for smart energy and charging technologies offers a comprehensive infrastructure for charging tests on 700 square meters. In addition to standard tests on interoperability and protocols such as ISO15118 and OCPP, the laboratory also enables the integration of photovoltaic systems and energy management systems to be tested.

Not every process step has the same impact on the customer satisfaction of installers and end customers. The statistical analysis of the market surveys as part of the P3 Wallbox Benchmark takes these differences into account and ensures a valid weighting of the test results.

#zaptec



As part of the tests, safety components such as DC fault current detection, charging behavior in 11 kW continuous operation and standby consumption were examined. A complete test of CE conformity was not part of the investigation.

One of the most important new features of the benchmark is the evaluation of energy control functions that enable dynamic load management, integration into energy management systems and adaptation to variable electricity tariffs. Extended cybersecurity tests were also integrated by the Cyber Threat Defense Unit (CTD) in order to examine the security of networked wallboxes.

The P3 Wallbox Benchmark analyzes the entire end-to-end process from delivery, installation and configuration to the use of a smart AC Wallbox based on a comprehensive 360° analysis.

The overall score is based on 225 customer requirements, divided into 115 test cases and 31 test categories. The results of the first 8 test categories are included in the installer score, while test categories 9 to 31 are included in the end customer score.

The diagram visualizes the breakdown of customer requirements into the individual test categories. The focus topics Energy Control and Cybersecurity are highlighted.



# COMPETITIVE ENVIRONMENT

In the second edition of the P3 Wallbox Benchmark, the experts at P3 have defined specific product and market premises that are aligned with the focus of the benchmark edition 02 | Energy Control & Cybersecurity. A wallbox could only be nominated if it fully met all the selection criteria. The pre-selection of wallboxes was validated by P3's comprehensive internal market analyses to reflect a broad spectrum of national and international market participants.

## **Product premises**

- Focus: Energy Control & Cybersecurity
- Home charging: Max. 22 kW charging power (1 charging point)
- Backend connection: proprietary and/or third-party provider
- Regulatory requirements profile: low voltage
- Smart charging functionality (with smart meter)
- Multiple authentication & individual configuration

#### **Market premises**

- Compliance with regulatory requirements on the EU market
- Various price segments: € 800 € 1,600 (gross)
- Highest possible market penetration in the
   EU
- End customer-based product range
- Availability of products (common sales channels)
- Future-proof product portfolio of the manufacturer
- Minimal overlap with already published benchmarks or winners of competitions (e.g. ADAC)

# Test objects

Based on these selection criteria, 8 models were chosen to participate in the P3 Wallbox Benchmark. All manufacturers were officially informed of their nomination before the start of the product tests and requested to provide product-specific information. If no feedback was received from the manufacturers, the tests were carried out with the current model and firmware version at the time of purchase by P3.

# **TEST OBJECTS A-Z**



 Type 2-Socket
 = Permanently attached charging cable

Mennekes   Amtron 4You 510			<b>Go-e</b>   Charger Gemini 2.0 22kW 😵		
Type Firmware	1315001205ВК 1.0.40		Type Firmware	CH-05-22-511.0.40 56.8	800 00-e
Price	1096,00 €		Price	829,00 €	
Smart Meter for SC*	ab 249,98 €	01	Smart Meter for SC*	ab 249,00 €	05
Heidelbe	rg Amperfied   o	connect.solar 🜘	Zaptec	Go	
Type Firmware	00.779.3056 5.0.1		Type Firmware	ZM000688 000688	
Price	1175,00 €		Price	809,00 €	
Smart Meter for SC*	229,00 €	02	Smart Meter for SC*	241,57 €	06
Elli   Charger Pro 2					
	rger Pro 2	<u></u>	<b>KEBA</b>   Ke	eContact P40 Pro	°
Type Firmware	139915006 R01.003.038.005-elli		KEBA   Ke Type Firmware	Contact P40 Pr KC-P40-16EUS 1.0.1	
Type Firmware Price	rger Pro 2 139915006 R01.003.038.005-elli 1099,00 €		KEBA   Ke Type Firmware Price	CONTACT P40 Pr KC-P40-16EUS 1.0.1 1529,00 €	
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Type Firmware Price Smart Meter for SC*	139915006 R01.003.038.005-elli 1099,00 € ab 92,82 €		KEBA   Ke Type Firmware Price Smart Meter for SC*	ECONTACT P40 Pro KC-P40-16EUS 1.0.1 1529,00 € ab 179,02 €	°
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\*SC = Smart Charging

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The price level (gross) of the charging stations refers to the stated RRP for direct sales by the manufacturer and to standard commercial prices for a multi-level sales concept. The prices for the smart meters are based on research carried out by P3.



