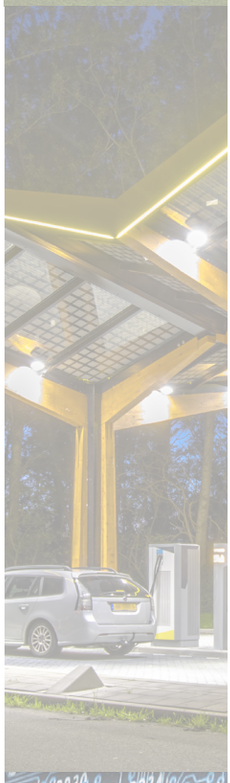
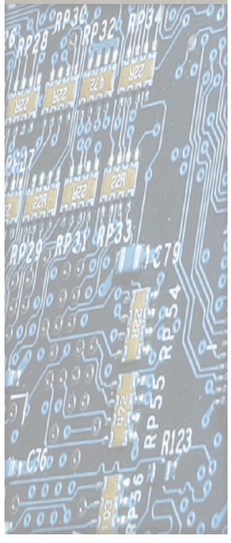
NMi WHITE PAPER

# EV CHARGING SYSTEMS

## Legal metrological infrastructure



### INTRODUCTION

The proliferation of electric vehicles (EV) continues due to numerous factors. A growing number of governments now pledge to phase out internal combustion engines or have ambitious vehicle electrification targets for the coming decades to reduce CO2 emissions. Meanwhile, technical improvements such as increased battery capacity spur carmaker plans to electrify their fleets. All leading to the delivery of many more new EV models in the coming years, increasing EV attractiveness for consumers.

Along with this accelerated adoption comes an increased need for charging options at residential and public places like parking areas and motorways. As a result, EV Charging Systems have flourished. Yet, unlike fuel stations — with a mature system in place for legal metrological control used to protect all parties involved in transactions — clear metrological requirements and proper technical standards for EV Charging Systems remain wanting. Many countries have limited legislation or no legislation at all.

A strong need exists to develop harmonised legislation and a level playing field for all parties. A coherent framework will also enhance competition, give clarity to manufacturers of EV Charging Systems and open legal barriers. Manufacturers could then sell their products in various markets against the same technical requirements.

This white paper examines the current legal metrological infrastructure for EV Charging Systems — primarily in Europe, technical developments on the issuance of essential requirements in progress by standardisation bodies and other international developments.

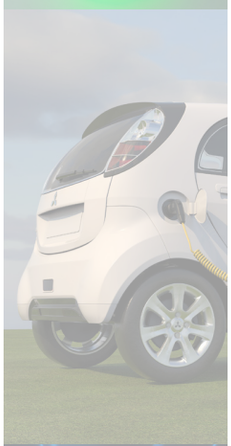
### AN IMPORTANT POLITICAL DRIVER

In Europe, an important political driver is Directive 2014/94/EU on deploying alternative fuels infrastructure [1]. In 2011 the European Commission adopted the 2050 Transport Strategy, aiming to reduce EU transport's dependence on oil [2]. The strategy establishes 40 transport initiatives to increase mobility and remove significant barriers in key areas. It identifies battery and fuel cell electric vehicles as a solution for reducing air emissions and is considered essential technologies for the 60% cut in transport emissions by 2050, as measured against the 1990 levels. In April 2021, the European Parliament and the member states took a further step with the agreement to increase efforts, with the objective of reducing 55% in 2030. Europe aims to be climate neutral in 2050.

The EU set up an array of policy initiatives to achieve these ambitious climate and energy targets. This includes the development of a sustainable alternative fuels strategy as well as the appropriate infrastructure. Apart from introducing new, less polluting fuels like LPG, CNG and hydrogen, the use of electric vehicles and the creation of the relevant charging infrastructure are considered crucial.

As prescribed in Directive 2014/94/EU, Member States are obliged to build an appropriate number of recharging points accessible to the public to encourage and facilitate the deployment of recharging points not accessible to the public (article 4). Ultimately, the aim is to ensure sustainable electric mobility throughout the European Union.

