



Open and Interoperable Electric Vehicle Charging in Emerging Markets

How OCPP supports the adoption of electric mobility

Version 1.0 16-09-2026

Table of Contents

Part 1: Electric Vehicles in Emerging Markets	5
1. Electric vehicle market overview for emerging markets	6
2. Case study on electric vehicle charging interoperability: Kenya	12
Part 2: Using OCPP for EV Charging in Emerging Markets	16
3. Introduction to OCPP	17
4. Dealing with intermittent power and data communications	19
4.1. Offline behavior	19
4.2. Local authorization cache and local authorization list	19
4.3. Message queue control	20
4.4. Power outage	21
5. Reducing data communication costs	23
5.1. Data compression in WebSocket connection	23
5.2. Highly configurable settings for reporting meter values and heartbeats	24
5.3. Reconnection and retry behavior	25
6. Battery swapping	26
7. Mobile payments	28
7.1. Manual mobile-money payment	28
7.2. API-based mobile-money payment	28
7.3. Prepaid limits and stopping the transaction	29
7.4. Mobile payments during communication outages	29
8. Support for low-cost platforms	31
8.1. A "light" OCPP 2.0.1 implementation	31
8.2. Selecting a practical feature set	32
9. Deployment recommendations	34
9.1. Why OCPP 2.1 is preferred over OCPP 1.6	34
9.2. Deployment profile	36
10. Conclusion	37
References	38

OCA White Paper

Copyright © 2026 Open Charge Alliance. All rights reserved.

This document is made available under the **Creative Commons Attribution-NoDerivatives 4.0 International Public License** (<https://creativecommons.org/licenses/by-nd/4.0/legalcode>).

The designations employed and the presentation of material in this report do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The term “country” as used in this material also refers, as appropriate, to territories or areas.

The boundaries and names shown and the designations used on the maps on this site do not imply official endorsement or acceptance by the United Nations.

Boundaries, names and designations may change over time.

The above references to specific territories, areas or boundaries are not exhaustive and are provided for illustrative purposes only.

Where the designations “economy” or “country or area” appear in texts or tables, they cover regions, countries, territories, cities or areas.

The designations “developing” and “developed” are intended for statistical convenience and do not necessarily express a judgement about the stage reached by a particular country or area in the development process.

We gratefully acknowledge the contribution from:



About OCA

The Open Charge Alliance (OCA) is a non-profit organisation founded in 2014. With members from all over the world, we focus on open standards and advancing the development of sustainable charging solutions. Please visit www.openchargealliance.org for more information.

About UNEP

The United Nations Environment Programme (UNEP) Global Electric Mobility Programme has contributed this report with the support of Global Environment Facility (GEF).

About GIZ

The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH works worldwide for a future worth living. Together with our partners, we create opportunities and sustainably improve people's lives. Through our networks, we turn international agendas into action – with a global vision and local impact.

Abbreviations

BSS	Battery Swap Station
CPO	Charge Point Operator, also known as Charging Station Operator (CSO)
CS	Charging Station
CSMS	Charging Station Management System. The CPO back-office system to which charging stations connect.
EMSP	e-Mobility Service Provider, also known as Card Provider or Mobility Operator
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment. The part of the charging station that supplies energy to the EV.
LEV	Light Electric Vehicle, such as an electric two- or three-wheeler
OCPP	Open Charge Point Protocol
OCPI	Open Charge Point Interface
RFID	Radio-Frequency Identification
TLS	Transport Layer Security

Management summary

Electric vehicle (EV) sales have reached record levels in 2025, and substantial growth has been observed beyond the traditional large vehicle markets, such as the European Union, the United States and China (IEA, 2026). Several emerging markets, including Nepal, Ethiopia, Costa Rica and Jordan, have achieved electric car sales shares of more than 10%, putting them on a par with advanced markets. Sustaining this rapid growth will require sufficient charging infrastructure designed for local operating conditions. In emerging markets, mobile data coverage may be intermittent, electricity grids may have different operating conditions, electricity markets may be less dynamic, and data communication costs may be significant. Vehicle fleets may also be dominated by two- and three-wheelers and small buses rather than passenger cars and heavier vehicles. At the same time, charging equipment often needs to use cost-efficient hardware and support locally prevalent payment methods. Effective charging communication infrastructure must account for all these conditions. Kenya is included as a case study where electric mobility is taking off supported by policies, where utilities and private companies are exploring to embed OCPP within their operating systems while tackling various hurdles.

The Open Charge Point Protocol (OCPP) is an open, generic communication protocol between a charging station and its Charging Station Management System (CSMS). It is internationally standardized as IEC 63584 by the International Electrotechnical Commission (IEC) and is not specific to any country or vehicle type. This flexibility makes OCPP particularly relevant to the operating conditions found in emerging markets. OCPP includes several existing and developing capabilities that make it particularly useful under these conditions:

- Charging can continue during a temporary loss of communication with the CSMS.
- Transaction-related information can be stored and sent after the connection is restored.
- Authorization caches and local authorization lists can allow known users to start charging while the station is offline.
- Reporting intervals and the amount of operational data can be configured to reduce data usage.
- OCPP 2.1 can resume transactions after a forced reboot and provides explicit support for battery swap stations.
- OCPP can be implemented on resource-constrained microcontrollers by selecting only the required functionality and carefully managing memory use.
- Mobile-first payment systems can be integrated at the CSMS level while OCPP remains the standardized interface used to control the charging station.
- OCPP can be combined with roaming protocols such as OCPI when networks grow beyond a single operator or service provider.

The main lesson is that a charging network for an emerging market should be designed according to local operating conditions, market characteristics and user needs, rather than replicating models developed for different contexts. The local availability of power, electricity market characteristics, mobile data, payment services, vehicle types and service personnel should determine the deployment profile. OCPP provides the building blocks to implement such a profile without giving up

interoperability.

Part 1: Electric Vehicles in Emerging Markets

Chapter 1. Electric vehicle market overview for emerging markets

This chapter covers a short global electric vehicle market overview for emerging countries, which includes vehicle deployment, charging infrastructure deployment, electric vehicle policies (focused on standard & regulations), electricity market maturity, and payment systems. Emerging countries that are assessed in this report are based on the World Bank definition of low- and middle-income countries.

[World Bank, 2026]

Electric vehicle (EV) sales have reached record levels in 2025, and substantial growth has been observed beyond the traditional large vehicle markets (the European Union, the United States and China) [IEA, 2026]. More than 10 emerging countries across all continents have already reached more than 10% market share for new electric car sales, which is similar to established EV markets (Figure 1). For most emerging countries, this has been a big leap since 2020, where nearly all of them had less than 3% electric car sales. In absolute terms, electric car sales have already reached 2 million outside the major car markets in 2025. This rapid growth requires significant deployment of charging infrastructure for these EV markets to function properly.

