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Charging points in underground garages of multi-family buildings in Poland: current status, challenges and development prospects

Stacje ładowania w garażach budynków wielorodzinnych w Polsce: stan obecny, wyzwania i perspektywy rozwoju

***Abstract**. The article describes key aspects of the development of electric vehicle charging points in underground garages of multi-family buildings in Poland. It presents an analysis of current legal regulations. In legal matters, in addition to presenting the necessary steps, we recommend contacting a lawyer. We also present the results of load measurements of EV charging points.*

***Streszczenie.** Artykuł opisuje kluczowe aspekty rozwoju punktów ładowania pojazdów elektrycznych w garażach podziemnych budynków wielorodzinnych w Polsce. Przedstawia analizę aktualnych przepisów prawnych. W kwestiach prawnych oprócz zaprezentowania niezbędnych kroków zalecamy kontakt z prawnikiem. Prezentujemy również wyniki pomiarów obciążeń ładowarek samochodowych.*

Keywords: charging points, electric vehicles, quality of electric power, multi-family buildings, renewable resource-related facilities
Słowa kluczowe: punkty ładowania, pojazdy elektryczne, jakość energii elektrycznej, budynki wielorodzinne, obiekty związane z odnawialnymi źródłami energii

Introduction

The dynamic rise of electromobility is one of the key challenges of contemporary urban planning and energy policy. The growing number of electric cars on Polish roads implies the need to adapt the infrastructure to the needs of electric vehicle (EV) users. In 2022 there were about 50 thousand EV in Poland and more than 2 thousand public charge points [1]. At the end of June 2024, the number of EV reached almost 120,000 passenger cars with electric drive, of which about 62,000 were fully EV and 57,000 were plug-in hybrids. The number of public charge points at this moment was 7255 [2]. One of the key elements of this infrastructure, which is crucial for the dissemination of EV are charging points [3], [4]. Issues related to public charging stations have been widely described in the literature e.g. [5]–[8]. Nevertheless, particular attention should be paid to the installation of charging points in the residential areas [9]. In the case of multi-family buildings, where a significant part of the population of Polish cities lives, the most common solution is to place charging points in underground garages. This approach brings a number of benefits, including increased access to vehicle charging, however it is also associated with numerous technical challenges. In the context of the Polish housing market, issues related to the adaptation of existing power infrastructure, meeting fire safety requirements and harmonizing solutions with building and energy law regulations are of particular importance.

The aim of this publication is to analyze the current status and development prospects of charging points in underground garages of multi-family buildings in Poland. Furthermore, there are presented results of load measurements of EV charging points.

Technical aspects of EV charging points

The charging processes for electric vehicles are defined in the IEC 61851 [10] and IEC 62196 [11] standards, which outline four types of charging systems:

- Type 1 (AC Charging) - This is a basic charging system using standard outlets, with a maximum of 16 A and 250 V. It is considered slow or semi-fast and lacks dedicated safety features or communication between the vehicle and charger.
- Type 2 (AC Charging) - A more advanced system than Type 1, including portable chargers with added protection like a control box, offering safer and more efficient charging.
- Type 3 (AC Charging) - This system allows slow or semi-fast charging with dedicated vehicle connections (e.g., TYPE 2) and advanced control functions. It supports up to 32 A and includes safety devices like an RCD in the charger.
- Type 4 (DC Charging) - A fast charging system using dedicated connectors (e.g., Combo 2), with the AC/DC converter built into the charger. It offers higher charging power and advanced control for quick and safe charging.

From the point of view of operational safety, it is very important to select appropriate protection. In the PN-HD 60364-7-722:2019-01 standard [12], it can be find guidelines on the need to use at least a residual current device (RCD) with a rated differential current not exceeding 30 mA. In addition, appropriate overcurrent protection should be selected. In the case of three-phase powered charging devices, the following relationship can be used:

$$(1)\ I_c = P/(\sqrt{3} \cdot U \cdot \cos\phi),$$

where I_c is the calculated nominal current, P is a nominal power of charger, U is its nominal input voltage and $\cos\phi$ is a power factor. Based on the calculated I_c value, the overcurrent protection with the closest (higher) nominal current should be selected. It should also be noted that the overload tripping current cannot exceed the long-term load capacity of the charging point's power supply cable. There are several options for connecting an EV charging point, including: connecting it to the apartment's electrical switchboard, installing a new metering system in the building's main switchboard, integrating it with the existing metering system of the premises, or setting up a new dedicated power connection. Furthermore, the installation must comply with technical requirements related to fire safety hazards. The above premises clearly indicate that, the installation of the charging point requires an individual approach depending on the case, therefore it is recommended to entrust this task to suitably qualified persons with the necessary authorizations and experience.