As a result, a significant political drive is evident in all European Member States to deploy a robust charging infrastructure.





## THE SITUATION FOR LEGAL METROLOGY IN EUROPE

While a mature system for legal metrology exists for fuel stations, the situation differs for relatively new EV Charging Systems. In 2020, an investigation by WELMEC Working Group 5 [3] revealed that many European countries still need a metrological system for these devices. revealed many European countries do not have a metrological system in place for these devices. Now, in 20232, this remains the case in several of them. Consequently, chargers can be placed on the market in those countries without being subject to metrological control.

Several other countries gave the opinion that the Measuring Instruments Directive 2014/32/EU (MID) [4] is applicable, although in most cases, the metrological inspection of instruments in use is not activated.

In 2013 the European Commission already found the MID applicable for EV Charging Systems, stating that "slow and medium-fast electricity charging meters for e-vehicles are in the scope of MID." [5]. However, it is also evident that the MID was not intended to be used for charging systems and that several areas of technical conflict exist.

Firstly, the MID covers only electricity meters, as listed in the instrument-specific Annex V (MI-003). Dedicated aspects of charging systems, like resetting registers or requirements for limiting energy losses between metering point and delivery point, are missing.

Furthermore, where MID treats the electricity meter as a utility measuring instrument, an EV Charging System is used for direct selling to the public. At the moment, dedicated requirements, which are in place for fuel dispensers, are not applied to EV Charging Systems. Where in Annex I of the MID, clause 11.1 (about non-repeatable measurements in the absence of one of the trading parties), utility measuring instruments are explicitly excluded from the requirement to record the measurement result by a durable means that would be likely applicable for EV charging applications.

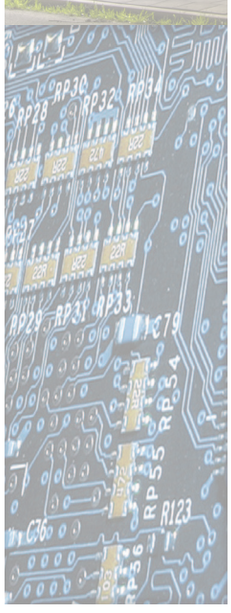
It is also questionable whether other requirements are appropriate for EV Charging Systems. For instance, according to the MID, utility meters shall be fitted with a metrologically controlled display accessible without tools to the consumer (Annex I, 10.5). However, debate persists about applying this requirement to EV Charging Systems. Several designs on the market do not have a display at all, for example, the use of mobile phone apps to inform the customer of the amount of energy delivered. Furthermore, the use of a display may not be helpful in situations of 'multiple tariffs' — where pricing changes throughout any given day.

## THE SITUATION IN GERMANY

Germany has a unique position in Europe with dedicated metrological legislation in place (Mess- und Eichgesetz; MessEG) [6], which came into force in 2015.

Apart from the measuring instruments covered by MID, German legislation covers approximately 130 other measuring instruments as well. A dedicated committee, the Regelermittlungsausschuss (REA), has determined each measuring instrument's regulations and technical requirements [7]. This includes EV Charging Systems. In most cases, these regulations are a mix of documents, including European norms, OIML Recommendations, WELMEC guides and pre-MID legal requirements.

The REA has harmonised a dedicated document with reference 6-A [8] for EV Charging Systems. Here, the regulations and technical requirements for measuring instruments and auxiliary equipment used for e-mobility are defined. The requirements of the MID, Annex V (MI-003), and class A for the applied electricity meters are listed for both AC and DC meters. For the EV Charging System as a whole, several functional requirements are stated, including the indication of results, internal clocks, data communication output, data security, data storage and software.

EN 50470 is a harmonised standard for AC electricity meters applied in AC chargers. A mix of older national documents is used for DC electricity meters applied in DC chargers. This was necessary as no dedicated European norms for DC meters were available when originally drafted.