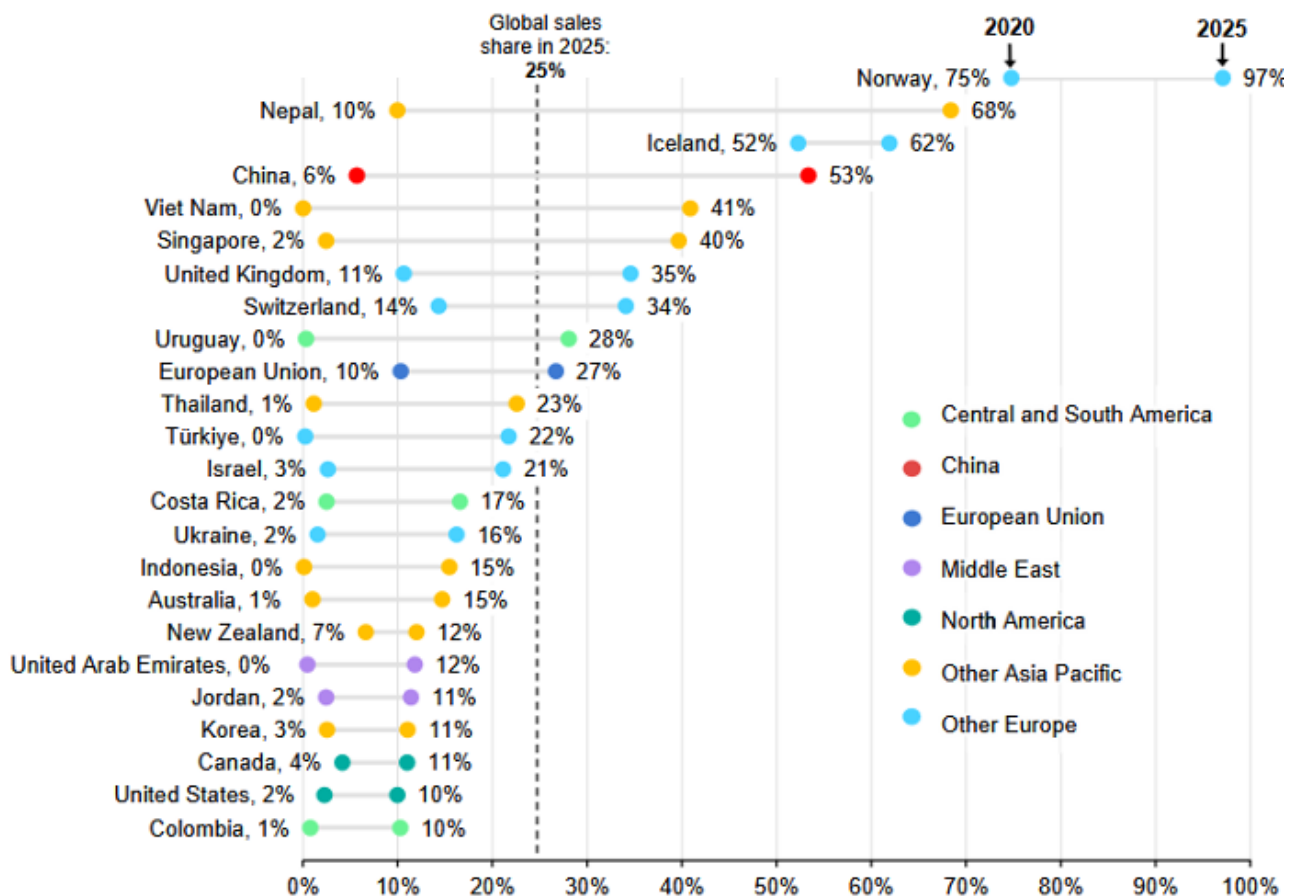


Figure 1. Electric car sales share in selected countries and regions where the share exceeds 10%, 2020-2025.

Source: IEA, 2026

Beyond cars, electric 2- and 3-wheelers have been a success story across emerging countries, such as India, Indonesia and Viet Nam. By 2025, around 10% of the global fleet is already electric and 15% of

new sales were electric as well [\[IEA, 2026\]](#). Various countries across Africa and Asia experience rapid growth of electric two-wheelers, where multiple types of charging solutions are being rolled out, including stationary charging and battery swapping. There is limited information available about the application of OCPP to 2- and 3-wheeler charging or battery swapping infrastructure.

Heavy-duty vehicles, including trucks and buses have become much increasingly common across the globe, as sales of electric buses and trucks reached around 10% in 2025 [\[IEA, 2026\]](#). Electric bus deployment has also expanded in emerging countries, whereas electric truck sales remain mostly concentrated in China and the European Union. Electric trucks have different charging solutions available, such as battery swapping, which mostly comes from China [\[ICCT, 2026\]](#). Some countries, such as Thailand have implemented demonstrations to check on feasibility of these solutions [\[Electrify, 2026\]](#). Consequently, experience with heavy-duty charging infrastructure deployment remains relatively recent in many countries, including the use of OCPP.

Charging infrastructure deployment data are less widely available in emerging countries than EV registration data. Available evidence shows that the number of electric vehicles per charger varies widely in both emerging and established EV markets (Figure 2). Most emerging countries with available data have expanded their charging networks rapidly, although charging infrastructure has often grown more slowly than the electric vehicle stock. This gap has been observed in Brazil and India [\[IEA, 2026\]](#), while Malaysia has more closely aligned charging infrastructure growth with EV sales growth. Data for Africa are particularly limited outside South Africa and Kenya, partly because EV deployment remains lower than in other regions. Limited access to funding and capital may also constrain equipment budgets, leading operators to procure lower-cost chargers with less technical functionality and capacity than those commonly deployed in established EV markets.

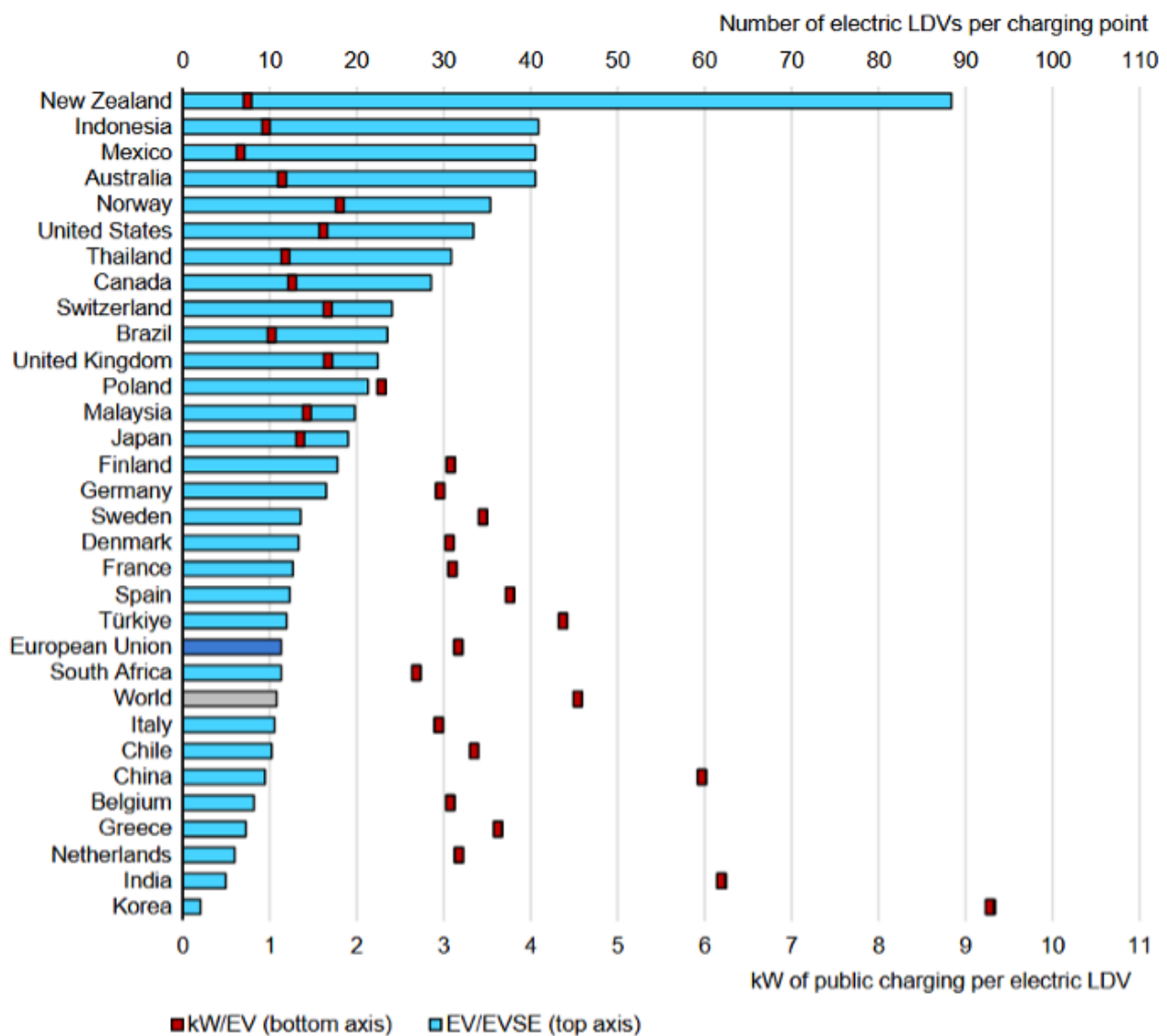


Figure 2. Number of electric light-duty vehicles per public charging point and kilowatt per electric light-duty vehicle, 2025. Source: [IEA, 2026]

Governments in emerging countries have played an important role in supporting the growth of their EV markets, with electric vehicle policies serving as a key component in the transition towards developed EV ecosystems. In 2018, fewer than 20 countries had specific electric vehicle policies in place. By 2026, the situation had reversed: fewer than 20 countries had no electric vehicle policies, meaning that more than 80% of emerging countries had adopted such policies (UNEP, not published). Nevertheless, a developed electric vehicle market requires a broad and coordinated policy framework. Charging infrastructure needs dedicated policies covering deployment strategies, standards and regulations, and incentives. Communication protocols may be established through standards and regulations, required as a condition for receiving incentives, or mandated in deployment tenders. In addition to being comprehensive, policies should be introduced in an appropriate sequence and updated as the market matures [ICCT, 2025].