# OUTCOMES

The most important finding right at the beginning: In the P3 Wallbox Benchmark 2024, all 8 wallboxes tested were convincing without exception in the charging tests. During the 11kW endurance tests under laboratory conditions and countless test series with shorter charging processes, there was not a single charging interruption. The measured power consumption ranged between 1.1 W and 5.6 W in standby mode. The noise emissions during the charging tests (11 kW; 16 A, 3-phase, measuring distance 1 m from the housing) were consistently below 40 dB(A) and thus corresponded to the background noise in the test laboratory. In the event of simulated power failures, all wallboxes resumed the charging process within a very short time after a restart, provided the authorization function was deactivated.

One focus was on the intelligent communication and control function, where the Elli Charger Pro 2 and the Zaptec Go stood out. The Elli Charger Pro 2 won both the overall and end user evaluation and offers easy installation with separate service and standard user interfaces via the WebUI. It should be noted that the Elli Charger 2 is identical in construction to the Charger 2 from VW, Skoda and Cupra and can therefore also be controlled via the respective vehicle app. Particularly noteworthy is the integration of live data from the electricity exchange via the EPEX spot price connection, which takes dynamic electricity prices into account at regular intervals. This enables particularly cost-efficient charging. Charging prices and processes can be monitored via the app connection and charging cards can be activated on request. The Pro 2 is equipped with Ethernet, Wi-Fi, hotspot and LTE, including a data volume for 10 years to connect to the Elli backend. Connection to EEBus devices as well as HEMS and PV systems is straightforward. In addition, the Charger Pro 2 is prepared for "Plug & Charge" (PnC) on the hardware side; the required software will be supplied later via OTA updates and app releases. For VW Group vehicles, an optimal charging plan can be calculated via the car interface, taking into account the PV surplus, weather forecast and electricity costs. With its extensive smart charging functions, such as PV surplus charging, forecast-based and dynamic charging, it also stands out from the crowd.



The Zaptec Go, winner of the "installer test", impresses with a quick and user-friendly installation and configuration process. Whether surface-mounted or flush-mounted installation, the models impress with their easy handling, which is further facilitated by the accessible terminal block for the electrical connection. The Zaptec Go combines numerous features and a charging capacity of 22 kW in a compact, attractive design. The integration of dynamic electricity tariffs and connection to energy management systems takes place via the OCPP interface, enabling flexible and future-proof charging. With a 5-year warranty, the Zaptec Go not only offers an attractive price-performance ratio, but also a high level of reliability. In addition, the upcoming Zaptec Go 2 is in the starting blocks, which is expected to offer improvements such as PV surplus charging and MID certification.

The wallboxes tested offer numerous innovative functions for modern electromobility. The Elli Charger Pro 2 enables intelligent control of charging processes and takes electricity prices into account in real time. Users can plan their charging processes flexibly via a user-friendly app and adapt them to market conditions. Safety features such as overload and residual current protection as well as remote control options ensure not only the safety but also the longevity of the devices.

Overall, the test results show that the manufacturers consistently offer high-quality products. Nevertheless, it should be noted that the possibilities for intelligent control and adaptation of charging behavior in the industry are still in the development phase. Smart charging functions such as CO2 optimization, photovoltaic use and dynamic charging current regulation are only partially available and require considerable implementation effort.



# P3 WALLBOX BENCHMARK 24 / 25 TEST WINNER OVERALL



# **ELLI CHARGER PRO 2**

With the second generation of its wallbox series, the Charger Pro 2, VW subsidiary Elli secured overall victory in the P3 Wallbox Benchmark 2024/2025 by a narrow margin.