All relevant conformity assessment bodies in legal metrology are part of a dedicated committee, "Ausschuss der Konformitätsbewertungsstellen" (AdKBS), where aspects of the German legislation for measuring instruments are discussed and interpreted. The dedicated subgroup "Messgeräte und Zusatzeinrichtungen für Elektrizität" (MuZE) groups the relevant bodies in the electricity area, covering the application of EV Charging Systems. Here, MuZE recently took the initiative to create a Guide, listing all interpretations for various legally relevant subjects related to e-mobility. Examples include

- interpretations of dedicated displays,
- the presentation to the end user,
- data security,
- requirements for energy losses,
- sealing, and more.

According to German legislation, local presentation of the measurement result to the end user is mandatory. This can occur via a dedicated client display or the visible display of the applied built-in electricity meter. Furthermore, the transaction data is communicated by the EV Charging System to a back-end system while cryptographically secured. Specific transparency software must be provided with which the end user can check the integrity and authenticity of the transaction data while receiving the bill after the transaction.

Although manufacturers can create their own data security methods for the transaction data, in Germany, the SAFE group was founded (Software Alliance For E-mobility) [9]. This group has developed dedicated means to protect the end-user and to fulfil the security requirements. This concerns the Open Charge Metering Format protocol (OCMF) [10], which manufacturers can use to implement in their charging systems, as well as dedicated transparency software, which end users can use to confirm their invoices by checking the validity of the digitally signed data formats, coming from the EV Charging System used.

In the conformity assessment procedure of an EV Charging System, the whole data chain is included. This starts with the measurement of the electricity meter through presentation on a local client display, as well as the generation of the data string. This continues up to and including the presentation of the transaction data to the end user (with checking possibilities via the transparency software).

In Germany, the association VDE published in November 2020 a new document for EV Charging Systems, "Elektromobilität – Messsysteme für Ladeeinrichtungen"[11]. This product standard provides EV Charging Systems requirements and contains a dedicated Annex A for DC meters. This document might play an important role in upcoming tenders in the German market. It is also offered to CENELEC in order to discuss whether it can be used as a basis for a European standard, which is discussed within CENELEC TC13 WG03.

## INTERNATIONAL LEGISLATION: OIML GUIDE FOR EVSE

The International Organization of Legal Metrology (OIML) is a worldwide, intergovernmental organization whose primary aim is to harmonize the regulations and metrological controls applied by the national metrological services, or related organizations, of its Member States. OIML publishes International Recommendations, which are model regulations that establish the metrological characteristics required for certain measuring instruments and specify methods and equipment for checking their conformity. The Member States have an obligation to implement those recommendations into their national legislation.

As indicated in the NMi white paper "Standards for electricity meters in motion" [12], the OIML document R 46 "Active electrical energy meters" [13] is currently under revision by technical committee TC 12. The document will also be updated to cover reactive energy and include DC electricity meters.

TC12 also introduced a distinct subgroup — P3 — to focus on and draft the requirements for EV Charging Systems. Chaired by the Netherlands, subgroup P3 prepared the draft document with contributions provided by the USA, Canada, Germany, Australia, Japan, South Korea, Austria, Switzerland, Finland, and the Netherlands. This document was published in September 2022. The Guide can be used as a basis for legislation in the various Member States and can play an important role in harmonising requirements. In the interim, subgroup P3 continues to work on transforming the Guide into an official OIML Recommendation.

The Guide covers Charging Systems with separate electricity meters and integrated measuring parts. It contains all relevant influence and disturbance tests while considering the specific conditions and applications of EV Charging Systems.

Furthermore, providing the transaction data available to the end user can be done in various ways. The first has a local, physically integrated client interface visible outside the charger. The second has the charger provided with communication means to send out all necessary legally relevant data. This needs to be secured by state-of-the-art cryptographic means. Other fit-for-purpose technical means can then be used to make the data accessible to end users. Countries can choose whether to require a local physical client interface mandatory, whether the secured data output may suffice, or whether both items are required.