By mid-2026, around 40 emerging countries—approximately one-third—had developed or were developing dedicated charging infrastructure regulations (UNEP, not published). The scope and quality of these regulations vary considerably between countries. Most do not explicitly identify specific

technical standards; instead, they describe a general need for standards covering particular components of the EV charging ecosystem. OCPP is explicitly mentioned or mandated in only a handful of regulations. However, these countries span Latin America, Africa and Asia, demonstrating OCPP's broad geographic reach and providing practical experience that can help identify implementation challenges and opportunities. Existing regulations also indicate potential interest among other countries in adopting OCPP as their standards and regulations become more specific. In addition, download statistics from the OCA website show that stakeholders in more than 133 countries have explored or expressed interest in learning about or applying OCPP.

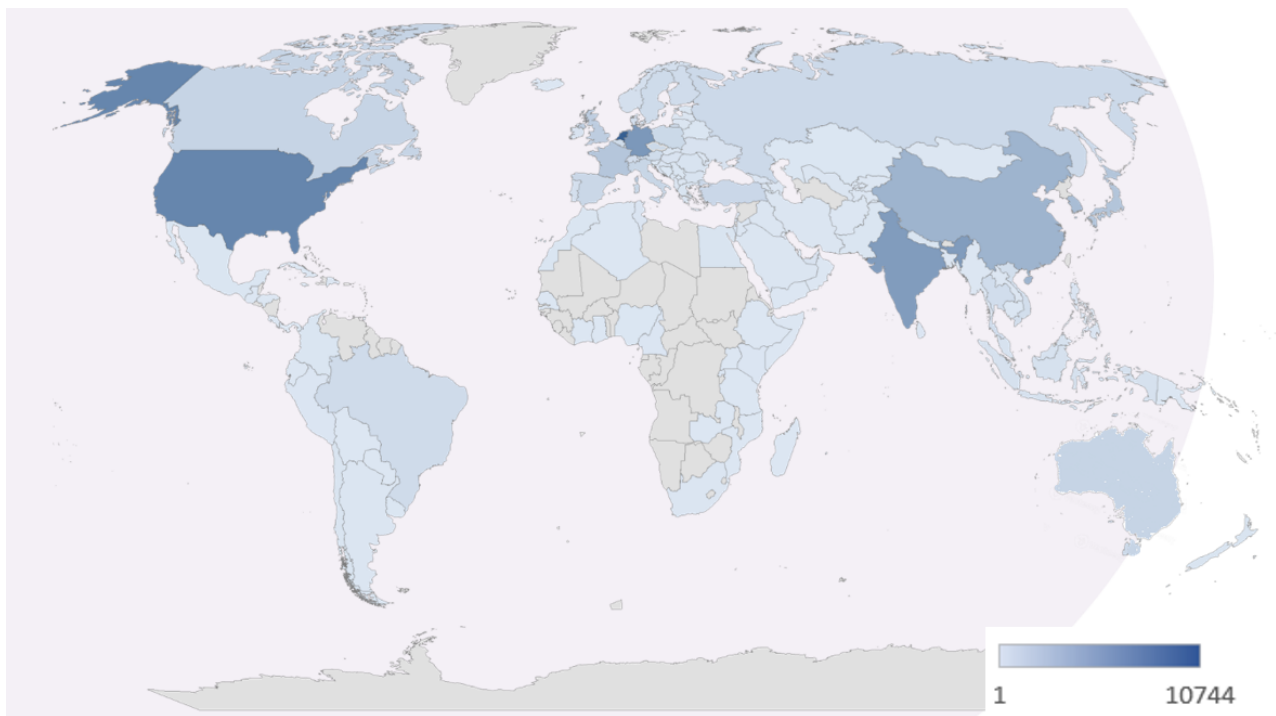


Figure 3. Overview of OCPP downloads across the world, 2024-2026

The electricity grid is another key consideration when developing charging infrastructure networks and their underlying communication systems. Grid reliability is an important indicator of electricity-system maturity. Emerging countries generally experience lower grid reliability than developed countries, as illustrated by the share of firms reporting electrical outages in 2025 (Figure 4). Charging infrastructure in emerging countries may therefore be exposed to more frequent power-supply disruptions. More advanced electricity grids may also offer technical capabilities that require charging infrastructure to support more dynamic forms of participation (for example ancillary services).

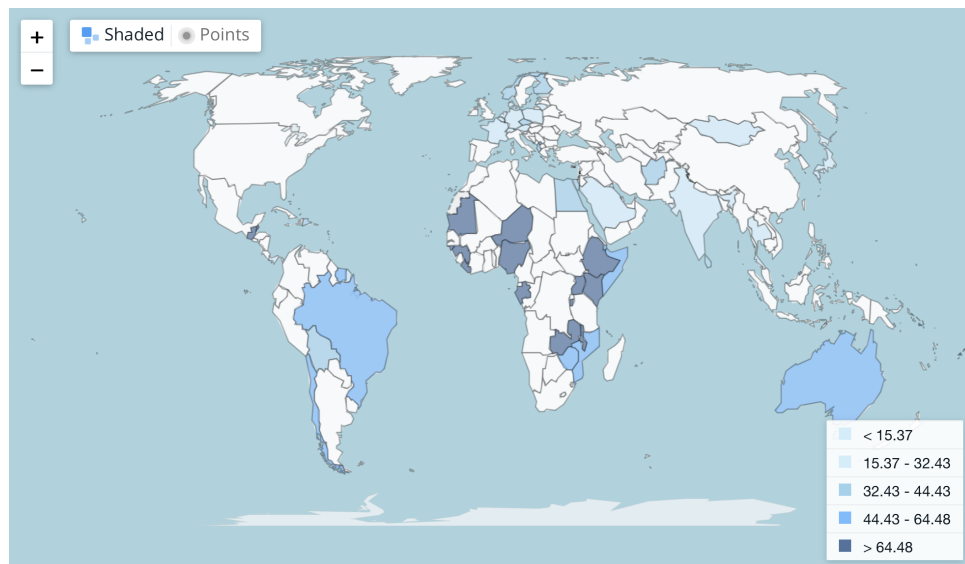


Figure 4. Firms experiencing electrical outages in selected countries (% of firms). Source: [World Bank, 2025]

Alongside differences in electricity systems, payment systems vary between emerging and developed countries and among emerging countries themselves. Mobile money is particularly widespread in Africa, Latin America and the Caribbean, where services such as M-PESA operate (see Figure 5) and around 40% of adults have a mobile money account [MEF, 2025]. Other countries have developed widely used domestic digital payment systems, including Pix in Brazil and UPI in India [PCMI, 2026]. These systems offer distinct functions that could be integrated into the charging infrastructure ecosystem.

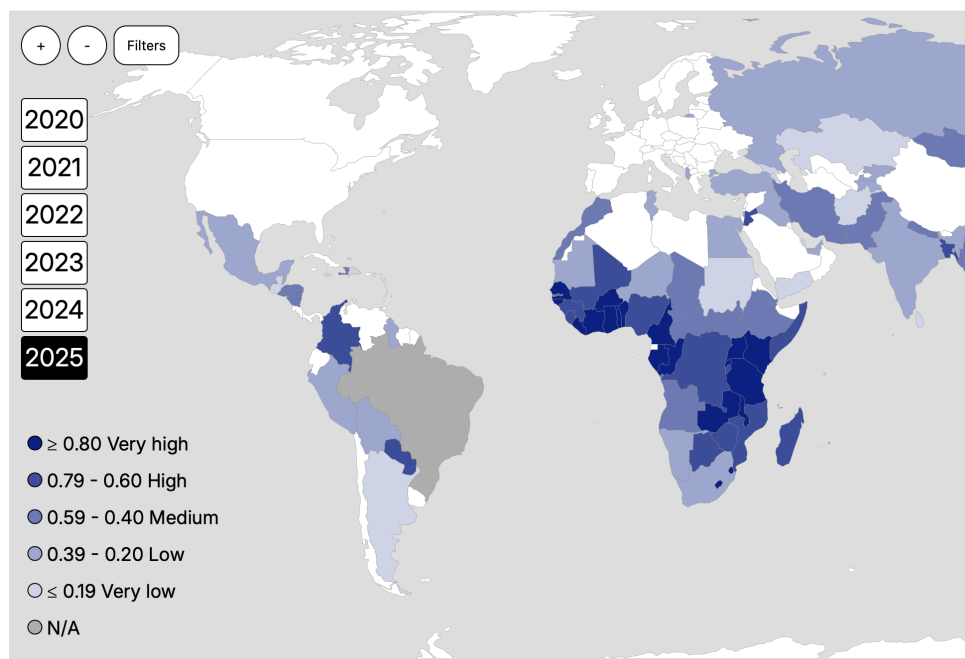


Figure 5. Prevalence index of mobile money systems in 2025. Source: [GSMA, 2025].