# Installer rating

The installation of the Charger 2 is designed to be efficient and time-saving for installers. The configuration area is clearly divided into service and standard users, each with their own access data. The user-friendly WebUI in the local network requires only a few settings, as many functions are automated. Several options are available for connecting to the backend: Ethernet, WLAN or LTE, the latter with a data volume runtime of 10 years. An EEBus interface enables uncomplicated integration of EEBus-capable devices and PV systems. Connection to third-party OCPP backends can also be implemented without any problems.

## **Customer rating**

The Charger 2 impresses with its innovative features. It is one of only two wallboxes tested that is already prepared for Plug & Charge (PnC) on the hardware side, and the software is supplied subsequently via an OTA update. For VW-G vehicles (VW, VWN, Cupra, Skoda), a direct interface enables the creation of optimal charging plans that take into account factors such as mobility requirements, PV surplus, weather forecasts and electricity costs. For other vehicles, the Charger 2 offers a choice of three charging modes. In addition, the wallbox supports smart charging functions such as PV forecast-based charging, dynamic surplus charging and price-optimized charging. The integrated HEMS is supplied at no additional cost and enables seamless integration with third-party energy meters. For fleet solutions, the Charger 2 offers a hub-satellite connection and support for OCPP 2.0.1, including export functions for charging data filtered by time period and RFID card. The Pro version is equipped with a MID meter and is also available with an optional calibration meter. Alternatively, a cheaper version without MID counter is also available. The cybersecurity test did not reveal any critical security vulnerabilities in the Elli, but did reveal some small to medium vulnerabilities that could potentially allow data to be intercepted.

# **ELLI CHARGER PRO 2**



### End customer rating

#### End Customer Configuration

- Charging
- Smart Charging
   Fleetmanagement

#### Technical Details

# Installer rating

- Delivery
- Installation, Electrical Connection and Interface Connection
- Installer Configuration





OUTCOME

KERD () Ø (\*)

# KEBA KECONTACT P40 (PRO)

The KeContact P40 (Pro) impresses even at the pre-series stage with its robust quality and a large number of control inputs, even if some app and web functions are not yet fully integrated.

# Installer rating

The KeContact P40 (Pro) from Keba impresses with its fast, uncomplicated installation. It is mounted on the wall or pillars with just three screws and can be surface-mounted or flush-mounted. Particularly practical: instead of separate apps for installers and users, access is simply controlled via a shared user/installer password, which simplifies the process. The initial configuration is intuitive and user-friendly.

## **Customer rating**

The KeContact P40 (Pro) offers comprehensive interfaces for energy control, including inputs for charging power control, for blocking the station and for a ripple control receiver. A switching contact for an upstream contactor and RS485 terminals are also available. The P40 (Pro) supports SIM cards and is available in 11 kW and 22 kW versions. There is also a MID-certified and calibration-compliant version. However, the many product options could be somewhat confusing for end customers. Another highlight is the integrated phase cut-off, which enables efficient PV overcharging. No critical security risks were identified in the security test; however, some medium and low risks, particularly in the areas of app and API security, should be further improved. As the wallbox was still in the pre-series stage during the test, some software functions were not yet available. Visually, it is available in the colors black/green and white/green.

# KEBA | KECONTACT P40 (PRO)





Installer rating Customer rating 82,3|100 72,0|100



An outstanding feature of the **KeContact P40 Pro** is the wide variety of control inputs for a comprehensive energy control concept.





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# Installer rating

Installation of the Zaptec Go wallbox is extremely user-friendly thanks to a quick, simple and intuitive process. Both surface and flush mounting is possible, and the electrical connection is also simple and efficient thanks to an easily accessible terminal block. The Zaptec Go supports Wi-Fi and LTE (e-SIM integrated), which ensures smooth communication and simplifies installation.