Load measurements of EV charging points

During the tests, two types of charging points were analyzed:

- Solution No. 1 - maximum charging current of 16 A, nominal power 11 kW, Type 2;
- Solution No. 2 - maximum charging current of 32 A, nominal power 22 kW, Type 3, remotely controlled via app (power regulation);

The mentioned above charging points were used to charge the batteries of a Tesla Model 3. The car allows the user to set and limit the charging current level. The user has constant access to the battery charge level and the current charging current value. Despite the higher nominal power of charging point No. 2, for unknown reasons, the vehicle's monitoring system limited the charging current to just 6 A. In both cases, the Metrel MI 2292 power quality analyzer was used to measure active, reactive, and apparent power, as well as to monitor currents, voltages, and their distortions during 1-second averaging periods. The startup process of the charging point in both cases indicates a sequential loading of individual phases of the power supply system at intervals of several seconds. The total startup time of both charging points in the analyzed vehicle is approximately 20 seconds, and overcurrent conditions may occur (only for charging point No. 2, e.g., in a transient state, the current may reach 8 A with a set charging current of 6 A). In both cases, the power drawn from the grid in the steady state is stable, and no changes in current intensity occur (see Fig. 1).

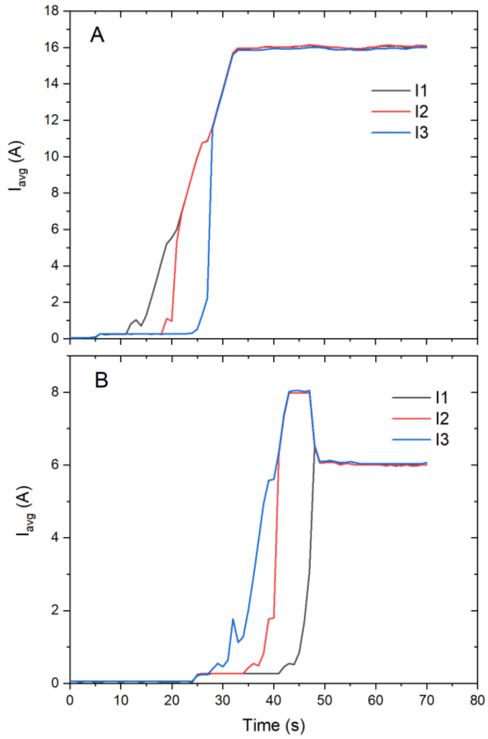

Fig. 1. Changes in current drawn from the mains after starting the charging process in the EV in the case of charging point no. 1 (A) and no. 2 (B)

Basically, in both types of charging points, a typical dependence of current harmonic emissions was observed, which decreases with the increase in the system load to the rated value. The changes in harmonics in the supply voltage (THDU in the range 1÷4.2%) shown in Figure 2 result from the specificity of the LV power grid connection point. Due to the change in voltage harmonics at the supply point, current harmonics fluctuate proportionally. Charging points used for the power electronic circuit systems proposed by the manufacturer and the filters used are characterized by different levels of current harmonic emissions. Their level may be subject to separate tests and should be carried out when installing voltage sources with a specified level of voltage harmonic emission stability.

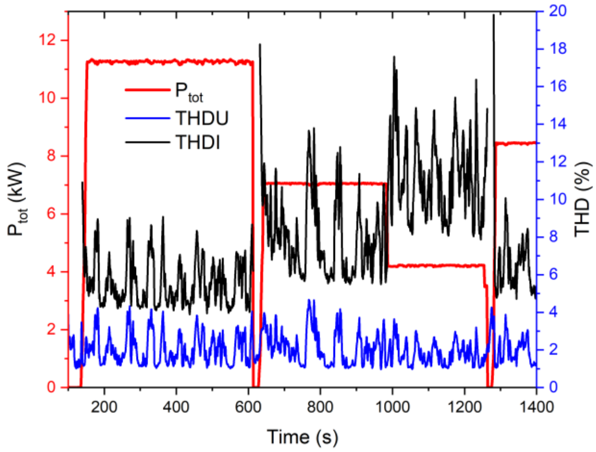

Fig. 2. Power drawn from the supply network and the total content of higher voltage and current harmonics of phase L1

Current Legal Regulations Overview

Nowadays, the most popular place of charging electrical car is a home garage, which is also often the most financially affordable option. It is a very intuitive solution, especially if there are no laws regulating such an activity for a garage that is subject to a single-family home. However, the situation of charging an electric vehicle in underground garages of multi-family buildings is more complicated.