Furthermore, data and communication costs are relatively higher in most emerging countries than in developed countries [Data Explained]. More efficient data transfer can therefore support the wider deployment of OCPP. Data costs are particularly high in Sub-Saharan Africa and Small Island Developing

States. Internet and mobile coverage also differ substantially between emerging and developed countries. 5G coverage remains uneven across countries and regions [GSMA, 2026]. Significant connectivity gaps remain between urban and rural areas, with important implications for charging networks [ITU, 2025]. Developed countries have more than one active subscription per person, whereas emerging countries have between 44 and 77 subscriptions, see Figure 6.

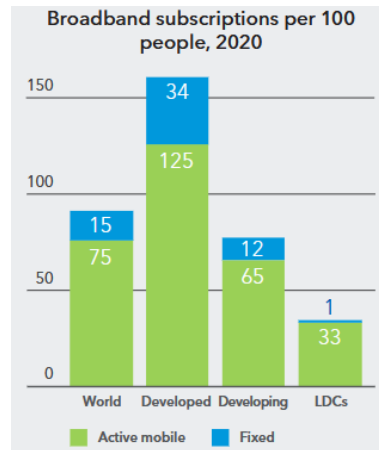


Figure 6. Broadband penetration in 2020. Source: UN, 2021

Based on the above observations, various topics have been identified where parts of the electric mobility ecosystem are different between emerging countries and developed countries.

Chapter 2. Case study on electric vehicle charging interoperability: Kenya

Over the past three years, Kenya has developed supportive policy and regulatory frameworks for electric vehicle charging infrastructure. Key measures include the Electric vehicle charging and battery swapping infrastructure guidelines issued in 2023 [EPRA, 2023]; development of electric vehicle charging standards in 2024; and the Electric Mobility policy in 2026 [Ministry of Roads and Transport, 2026]. These frameworks establish a foundation for the deployment and development of charging infrastructure in Kenya. They provide guidance on technical specifications of charging equipment, installation procedure and the selection of suitable locations for charger deployment. The 2023 guideline document has a separate section on EV charging infrastructure communication, which does not mandate a specific standard. It does mention several functional requirements, such as remaining functional if communication with the charging network is temporarily disrupted.

Developing such frameworks is particularly important as Kenya advances its electric mobility ecosystem and charging infrastructure network. At this early stage, the country can establish common technical and regulatory requirements that embed interoperability and prevent fragmentation across proprietary technologies. Open communication protocols such as the Open Charge Point Protocol (OCPP) can complement these requirements by enabling communication between charging points and charging point management systems, regardless of equipment manufacturer. This approach can support a more flexible, scalable and competitive charging ecosystem.

The Kenya Bureau of Standards developed a series of electric vehicle charging standards covering conductive charging systems, specifications for plugs, socket outlets, vehicle connectors and safety standards. The standards are based on the International Electrotechnical Commission (IEC) standards, IEC 62196 and 61851 series. The IEC 61851 establishes safety requirements and supports compatibility between electric vehicles and charging stations. However, none of the Kenyan electric vehicle charging standards address charger to CSMS communication, such as the Open Charge Point Protocol (OCPP).

Kenya's charging ecosystem has been shaped from both the private sector and electric utilities. Because the market remains at an early stage, the country has an opportunity to incorporate interoperability in charging infrastructure before proprietary systems become deeply embedded. In this context, the Open Charge Point Protocol (OCPP) would play an important role in enabling communication between charging stations central management systems, regardless of the equipment manufacturer or charging network operator.

Kenya's public charging infrastructure ecosystem has been developed by the private sector led and is concentrated in urban areas such as malls, fuel stations and corporate parks. The number of public charging stations remains small, with an estimated 76 public charging stations [GIZ, 2026]. The deployment consists of AC and DC chargers, alongside private and home charging stations used by some vehicle owners. Significant deployment gaps remain in rural areas and along major highways, particularly for fast DC chargers along major highways. Below is a table highlighting the existing number of chargers installed by different Charge Point Operators (CPO) and their type. From Table 1, a significant share of the public chargers have been deployed by the private sector with the utilities

(KenGen and Kenya Power) also contributing to the share.

Table 1. CPOs with number of chargers installed and their type [GIZ, 2026]

CPO	Number of Chargers	AC	DC
Knights Energy	41	21	20
EV Chaja	10	9	1
Ecotrify	8	8	-
Kenya Power	7	6	1
KenGen	3	3	-
ChargeNet	1	1	-
SupaChaja	5	5	-
UTU	7	7	-
Total	82	60	22

Kenya Power plans to install 45 electric vehicle charging stations across six counties in Kenya. These plans extend beyond Nairobi to other counties such as Nyeri, Kisumu, Uasin Gishu, Nakuru, Mombasa and Taita Taveta [KPLC, 2025]. As both an electric utility and a charging infrastructure provider, Kenya Power is well positioned to promote open and interoperable charging, and support its adoption across Kenya's growing charging ecosystem.

As Kenya Power expands its charging infrastructure across multiple counties, adopting open communication protocols such as OCPP can enable charging points from different manufacturers to communicate seamlessly with compatible management systems. This flexibility supports the integration of charging equipment, reduces vendor lock-in, and facilitates the future expansion of charging networks. In 2025, Kenya Power has launched a tender for development support for their CSMS [Kenya Tenders 2025], where progress is made to embed OCPP.

Several other East African CPOs are testing the implementation of OCPP, where they indicate challenges related to errors during power outages, as well as harmonization between equipment. Kenya is also home to various operators of battery swapping systems for 2- and 3-wheelers, such as Spiro, Ampersand, Roam, Arc Ride etc. There is limited information available whether OCPP has been adopted by these operators.

A geographically distributed charging network requires effective remote monitoring, management, billing, fault management and data exchange. OCPP can be the interoperability layer between charge points and the central management system (CSMS) for such networks, enabling compatible back-end systems to manage equipment regardless of the charge point operator or manufacturer.

For emerging markets such as Kenya the early stage of charging-network development presents an opportunity to embed OCPP and other interoperability requirements into public procurement, utility charging projects and future charging-station regulations. Establishing these requirements now is more effective than retrofitting interoperability into proprietary systems after they have been deployed.

Key lessons from Kenya

- Electric utilities can accelerate early infrastructure development by leveraging their technical capacities, customer confidence and electricity networks.
- Embedding interoperability requirements and open communication protocols at an early stage can prevent vendor lock-in, strengthen investor confidence and promote large-scale deployments.
- Interoperability should cover both physical and digital systems, including connectors, communication protocols, authentication, payment, billing, roaming and data exchange.
- Charging infrastructure should be planned at network level rather than isolated private installations to support interoperability.
- Capacity building and technical training of stakeholders in the sector can help to incorporate best practices when adopting communication protocols suitable for local market conditions.

Part 2: Using OCPP for EV Charging in Emerging Markets

Chapter 3. Introduction to OCPP



OCPP, or Open Charge Point Protocol, describes the information exchange between a charging station and a charging station management system.

OCPP describes, for example, how to authorize, start and stop a charging session, how to manage the energy flow (smart and bidirectional charging) and how to monitor the status and health of the charging station.

OCPP started in the Netherlands in 2009 and has been developed by the industry over the past 15 years, following the need of the growing EV Charging sector and incorporating field experience. OCPP is published as the International standard IEC [63584](#), and is used around the world in 129 countries.

OCPP is an open protocol for unrestricted use by any interested party with no requirement for licensing, payment, or registration

Figure 7. OCPP explainer

The Open Charge Point Protocol (OCPP) is a communication protocol for exchanging information between electric vehicle charging stations and a Charging Station Management System (CSMS). It supports, among other things, authorization, charging transactions, monitoring, remote control, firmware management and smart charging. [\[OCPP 2.1\]](#)

OCPP is used in many different types of charging infrastructure. A small AC charging station, a high-power public charger and a battery swap station may have very different hardware and operating models, but they can all benefit from a standardized interface to a management system. This separation between the charging equipment and the back-office system makes it possible to select equipment from different vendors, replace a CSMS and add new services without redesigning the complete charging network.

OCPP has been updated several times since its inception in 2009. Various requirements have been added to deal with different types of use cases. Emerging countries and developing charging markets do not form a homogeneous group. Conditions differ between regions, countries, cities and even individual charging locations. The next priority is to ensure that use cases from emerging countries are already present or will be incorporated in the next version of OCPP. Identifying these use cases has been approached in several steps:

- Open Charge Alliance meetings, where the industry shares their experience and learnings
- Desk research
- Online interviews
- Regional visits

Based on the collected input, several recurring deployment challenges have been identified:

- Mobile data communication may be intermittent or expensive.
- Power outages and forced restarts may occur more frequently.