## **Customer rating**

The Zaptec Go offers end users numerous advantages. The direct integration of dynamic electricity tariffs, such as those from Tibber, enables cost-efficient use. Its compact design combines an impressive charging capacity of 22 kW. There are no physical control connections; higher-level control takes place exclusively via an OCPP connection, which increases flexibility. Energy management systems (EMS) can also only be integrated via the OCPP interface, such as CleverPV with the Shelly Smart Meter. Users also benefit from a 5-year warranty. A preview of the upcoming Zaptec Go 2 wallbox, which is due to be released at the end of the year, promises additional features such as PV surplus charging, MID certification and phase switching. The security assessment of the Zaptec wallbox revealed no critical vulnerabilities, but some medium and low-risk points of attack, particularly in communication in the mobile application.

# ZAPTEC | GO





1,0

Installer rating Customer rating 91,4|100 73,1|100



End customer rating • End Customer Configuration • Charging • Smart Charging • Fleetmanagement

Technical Details

#### Installer ratir

Delivery

- Installation, Electrical Connection and Interface Connection
- Installer Configuration



# **GO-E** CHARGER GEMINI 2.0 22KW

The go-e Charger Gemini is a sophisticated choice for home use and offers numerous practical functions. The compact charger combines modern technologies for flexible charging and intuitive control. The connection to the go-e Cloud and external OCPP servers enables versatile charging management with future potential.

# GO-E | CHARGER GEMINI 2.0 22KW

# Installer rating

The go-e wallbox scores points for its ease of use and the clearly structured installation manual, which explains all the steps in a comprehensible manner. It only supports Wi-Fi and LTE and is supplied with a pre-installed connection cable - the manufacturer from Carinthia (AT) is thus clearly focusing on minimizing the amount of cabling required. The well thought-out and graphically appealing app design allows uncomplicated setup, supported by a local hotspot for installation.

## **Customer rating**

The go-e Charger Gemini offers user-friendly operation with numerous setting options in the go-e app. The LED ring visualizes the charging status, and a practical button allows easy adjustment of the charging current directly on the device, while the boost mode ensures faster charging. The flexible, customizable charging solution offers a convenient charging experience and allows up to 10 RFID cards to be programmed - ideal for households with multiple users. In some cases, the cloud connection proved to be less stable, but the hotspot mode is a reliable alternative. There is some catching up to do in terms of cyber security: unencrypted communication via HTTP WebSockets leaves sensitive data unprotected, and replay attacks could potentially be used to manipulate critical settings.





The user-friendly app interface of the **go-e Charger** gives you full control over the charging process. The charging current can be flexibly adjusted, and the current status can be viewed at any time.





# HEIDELBERG

The Heidelberg wallbox offers versatile installation options, but only receives average ratings. With a maximum charging power of 11 kW, it is primarily suitable for home use.

# Installer rating

The wallbox can be mounted on the wall or on a pedestal and offers the option of surface-mounted or flush-mounted installation. Despite sufficient space inside, the comparatively large design makes handling difficult. In addition, there is no clear separation between the installer and end customer areas in the configuration, which makes the set-up process somewhat more complicated.

#### **Customer rating**

The Heidelberg wallbox can be configured intuitively for end customers via a web server and supports the addition of RFID cards. Status displays via LEDs and detailed data in the app make it easy to use. With low self-consumption and support for smart charging, such as PV surplus charging via the Heidelberg Controller, it is also energy-efficient. Up to 16 wallboxes can be networked and over 90 days of charging data can be retrieved. The wallbox is compatible with many third-party HEMS and can be easily connected. The cybersecurity assessment did not reveal any critical security vulnerabilities, but did identify some low to medium risk vulnerabilities, particularly in the mobile application.

# HEIDELBERG | CONNECT-SOLAR





GRADE

3,4

Installer rating Customer rating 80,2|100 72,7|100 Total score Ø 76,4|100



End customer rating • End Customer Configuration • Charging • Smart Charging • Fleetmanagement

Technical Details

# Installer rating

Delivery

- Installation, Electrical Connection and Interface Connection
- Installer Configuration





# MENNEKES AMTRON 4YOU 510

The Amtron 4You 510 scores with flexible mounting options and versatile functions, ideal for private and commercial applications.