The Guide also addresses several other aspects, such as multiple tariffs, various accuracy classes, limits for energy losses, behaviour during power outages and vehicle-to-grid solutions. Apart from the requirements for the type-approval process, the requirements for initial and subsequent verifications are also listed.

## STANDARDISATION ACTIVITIES WITHIN IEC AND CENELEC

IEC TC 13 has published product standards for electricity meters for many years. In June 2020, TC 13 formally reviewed the well-known 62052 / 62053 series. These revised standards contain up-to-date requirements for modern meters for both residential and industrial applications.

In June 2021, IEC TC 13 published a new dedicated standard for DC meters 62053-41, intended to be applied in conjunction with the IEC 62052-11:2020 standard (see figure 1).

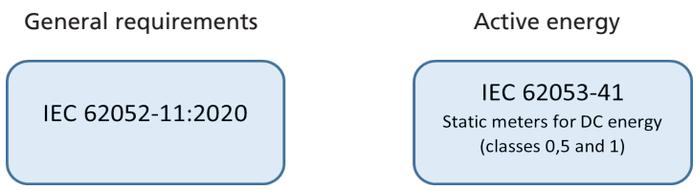


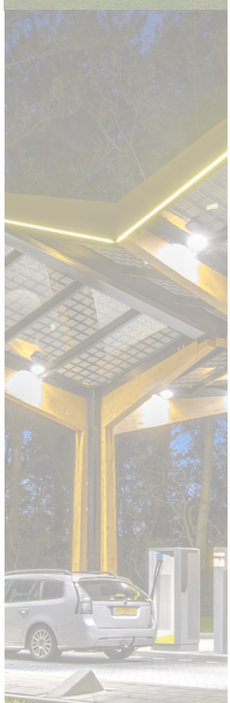

Figure 1: Applicable IEC standards for DC meters

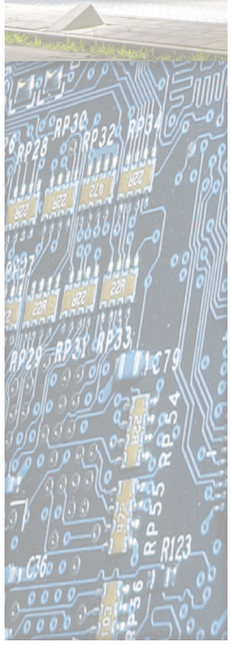
CENELEC TC 13 will publish the European version EN 62053-41. This will be an exact copy of the IEC 62053-41. CENELEC TC 13 also prepares a dedicated version EN 50470-4, proposed to be used as a harmonised standard under the MID.

In general, these new IEC and CENELEC DC standards, followed by the revised OIML R 46 covering DC requirements, are considered suitable candidates for assessing DC meters for use in billing applications.

Also important is the work being done by IEC TC 69, active in the field of electrical power/ energy transfer systems for electrically propelled road vehicles and industrial trucks. This committee has published a dedicated suite of standards.

IEC 61851-1 contains the general requirements for Electric vehicle conductive charging



systems, whereas the additional 61851-21-1 and -2 include specific EMC requirements. The 61851-23/24/25 describes specific requirements for DC charging systems, including digital communication with the car and DC EV supply equipment where protection relies on electrical separation. The 61851 is a harmonised European standard under the Low Voltage Directive 2014/35/EU.

## DC ELECTRICITY METERS UNDER THE MID

An interesting development is also going on around the use of the MID for DC electricity meters. The traditional view was that this Directive could not be used for these types of meters. As a matter of fact, Annex V was originally intended for AC electricity meters only. However, specifically initiated by the work of LegalEVcharge [14], several arguments are present to change this view. For instance, the MID describes meters for 'active electrical energy'. This does not exclude but includes DC electricity meters. Also, as laid down in Annex V, the instrument-specific requirements can be fulfilled for both types of meters.
The fact that via Mandate M/541, European standardisation committees were requested to create standards for DC meters for legal metrological applications is also a clear sign that the European Commission wants to apply the MID for the use of DC meters.