- Deployment of two- or three-wheelers with small batteries or swappable battery cartridges.
- Charging stations may need to use low-cost, resource-constrained hardware.
- Mobile money can be more accessible than payment cards or dedicated charging subscriptions.
- Charging networks may initially operate as isolated systems but later require roaming and interoperability.

OCPP does not remove these constraints. A communication protocol cannot prevent a power failure or create a mobile data connection where no network is available. It can, however, define predictable behavior when these situations occur. This is important because poor connectivity should not automatically mean that a driver cannot charge, and a temporary outage should not cause transaction information to be lost.

This paper explains how existing OCPP mechanisms can be used to design charging infrastructure for these conditions. It focuses on operational robustness and cost-conscious implementation. The exact configuration must always be selected by the operator based on the local use case and the financial and operational risks that the operator is prepared to accept.



Why open standards matter: Using an open standard for charging infrastructure allows buyers and investors the freedom to select the vendors of their choice for equipment and services, now and in future. It enables an open and competitive market, for domestic players as well as international suppliers and keeps the market open for new players to enter the charging industry at a later stage. It keeps the option open to migrate charging stations to another network — in case of market exit or contract termination and as such prevents stranded assets. Using an open standard establishes a minimum set of guaranteed functionalities and available data in Charging Infrastructure for all stakeholders such as regulators and other data consumers. And by selecting an open standard, emerging countries can participate in shaping the future of the standard, making sure their voices will be heard and their needs are included in future developments.

Chapter 4. Dealing with intermittent power and data communications

4.1. Offline behavior

OCPP was designed to allow useful operation during temporary interruptions of the connection between the charging station and the CSMS. An ongoing transaction does not need to stop only because the data connection is lost. The charging station can continue the transaction locally and store transaction-related messages until communication is restored.

Once the station reconnects, the stored transaction information is sent to the CSMS. This allows the CSMS to reconstruct what happened while the station was offline and, for example, process the energy consumption for billing and reporting.

This behavior is especially valuable when a charging station uses a mobile connection in an area with variable coverage. A short network interruption becomes primarily a management issue rather than a customer-facing charging failure.

The charging station should be designed with enough persistent storage for the expected offline period (case dependent). The required capacity depends on the number of EVSEs, the number of transactions, the reporting interval and the amount of meter data that is stored. A DC charger that sends meter value updates every 30 seconds will fill offline storage much faster than an AC charger that typically only sends meter updates every 5 minutes.



Offline operation does not mean that every OCPP function remains available. Commands that must originate from the CSMS, such as a remote start request, cannot reach a charging station that has no connection. A deployment should therefore distinguish between functions that must remain locally available and functions that can wait until communication is restored.

4.2. Local authorization cache and local authorization list

Continuing an existing transaction while offline is relatively straightforward. Starting a new transaction is more complicated because the charging station may normally ask the CSMS whether a user is authorized.

OCPP provides two mechanisms that can reduce this dependency on a live connection when RFID card readers are used to identify a user:

Authorization cache

The charging station stores recent authorization results. When the same identifier (card) is presented while the station is offline, the station can use the cached result. This is useful at locations with repeat users, such as workplaces, depots, residential sites and fleet charging locations.

Local authorization list

The CSMS provides the charging station with a list of identifiers (cards) that may be accepted locally. The list can be maintained centrally and synchronized with the charging station. This is useful when a defined group of users must be able to charge even during a longer communication outage.

The two mechanisms serve different purposes. A cache learns from recent successful use, while a local authorization list is deliberately managed by the operator. They can also be combined.

The operator should configure the validity and size of local authorization information with care. A very long cache lifetime increases availability but also increases the chance that a credential that has been revoked centrally is still accepted offline. A very large local list requires more storage and synchronization. The correct balance depends on the location and use case.

OCPP also supports configurations in which an unknown identifier (card) may be accepted while the charging station is offline. This maximizes availability, but it creates a clear financial risk: after the connection is restored, the CSMS may discover that the user cannot be billed. Such a configuration can be reasonable for a free charging service or a controlled fleet environment, but it should not be enabled for a commercial public network without an explicit risk decision.

For networks with intermittent connectivity, the following questions should therefore be answered during deployment design:

- Which users must be able to start a transaction while the station is offline?
- Is an authorization cache sufficient, or is a managed local authorization list required?
- How quickly must credentials that have been revoked stop working at offline stations?
- Is the operator willing to accept transactions from unknown users while offline?
- How much persistent storage is available for authorization data and queued transaction information?



The described mechanisms do not apply when user authorization depends on mobile payments, because that requires the management system to remotely start a transaction on the charging station once payment has been approved, but that will not work if the charging station is offline.

4.3. Message queue control

When a charging station remains offline for an extended period, the number of messages waiting to be sent can become significant. It is therefore important to distinguish between information that is essential and information that is merely useful.

Transaction start and end information, identifiers, timestamps and the meter information needed for billing have a high value and must be queued. Routine monitoring information has a lower value and is

not stored. If storage is limited, the charging station may remove intermediate meter values that are not essential to reconstruct the transaction.

A practical implementation can use a persistent pending-message queue. Transaction events are added to this queue and retried after communication is restored. The queue implementation can also apply a removal policy when storage becomes full. For example, intermediate meter values can be removed before the first and last meter values of a transaction are removed.

The OCPP 2.Lite application note [\[OCA OCPP-Lite, 2025\]](#) mentions this separation between the transaction state machine and a pending-message queue as a useful implementation pattern. It also describes compression and other compact storage methods that can reduce the memory required for queued messages. This approach can also be used for OCPP 1.6 and 2.x implementations.

After reconnection, the station should avoid creating a new communication problem by immediately sending a very large backlog without control. In OCPP 1.6 the queue needs to be emptied in chronological order — oldest messages first. In OCPP 2.x this is no longer the case. A transaction event for a newly started transaction can be sent first without having to wait for the queue to empty, and start and end events of transactions, which are needed for billing, can be sent first while intermediate meter values updates are sent later.

4.4. Power outage

A loss of data communication and a loss of power are different events. During a communication outage, the charging station can remain operational and retain its active transaction state in memory. During a power outage, the station itself may stop operating.

A robust charging station should therefore persist enough transaction state to recover after a restart. At a minimum, this includes the information needed to determine that a transaction was active and to report the correct transaction state and meter values after the station comes back online. In case of a power outage an ongoing charging transaction is interrupted. At a minimum the transaction must be reported to CSMS as stopped when the power is restored. Stations exist that have a small battery for a "last gasp" that allows them to send an error message about the power loss, before going down.

OCPP 2.1 extends transaction handling with the possibility to resume a transaction after a forced reboot. This is useful in locations where brief outages or unstable local power would otherwise cause unnecessary transaction termination. The charging station determines, based on its configuration and the situation after restart, whether the previous transaction can safely be continued. For longer outages, the preferred result may be to close the previous transaction cleanly and start a new one when the driver reconnects or reauthorizes. The deployment policy should define the maximum interruption that may be treated as a continuation of the same customer transaction.

How OCPP supports charging stations during communication loss and power interruptions

1. Offline behavior



- Ongoing transactions do not need to stop when the CSMS connection is lost.
- Stored data allows billing, reporting, and reconstruction of offline activity.
- Especially useful for stations using mobile networks with variable coverage.
- Storage sizing depends on: number of EVSEs, number of transactions, reporting interval, and amount of meter data stored.

**Important:**

Offline does not mean every OCPP function remains available. CSMS-initiated actions such as remote start cannot reach an offline station.

2. Starting transactions while offline

**Authorization cache**

- Stores recent authorization results.
- Can accept the same identifier while offline.
- Best for repeat users.



Typical sites: workplaces, depots, residential sites, fleet charging.

**Local authorization list**

- Operator-managed list synchronized from the CSMS.
- Allows a defined group of users to charge during longer outages.
- Best when offline access must be planned in advance.

**Trade-offs:**

- Longer cache lifetime = higher availability, but slower revocation.
- Larger local list = more storage and synchronization.
- Accepting unknown users offline maximizes availability, but creates billing risk.



Cache = learned from recent successful use. Local list = deliberately managed by the operator. They can be combined.

3. Message queue control

Queue what matters most**High-value data (prioritize)**

- ✓ Transaction start and end
- ✓ User identifiers
- ✓ Timestamps
- ✓ Meter values needed for billing

**Lower-value data (can be discarded first)**

- Routine monitoring information
- Non-essential intermediate meter values



- Use a persistent pending-message queue.
- If storage becomes full, remove lower-value data first.
- Keep first and last meter values before removing intermediate values.
- After reconnection, send the backlog in a controlled way.
- Prioritize critical transaction data; delay or discard less important data when allowed.