#### Installer rating

The wallbox can be mounted on a wall or pedestal as well as surface-mounted or flush-mounted, allowing it to be adapted to different situations. The space for the cable connection is sufficient but could be limited with larger cable cross-sections. The positioning of the terminal block inside is not optimal, which makes installation more difficult. With an output of up to 22 kW, the wallbox meets high requirements. Configuration is carried out via an app or a web server; it should be mentioned that the app only offered limited functionality during the test period as it was still in the development phase. The clear separation of the areas for installers and end customers is a positive feature.

### **Customer rating**

For end users, the wallbox offers a status display via LEDs directly on the device. An app for iOS and Android displays current charging data; however, the control functions were limited at the time of testing. Authentication takes place both via RFID and via the app. With a power consumption of just 4 W, the wallbox is energy-efficient. It supports automatic phase switching and enables dynamic load management via an external measuring device. It also supports PV surplus charging and third-party HEMS can be easily connected. The charging history can be viewed for more than 90 days, ensuring maximum transparency. In terms of cyber security, no critical or high-risk security gaps have been identified, which underlines the security of the wallbox.

# **MENNEKES | AMTRON 4YOU 510**





PRICE-PERFORMANCE GRADE

2,9

Installer rating Customer rating 85,2|100 75,2|100



The **Mennekes Amtron 4You 510** gives you a transparent view of your charging history for more than 90 days, keeping track of your energy consumption.

:

OUTCOME





# KOSTAL ENECTOR

The KOSTAL Enector is a wallbox that has been specially developed for seamless integration with KOSTAL products such as inverters and SmartMeters. However, this severely limits its compatibility with third-party systems.

## Installer rating

The wallbox is installed efficiently and offers various mounting options, including wall, pedestal, surface and flush mounting. There is sufficient space inside for the cabling, but there is no strain relief for the supply cable. The well-thought-out mounting concept requires an additional KOSTAL SmartMeter for configuration, which increases the installation effort. In addition, there is no clear separation between the configuration areas for installers and end customers; the maximum charging power is 11 kW.

## **Customer rating**

End customers benefit from functions such as PV surplus charging and automatic phase switching. The wallbox can be configured via a web server and offers an LED status display. The charging process starts without authentication, but the wallbox can be locked. With a self-consumption of just 1.1 W, it is energy-efficient and supports connection to KOSTAL's own HEMS, but not to third-party HEMS. The security assessment did not identify any critical risks, but did identify some minor to moderate vulnerabilities that can be addressed by appropriate security measures.

# KOSTAL | ENECTOR



OVERALL GRADE 2,6 PRICE-PERFORMANCE 2,6

Installer rating Customer rating 72,7|100 63,5|100



The generously designed interior of the **KOSTAL Enector** wallbox offers sufficient space for simple cabling and a well-thought-out installation, ensuring efficiency and user-friendliness.

# WALLBOX ABL PULSAR

The Pulsar Max wallbox is a compact and powerful charging station with an output power of up to 22 kW. It offers a flexible solution for users who value simple installation and intuitive operation.

# Installer rating

The Pulsar Max is extremely user-friendly to install. Thanks to its compact design, it is suitable for both space-saving wall and pedestal mounting, in surface-mounted or flush-mounted versions. Inside, the wallbox offers sufficient space for cable routing, which further simplifies the installation process. The installation area is clearly separated from the end customer area, which enables effortless configuration.

### **Customer rating**

The wallbox enables intuitive control via the app, which displays the charging status and current charging data. Authorization is done via a web server or the app, while support for PV surplus charging and integration with third-party backends is provided. Charging data can be retrieved for 90 days, but there is no MID meter. The wallbox can be operated in combination with up to 100 devices, which increases its flexibility. Dynamic charging current regulation is also possible but requires additional hardware. No critical security risks were identified, but some vulnerabilities with low to medium risk were found, especially in the mobile application. To improve cyber security, we recommend the implementation of SSL pinning.

# WALLBOX ABL | PULSAR





The Pulsar Max wallbox - your powerful and compact solution for efficient charging that impresses with its modern design and intuitive operation.

# OVERALL RATING



Customer rating

All 8 wallboxes tested achieved good results in both the installer and end customer ratings. With the Elli Charger Pro 2 (overall and end customer test winner) and the Zaptec Go (installer test winner), two wallboxes easily set themselves apart from the competition.