Recently the Certification Body of NMi, as one of the leading Notified Bodies for the MID, decided to issue MID approvals for DC meters. The use of the MID for these types of meters can be considered a breakthrough on a European level and for the use in EV Charging Systems.

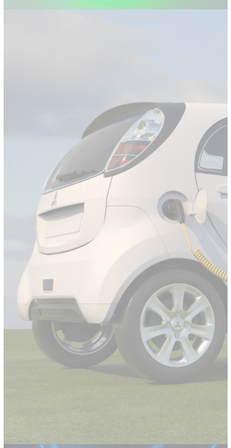
## LOOKING TO THE FUTURE

Europe has a significant political driver for the rollout of mature charging infrastructure for electric vehicles. However, in general, the requirements for legal metrology are unclear and not harmonised among the Member States. The application of the MID, in particular, can play an important role. However, in that case, the MID or its interpretation needs to be adapted, where areas relevant to EV charging should be clarified. Interpretation of the MID should give special attention to dedicated aspects of EV Charging Systems. This includes resetting energy registers, requirements for energy loss and recording measurement results by a durable means. It is positive that awareness of these aspects and the will to find solutions is growing in the responsible committees (OIML, WELMEC, measuring instruments committee).

Some countries have dedicated national requirements, covering the need for legislation locally. Other countries are also considering creating these. However, differences between member states must be limited as much as possible to avoid trade barriers and constrain competition. The OIML Guide for EV charging systems, created by OIML TC 12, is a sound basis for the international implementation of dedicated legislation. Also, the work of standardization committees, like the new standard IEC 62053-41 and the upcoming EN 50470-4, will assist in resolving the lack of requirements for DC meters.

It is expected that growing awareness of the need for harmonised requirements and legislation, together with the activities from various regulatory and standardization committees, will create a new situation with clear and harmonised requirements. This will be beneficial for manufacturers, regulatory bodies, test houses, Notified Bodies and moreover, it is very important for the EV user themselves!








## AUTHOR

Henri Schouten is a Senior Expert at NMi and member of several international committees for electricity meters, like OIML TC 12 (part of the secretariat of the subgroup p3 for EV Charging Systems), IEC / CENELEC TC 13 and WELMEC 11. He is also chairman of NEC 13. Furthermore, he is a member of the AdKBS committee and the AdKBS MuZE subgroup in Germany, as a delegate for NMi as Notified Body for the German metrological legislation.

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NMi is an internationally renowned Test House and Notified Body for all measuring instruments covered by the MID, including electricity meters. Furthermore, NMi is a Notified Body (Konformitätsbewertungsstelle) for the German metrological legislation for various measuring instruments related to electricity metering. NMi's ISO 17065 scope includes AC and DC chargers, and DC electricity meters. This includes all necessary legal German requirements, IEC standards for (DC) electricity meters, including the VDE document [11] for e-mobility.

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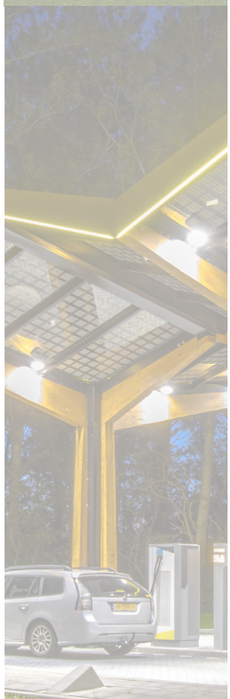

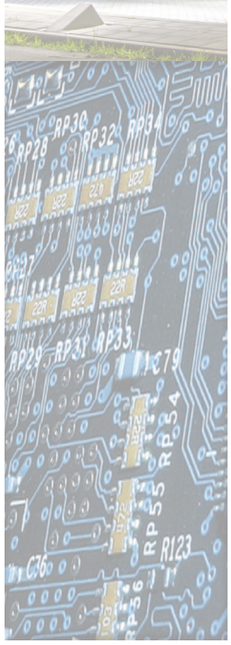

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