OCPP 2.Lite recommends separating the transaction state machine from the pending-message queue, and using compact storage or compression.

4. Power outage

A communication outage and a power outage are different events.**A. Communication outage**

- Station stays powered.
- Active transaction can continue locally.

**B. Power outage**

- Station may shut down.
- Charging transaction is interrupted.



After restart, the station should recover enough persisted transaction state to report the correct status and meter values.



Minimum requirement: when power is restored, the interrupted transaction must be reported to the CSMS as stopped.



OCPP 2.1 can support transaction resume after a forced reboot.



Resume only if it is safe and consistent with configuration, physical connection state, metering, and operator business rules.



For longer outages, the better policy may be to close the old transaction and start a new one after reconnect or reauthorization.

**Deployment checklist**

1

Which users must be able to start a transaction while offline?



2

Is an authorization cache sufficient, or is a local authorization list required?



3

How quickly must revoked credentials stop working at offline stations?



4

Is the operator willing to accept transactions from unknown users while offline?



5

How much persistent storage is available for authorization data and queued transaction information?



Figure 8. Infographic: Dealing with intermittent power and data communications

Chapter 5. Reducing data communication costs

In some markets, the cost of mobile data is a relevant part of the operating cost of a charging station. Data usage can be reduced without giving up the information needed to operate the network.

The largest savings usually come from configuration. Sending less unnecessary data is more effective than trying to optimize every individual OCPP message. Message definitions have not changed between OCPP 2.0.1 and OCPP 2.1 to ensure backward compatibility.

5.1. Data compression in WebSocket connection

OCPP messages are commonly encoded in a data format called JSON. These messages are exchanged over a WebSocket, which provides a persistent, bidirectional connection between the charging station and the CSMS. Unlike traditional HTTP request-response communication, the WebSocket connection remains open, allowing both the charging station and the CSMS to send messages to each other at any time. This means that the CSMS does not have to wait for the charging station to contact it before it can send a command; both sides can communicate whenever necessary.

Example of an OCPP TransactionEvent message in JSON format

```
[2, "9f90c843-f825-43d4-8f0e-feaec8ecfc4b", "TransactionEvent", {
  "eventType": "Started", "evse": {"connectorId": 1, "id": 1},
  "offline": false, "seqNo": 0, "timestamp": "2023-06-06T15:33:28Z",
  "transactionInfo": {
    "chargingState": "Idle", "remoteStartId": 1,
    "transactionId": "47ce3090-5760-4dde-a2de-882a9112eb13",
    "triggerReason": "RemoteStart",
    "idToken": {"idToken": "1234ABCD", "type": "ISO14443"},
    "meterValue": [{
      "sampledValue": [
        {"context": "Transaction.Begin",
"measurand": "Energy.Active.Import.Register",
"phase": "L1", "unitOfMeasure": {"multiplier": 1,
"unit": "Wh"}, "value": 0}
      ],
      "timestamp": "2023-06-06T15:33:28Z"
    }]
  }
}]
```

WebSockets can use compression to reduce the number of bytes to send. WebSocket compression can be negotiated using the per-message compression mechanism defined in the internet standard RFC 7692. JSON contains repeated field names and other text that generally compresses well, so compression can reduce the number of bytes sent over the mobile network. See [\[OCPP 2.1 Part 4 JSON over WebSockets\]](#) and [\[RFC 7692\]](#)

Compression is negotiated between the charging station and the CSMS. Both sides must support it, and the implementation should verify that the reduction in data usage justifies the additional processing

and memory required on the charging station.

Compression does not replace transport security. Compression operates on the application data exchanged through the WebSocket connection. Security is created by adding TLS to protect the communication channel. OCPP security profile 2 adds TLS with server certificates; security profile 3 adds TLS with client and server certificates.

Note that compression requires a bit of extra memory. Some resource-constrained devices might not be able to support it due to a lack of RAM memory.

5.2. Highly configurable settings for reporting meter values and heartbeats

The amount of OCPP traffic generated by a charging station depends strongly on its configuration. OCPP allows the CSMS to configure which meter values are reported and how frequently they are sent. A station that sends multiple measurands every few seconds will use much more data than a station that reports only the values needed by the operator at a longer interval.

A cost-conscious deployment should decide which information is actually required for:

- billing;
- customer information;
- operational monitoring;
- energy management; and
- diagnostics.

Not every measurement needs to be sent during every transaction. For a simple low-power charging service, start and end meter values plus occasional progress information may be sufficient. A high-power charging hub or a site participating in active energy management may need more frequent reporting.

The same principle applies to heartbeat and WebSocket ping intervals. These mechanisms are important because the CSMS must be able to distinguish between a healthy connection and a failed station. Setting the intervals too long makes failure detection slow; setting them unnecessarily short consumes data and network capacity. The fact that a data connection is lost, does not normally mean that the charging ends, but the operator and user will not receive any updates anymore and new transactions cannot be started.

A practical configuration should therefore use the longest intervals that still meet the operational requirements of the service. More guidance can be found in the OCA paper on improving UPTIME with OCPP [[OCA Uptime, 2024](#)].

Where possible, event-driven reporting should be preferred over repetitive reporting of unchanged information. OCPP provides monitoring mechanisms to report changes and errors, so the CSMS does

not need to poll every station continuously for information that has not changed.

5.3. Reconnection and retry behavior

Unreliable networks can cause a second type of data waste: repeated connection attempts. A station that tries to reconnect every second during a long network outage may consume power, processing capacity and signaling resources without improving availability.

OCPP 2.x provides communication settings that can be used to configure retry and connection behavior. A deployment should apply back-off behavior that reconnects quickly after a short interruption but becomes less aggressive when the outage persists [[OCPP 2.1 Part 4 JSON over WebSockets](#)].

Where the hardware supports more than one network interface, the operator can also consider multiple network profiles (modem, LAN, APN, VPN, etc). For example, a station could normally use a local IP connection and fall back to cellular communication. The exact strategy is implementation-specific, but the CSMS should remain the central place from which the communication configuration can be managed.

Chapter 6. Battery swapping

In many emerging markets, electric two- and three-wheelers are important for personal mobility, delivery services and passenger transport. For vehicles that operate for many hours per day, waiting for a battery to recharge can directly reduce income or fleet utilization. Removable batteries and battery swapping can therefore be an attractive alternative to conventional plug-in charging. [\[IEA 2025\]](#)

OCPP 2.1 introduces explicit support for battery swap stations for any type of vehicle — not only 2- and 3-wheelers but also for cars and trucks. This feature allows a Battery Swap Station (BSS) to exchange battery-related information with a CSMS through a standardized protocol instead of relying entirely on a proprietary back-office interface. This is described in detail in section S. Battery Swapping of [\[OCPP 2.1\]](#).

A battery swap station differs from a conventional charging station in that it is the battery swap action that is billed and not the actual charging of the battery.

Typical management functions include:

- identifying battery cartridges;
- tracking the state of charge and state of health of batteries;
- reporting battery information to the CSMS;
- managing the exchange of a returned and issued battery;
- monitoring the availability of charged batteries; and
- coordinating the charging of batteries inside the station.

Using OCPP for these functions creates the same type of separation that OCPP already provides for conventional charging: the hardware and the management system can evolve independently behind a standardized interface. This means that an operator does not have to use a management system from the provider of the battery swap station, but can use any OCPP 2.1 management system with support for battery swap stations. This is especially of interest when the operator runs a network that combines regular charging stations and battery swap stations in the same network.

This is particularly relevant for networks that start with one battery swap station vendor but expect to expand. A proprietary interface may be acceptable for a small pilot, but it can create a barrier when a second hardware supplier is introduced or when the operator changes management systems.



The battery swapping functionality is part of OCPP 2.1. An OCPP 2.0.1 or OCPP 1.6 deployment that needs to manage battery swapping would require a vendor-specific customization. Operators planning a new battery swapping network are therefore encouraged to use OCPP 2.1 from the start.



OCPP standardizes communication between the battery swap station and the CSMS. It does not standardize the mechanical battery format, the battery-to-vehicle

interface or the commercial agreement between battery network operators and vehicle manufacturers.

Chapter 7. Mobile payments

In many emerging countries, mobile money is more accessible than bank cards or dedicated EV charging subscriptions. M-PESA is a well-known example in Kenya and other African markets, and similar concepts are used by other mobile money services, including Airtel Money [\[OCA MPesa, 2025\]](#). UPI is a common mobile payment method used in India [\[OCA UPI, 2025\]](#).

The payment system itself is outside OCPP. OCPP does not transfer money between the driver and the operator. Instead, the payment service is integrated with the operator's business system or CSMS, and OCPP is then used to control the charging station.