# PRICE-PERFORMANCE RATING

When comparing the price-performance ratio, the Zaptec Go emerges as the clear test winner. As one of the cheapest models in the test, it impressively proves that intelligent wallboxes can now offer a comprehensive range of services for end customers for less than 1,000 euros and impress installers with a simple installation and configuration concept.



# CONCLUSION

# CONCLUSION AND OUTLOOK

The second edition of the P3 Wallbox Benchmark offers an in-depth analysis of the market for intelligent AC Wallboxes, which has been difficult to understand until now, and sets new accents through the topics of energy control and cybersecurity. With an independent, practical comparison from the perspective of installers and end customers, the report provides valuable decision-making aids for selecting the right wallbox. A total of eight intelligent AC Wallboxes for home use were analyzed using a comprehensive test concept with 225 customer requirements.

In the end, the overall ranking was decided by a narrow margin of just 0.6 points. The Elli Charger Pro 2 is therefore the deserved test winner. While the two individual category winners, Elli Charger Pro 2 and Zaptec Go, stand out somewhat from the competition, the conclusion remains that all 8 wallboxes tested perform at a high level. Subtle differences in quality and different functionalities of the models lead to differences in points, which can be decisive in a tight competitive field.

Although the benchmark covers many criteria from different perspectives, it does not claim to be exhaustive. Other factors in the product life cycle can influence the evaluation of a wallbox, which were not taken into account for capacity reasons. Therefore, the individual customer profile remains central to the purchase decision.

Innovations in the areas of energy control and cyber security are crucial for the future of the charging infrastructure. Dynamic load management and the integration of energy management systems enable the efficient use of resources and help to reduce energy costs. At the same time, modern wallboxes must be protected against cyber threats as they are part of complex, networked systems. The P3 Wallbox Benchmark 02 takes this into account through comprehensive security tests by the Cyber Threat Defense Unit (CTD). The results show that most of the identified cyber security issues are informational to medium in nature and mainly affect the mobile applications and web management interfaces. While some wallboxes offer solid protection, others lack specific features. We are happy to carry out a comprehensive audit on request to examine the security of the products in more detail.

The market for charging infrastructure is facing enormous growth, particularly due to the impending restrictions on the registration of combustion engines in the EU from 2035. Despite the potential for expansion, competition remains intense and market consolidation is likely. P3 will actively accompany this change and support it as a partner with comprehensive technological and market expertise. Issue 02, which focuses on energy control and cyber security, has already laid the foundation for further topic-specific reports. Planning for issue 03 is underway and promises further valuable insights for companies and end customers.

Do you have any questions? Please contact us. The P3 Charging & Energy Team



Breaking new ground is our strength - through versatile skills and innovative approaches.

## Core competences

- Market & competition analysis
- Market modeling & business cases
- Go-to-market strategies & business model development
- Technical specifications
- Standardization & technical project management
- Interoperability assurance & OCPP integration tests
- Technical due diligence & M&A consulting

#### Charging infrastructure as the key to e-mobility

It is the backbone of e-mobility - a dynamic market with huge potential and major challenges. Barely existing a decade ago, the field is now developing rapidly. Players from a wide range of industries - from car manufacturers, energy suppliers and oil companies to filling station operators and the public sector - are driving the expansion forward. Even insurance companies and banks have to deal with the constantly changing standards and technologies.

## Our approach at P3

We have been accompanying this dynamic market for years and understand not only the technologies, but also the key players and value chains. Our strength lies in our holistic approach - from the development of the business model to the implementation of hardware and IT solutions.

#### **Comprehensive solutions**

At P3, we connect the power supply for e-mobility with the entire energy system - from the vehicle to the charging infrastructure and the energy grid. Thanks to our broad network of experts, we ensure that the right consultants work on your project. Our teams cover all relevant disciplines, from mechanical engineering to IT and business administration.

Our experience from over 6000 charging tests conducted worldwide enables us to identify typical interoperability problems at an early stage and offer solutions. Whether business models, funding opportunities or technical solutions - we support you through to successful implementation.

## OSNABRÜCK, 02 | 12 | 2024

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