The regulations in force in Poland do not define detailed regulations governing the charging of electric cars in underground garages of multi-family buildings. In the other hand, the Act of 11 January 2018 on electromobility and alternative fuels [13] requires that newly constructed multi-family residential buildings, or any new public utility building, with their external and internal parking spaces is obliged to have the connection power that shall enable them to be equipped with vehicle charging installations with a minimum power of 3.7 kW. Despite this, many drivers face challenges due to a lack of permission from building managers to charge or park their electric vehicles. The most common reason for denial is the concern over fire hazards associated with charging or even parking an electric vehicle. Although the fire risk probabilities of electric and conventional cars are similar [14], an electric vehicle fire is potentially much more difficult to control and dangerous due to the release of significantly more heat and substances that are harmful or toxic to human health [15].

The building manager has the right to deny access to parking spaces and charging points if there are technical limitations or insufficient power reserves to support the installation of a charging point. Therefore, it is strongly recommended arranging parking and charging conditions with the manager beforehand. It's essential to understand that even using an Electric Vehicle Supply Equipment (EVSE), which is not classified as a charging point under Polish law, requires prior arrangement as well. According to the mentioned above Electromobility Act, a charging point is defined as "a device enabling the charging of a single electric vehicle, hybrid vehicle, or zero-emission bus, as well as a location where the battery used to power such a vehicle is replaced or charged" [13]. This law also provides guidelines for installing charging points in buildings constructed before the act was passed. Before purchasing a charger or charging point, it's advisable to consult with the building manager to determine the appropriate device parameters, ensuring that it is both suitable and safe for the building. The technical expertise must clearly confirm that the installation of a charging point in the building is feasible. Additionally, in accordance with Polish law, if the building or area is listed in the Polish register of monuments, permission from the provincial conservator of monuments is required before any installation. The applicant must also secure permission from the building owner.

It is important to note that an appraisal is not mandatory. Once the application is submitted, the building manager has 30 days to order an expert opinion on the construction of the charging station. This assessment must be carried out by someone with construction qualifications in electrical and power grid installations. The cost of the expert opinion is covered by the applicant. However, this opinion is not required if a charging point already exists on the property. Once the application is submitted, the building manager reviews it and, if favorable, forwards it to the Residents' Council for consideration. Approval requires consent from the Housing Community Board, the owner of the second apartment in two-apartment communities, or at least half of the residents in communities of three or more apartments. Notably, for charging points with a power of 11 kW or more, the consent of at least half of the residents is required, whereas for lower power points, only the approval of the Housing Community Board is necessary. It's also important to highlight that the power limit for EV charging points is nearly double that of photovoltaic (PV) installations. For PV systems, the limit is set at 6.5 kW, and any installation exceeding this power must be reviewed and approved by a fire safety expert. [16]. The Board or apartment owners may reject the application if the applicant has not agreed to cover the installation costs or, if the expert opinion shows, modifications to the electricity network are needed. Other reasons for refusal, as outlined by Polish law, include the applicant's lack of legal title to the apartment or exclusive-use parking space, lack of the apartment owner's consent, or a negative expert opinion regarding the installation. This procedure applies to both internal and external charging points. It is strongly recommended to consult with a lawyer before beginning the application process for installing a charging point.

Conclusions

With the rapid growth of electric and hybrid vehicles in Poland, the demand for more charging points is increasing significantly. According to the Act on Electromobility and Alternative Fuels of 11 January 2018, all newly constructed multi-family residential buildings and public utility facilities with internal and external parking spaces must be equipped to support vehicle charging installations with a minimum power of 3.7 kW. This article outlines the procedure for installing new charging points in both indoor and outdoor parking areas. If the planned charging station's power is below 11 kW, the Housing Community Board can approve the application without needing the consent of at least half of the residents. For photovoltaic installations, the power limit is 6.5 kW. During the activation of battery charging in an electric vehicle, short-term current surges may occur due to the design and applied algorithms of the charging current regulators. The tested charging points, in their steady-state operation, demonstrated stable and symmetrical current draw from the low-voltage electrical grid. The level of current harmonic emissions depends on the design features of the device and decreases as the power drawn from the grid increases.

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