This separation makes it possible to use a locally popular payment method without creating a proprietary charging protocol.

7.1. Manual mobile-money payment

In the case of M-PESA, the simplest model uses a merchant account, PayBill or Till number. The driver transfers money and provides a reference, such as the charging station or connector identifier. The operator verifies the payment and then starts the charging transaction.

This model requires little technical integration and can work for small networks. Payment confirmation may be received through a merchant portal or SMS, which can be useful where full-time data connectivity is not always ensured. The disadvantages are the manual steps and the possibility of mistakes. An operator must match the payment to the correct station, start the transaction and make sure the value of the energy delivered does not exceed the prepaid amount.

A manual process can therefore be suitable for a pilot, a rural location with low utilization or a staffed charging site, but it becomes difficult to operate at scale.

7.2. API-based mobile-money payment

A more scalable model integrates the mobile-money provider's API with the CPO backend. The driver selects a charging point and authorizes a payment request on the phone. After the payment provider confirms the payment, the backend can automatically send an OCPP remote-start command to the selected charging station.

For OCPP 1.6, the CSMS can use `RemoteStartTransaction`. For OCPP 2.x, it can use `RequestStartTransaction`.

The payment backend and the CSMS may be separate systems, but they must share enough information to associate:

- the customer payment;
- the selected charging station and EVSE;

- the OCPP transaction; and
- the final amount of energy or cost.

This creates a largely automated customer journey while keeping the charging station independent from the specific payment provider.

7.3. Prepaid limits and stopping the transaction

Mobile-money payments are often prepaid. The operator must therefore ensure that the delivered service does not exceed the amount that was paid. There are several ways to implement this, depending on the OCPP version and tariff model:

- The CSMS can translate the prepaid amount into an energy or time limit and stop the transaction when the time limit is reached or a received meter value (almost) exceeds the energy limit.
- The CSMS can calculate the running cost from received meter values and stop the transaction before the prepaid amount is exceeded.
- OCPP 2.1 provides extended transaction options for the charging station to automatically stop at a fixed cost, energy or time and introduces additional support for prepaid authorization models. This is the preferred option for limited mobile connections.

A margin should be included when a transaction is stopped remotely. There is always some delay between the latest meter information, the calculation in the backend, the stop command and the actual end of energy delivery. The margin depends on charging power, reporting interval and communication delay. A safe margin would be the cost that can be accrued during one meter reporting interval.

For a dynamic tariff with different rates per time of day, translating a payment into a fixed energy amount may not be accurate. In that case, running-cost calculation is more appropriate, but it also depends more strongly on reliable communication. A deployment should select a payment and tariff model that remains understandable and predictable under the local connectivity conditions.

7.4. Mobile payments during communication outages

Mobile money can remain available even when the charging station's OCPP connection is unavailable, because the payment service and the charging station may use different networks. This can create a misaligned situation: the customer has paid, but the CSMS cannot send a remote-start command to the station.

The deployment should therefore define the behavior for this case before going live. Possible approaches include:

- Do not accept payment for a station that the CSMS currently considers offline.
- Delay the payment request until the station is reachable.
- Use a staffed location where an attendant can start the charging process locally.

- Automatically refund a payment when charging cannot be started within a defined period.

The correct approach depends on the payment provider, local consumer requirements and the operating model. The important point is that payment success and OCPP connectivity are separate states and must be coordinated by the backend.

The OCA white paper *OCPP & M-PESA mobile payments* provides a more detailed description of manual and API-based M-PESA integration models. [\[OCA MPesa, 2025\]](#)

Chapter 8. Support for low-cost platforms

The cost of charging equipment is a major factor in the business case for electric mobility. This is especially true for low-power charging equipment used for scooters, motorcycles, three-wheelers and other light electric vehicles. The communications controller in such a product may be a microcontroller with only a few hundred kilobytes of RAM and a few megabytes of program memory.

OCPP 2.x contains more functionality than OCPP 1.6, but this does not mean that every charging station must implement every feature. OCPP is organized so that a product can implement the functionality that is relevant to its purpose.

8.1. A "light" OCPP 2.0.1 implementation

The OCA application note *OCPP 2.Lite - OCPP for Resource-Constrained Devices* [[OCA OCPP-Lite, 2025](#)] describes how OCPP 2.0.1 (OCPP 2.1 for that matter) can be implemented on constrained hardware. OCPP 2.Lite is not a separate protocol version. It is a practical implementation approach, available as open source, that was developed by OCA members in the OCPP 2.Lite task group. It starts with the minimum required OCPP functionality and omits optional features that are not needed by the product.



Figure 9. Logo from the OCPP2.Lite task group

For a simple charging station, the implementation can focus on the Core functionality needed to:

- connect securely to the CSMS;
- authorize a user where applicable;
- start and stop a transaction;
- report essential meter values and status information; and
- support the remote control required by the use case.

Features such as complex smart charging, display messaging, local authorization lists or advanced diagnostics can be added only when the product needs them.

The OCPP 2.Lite paper describes several techniques to keep the implementation small:

Limit message sizes

The device can report realistic limits for the number of items and bytes it can process in large requests and reports.

Avoid unnecessary data duplication

Incoming JSON data does not need to be copied through multiple large buffers before it is processed.

Keep the device model small

Many device model values can be read-only and derived directly from firmware or real-time state instead of being stored in an embedded database.

Reduce persistent storage requirements

Only information that must survive a reboot needs to be stored. Transaction state and queued transaction messages require particular attention.

Optimize TLS buffers

A resource-constrained implementation can evaluate smaller TLS fragment sizes and carefully size communication buffers, while remaining interoperable with the CSMS.

Use a persistent pending-message queue

Transaction handling can be kept separate from storage and retry logic. Compact internal storage or compression can reduce the space used by queued messages.

The case studies in the OCPP 2.Lite paper show that a streamlined OCPP protocol stack can fit within approximately 200 kB of ROM, with implementations operating within approximately 50 kB of RAM. Actual requirements depend on the selected OCPP features, TLS library, platform, application architecture and the rest of the charging station firmware.

Two open-source projects, MicroOCPP and OpenOCPP, demonstrate approaches for implementing OCPP on embedded platforms. An equipment manufacturer can use such projects as a starting point or as reference architecture rather than implementing the complete protocol stack from the beginning.

A low-cost platform should not be confused with an insecure platform. Security requirements remain relevant, particularly when a charging station can control electrical power or is connected to a payment service. The hardware selection should include the memory and processing capacity needed for the selected OCPP security profile, secure firmware updates and safe storage of credentials.

8.2. Selecting a practical feature set

The lowest hardware cost is not always achieved by choosing the smallest possible implementation. Removing a function from the charging station can create operational costs elsewhere.

For example, omitting local authorization can reduce firmware and storage requirements, but it can also make the station unusable during a network outage. Omitting remote diagnostics can reduce

complexity, but it may increase the number of site visits. Sending very little operational data can save mobile data, but it can make fault detection slower.

The product designer should therefore select features based on the total cost of operating the service, not only on the purchase price of the controller.

A useful minimum profile for an intermittent-connectivity environment may be different from the absolute minimum OCPP implementation. It may be worth allocating additional memory for:

- a persistent transaction message queue, i.e. transaction messages can be queued during communication outages;
- an authorization cache or local authorization list;
- secure firmware updates;
- useful remote diagnostics; and
- enough meter history to recover from communication outages.

Chapter 9. Deployment recommendations

9.1. Why OCPP 2.1 is preferred over OCPP 1.6

OCPP 1.6 was published in 2015. It remains widely used, but no new functionality is being added to it; new protocol development is focused on the OCPP 2.x series. Choosing OCPP 1.6 for new infrastructure may therefore reduce the initial implementation effort but can also result in additional proprietary solutions to include all functionalities that are needed in diverse emerging markets, and as a result a more difficult migration later. In contrast, OCPP 2.1 provides standard solutions for several use cases that are particularly relevant in emerging markets. Although OCPP 1.6 may initially appear attractive because it is smaller and widely implemented, new deployments are strongly recommended to use OCPP 2.1 as their starting point.

One important example is payment. In many emerging markets, a large proportion of EV drivers may not have a roaming contract or a conventional bank-issued credit card. Charging infrastructure must therefore support a wider range of payment models. OCPP 2.1 includes native support for ad hoc payment, prepaid transactions, local cost calculation and transaction limits. This makes it possible, for example, to:

- integrate a payment terminal with the charging station or CSMS;
- authorize a transaction using an external payment method, such as mobile money;
- limit a transaction by cost, energy or time;
- ensure that a prepaid transaction does not exceed the available balance; and
- calculate costs locally at the charging station when this is required.

These mechanisms provide a standardized basis for implementing payment solutions such as M-PESA or other mobile-money systems. OCPP does not replace the payment service itself, but OCPP 2.1 provides the transaction mechanisms needed to connect such payment services to the charging process. With OCPP 1.6, these flows generally require proprietary extensions or application-specific logic outside the protocol.

OCPP 2.1 is also better suited to the types of electric vehicles that are important in many emerging markets. It includes support for battery swapping, including use cases for two- and three-wheelers. This is relevant in markets where electric motorcycles, scooters, rickshaws and other light electric vehicles may grow faster than conventional passenger EVs. Using OCPP 2.1 allows operators to support these business models without developing a separate proprietary management solution.

A further reason to choose OCPP 2.1 is the expected development of the electricity system. An emerging market may have limited grid capacity today, but charging infrastructure installed now may remain in operation for many years. OCPP 2.1 supports ISO 15118-20, bidirectional power transfer and V2X use cases, as well as control of Charging Stations as distributed energy resources. These capabilities can become important where local grids are weak, renewable generation is growing, or EV batteries may eventually be used to support homes, businesses or the electricity grid. OCPP 1.6 does

not provide native support for these use cases.

OCPP 2.1 also contains improvements that are directly relevant to difficult operating conditions. For example, it supports resuming transactions after a forced reboot. This can be valuable in environments where power interruptions are common. More advanced transaction handling, security and device management also provide a stronger foundation for operating infrastructure remotely, where frequent site visits may be expensive or difficult.

The main argument for continuing to use OCPP 1.6 on low-cost hardware is often the perceived complexity and resource requirements of OCPP 2.x. However, a charging station does not need to implement every optional OCPP function. As described in section [A "light" OCPP 2.0.1 implementation](#), a streamlined OCPP 2.x implementation can focus on the functionality required for the specific product and market. Experience with resource-constrained implementations has shown that such an implementation can be comparable in size to, or only marginally larger than, an OCPP 1.6 implementation.

For new deployments, the recommended approach is therefore not to reduce hardware cost by reverting to OCPP 1.6, but to implement a streamlined OCPP 2.1 solution. Start with the functionality required for reliable basic charging and add only those optional functions that are relevant to the deployment. This allows low-cost Charging Stations to remain interoperable with the wider charging ecosystem while retaining a path towards standardized payments, battery swapping, bidirectional charging and future grid integration.



In emerging countries that are only just starting to deploy charging infrastructure, OCPP 2.1 is the preferred choice, even for resource-constrained hardware. By leapfrogging the older and no longer evolving OCPP version 1.6, emerging countries will immediately benefit from the lessons learned and improvements made in large EV markets and are off to a flying start.

9.2. Deployment profile

The most suitable OCPP deployment profile depends on the local environment. The following table summarizes common challenges and the OCPP mechanisms that can help address them.

Challenge	Relevant OCPP mechanism	Deployment consideration
Intermittent mobile data	Offline transactions, persistent transaction message queue, configurable reconnect behavior	Size the queue for the expected outage duration and preserve essential transaction data before telemetry.
Users must start charging while offline	Authorization cache, local authorization list, offline authorization policy	Balance service availability against the risk of accepting revoked or unknown credentials.
Frequent short power interruptions	Persistent transaction state; OCPP 2.1 transaction resumption after forced reboot	Resume only when electrical safety, connection state and transaction policy allow it.
High mobile data cost	Configurable meter-value reporting, heartbeat and ping intervals, WebSocket compression	Send only the data needed for billing, operations and the selected energy services.
Low-cost charging hardware	Minimal OCPP 2.0.1 implementation using the OCPP 2.Lite approach	Select the feature set based on total operational cost, not only minimum firmware size.
Two- and three-wheeler battery swapping	OCPP 2.1 battery swapping functionality	Use OCPP for BSS-to-CSMS communication; mechanical battery interfaces remain outside OCPP.
Mobile-first payments	Backend payment integration combined with OCPP remote start/stop and transaction reporting	Handle the case where payment succeeds but the station is offline.
Growing multi-operator market	OCPP between station and CSMS; OCPI between CPO and EMSP systems	Introduce roaming at the business-system level without changing the station interface.

The table also shows an important design principle: resilience is normally achieved by combining mechanisms. For example, offline transaction support is much more useful when it is combined with local authorization and enough persistent storage. A mobile payment integration is more reliable when the backend checks station availability before requesting payment. A low-cost controller is only operationally attractive when it still supports the remote management needed to avoid frequent site visits.

Chapter 10. Conclusion

OCPP is an internationally recognized communication protocol, but it does not require every charging network to use the same operating model. Its value in emerging countries lies in the ability to combine interoperability with local adaptation. CPOs in emerging countries have been testing and embedding OCPP, though there is no consolidated dataset to confirm the scale of adoption. Several implementation challenges have been identified, for which this report provides solution pathways.

The recommended approach is to start with the local operating conditions rather than with a fixed reference architecture. Determine how long stations may be offline, which users must still be served, how payments are made, which vehicle types dominate and how much remote maintenance is required. The OCPP feature set and configuration can then be selected around these requirements.

By using OCPP from an early stage, an EV market can deploy cost-effective charging infrastructure while retaining flexibility to multi-vendor operation, roaming and future growth.

The Open Charge Alliance is proud to support emerging countries in their endeavors to roll out charging infrastructure. We hope that many parties will benefit from this publication, will reach out to OCA for further discussions and will join our community of OCPP enthusiasts!

References

- [Data Explained] Data Explained, Average Mobile Data Cost by Country, 2 June 2026, <https://dataexplained.com/tech/mobile-data-cost-by-country/>
- [Electrive, 2026] Electrive 2026, U Power to deploy battery-swapping electric trucks in Thailand, 10 January 2026, <https://www.electrive.com/2026/01/10/u-power-to-deploy-battery-swapping-electric-trucks-in-thailand/>
- [EPRA, 2023] Energy and Petroleum Regulatory Authority, ELECTRIC VEHICLE CHARGING AND BATTERY SWAPPING INFRASTRUCTURE GUIDELINES, 2023, <https://www.epra.go.ke/sites/default/files/2025-03/E-Mobility%20Charging%20Infrastructure%20Guidelines.pdf>
- [GIZ, 2026] GIZ and Pmanifold, Feasibility Study for Electric Vehicle Charging Infrastructure Deployment in Kenya, 2026, Not public.
- [GSMA, 2025] Global System for Mobile Communications Association (GSMA), Mobile Money Metrics – Prevalence index, 2025, <https://www.gsma.com/mobile-money-metrics/#prevalence-index?y=2025>
- [GSMA, 2026] Global System for Mobile Communications Association (GSMA), Network coverage maps, September 2026, <https://www.gsma.com/coverage/#457>
- [ICCT, 2025] International Council on Clean Transportation (ICCT), Policy sequencing for electric vehicle charging infrastructure deployment, 16 December 2025, <https://theicct.org/publication/policy-sequencing-for-ev-charging-infrastructure-deployment-dec25/>
- [ICCT, 2026] International Council on Clean Transportation (ICCT), Zero-emission medium- and heavy-duty vehicle market in China: A 2025 update, 16 June 2026, <https://theicct.org/publication/zero-emission-medium-and-heavy-duty-vehicle-market-in-china-a-2025-update-may26/>
- [IEA, 2026] International Energy Agency, *Global EV Outlook 2026*, <https://www.iea.org/reports/global-ev-outlook-2026.org/reports/global-ev-outlook-2025/trends-in-other-light-duty-electric-vehicles>
- [IEA 2025] International Energy Agency, *Global EV Outlook 2025 - Trends in other light-duty electric vehicles*, <https://www.iea.org/reports/global-ev-outlook-2025/trends-in-other-light-duty-electric-vehicles>
- [ITU, 2025] International Telecommunication Union (ITU), Measuring digital development: Global Connectivity Report 2025, https://www.itu.int/hub/publication/D-IND-ICT_MDD.GCR-2025-4/
- [Kenya Tenders 2025] Kenya Tenders, Supply of an Electric vehicle Charging Infrastructure (EVC) Management Solutions, 12 May 2025, <https://www.kenyatenders.com/tender/supply-electric-vehicle-charging-infrastructure-evc-management-solutions-70950cb.php>
- [KPLC, 2025] Kenya Power and Lighting Company (KPLC), Kenya Power to Install 45 EV Chargers Across Six Counties, 16 May 2025, <https://newsroom.kplc.co.ke/articles/kenya-power-to-install-45-ev-chargers-across-six-countiesretry>

- [MEF, 2025] Mobile Ecosystem Forum (MEF), The Global Findex 2025: Mobile Money's Expanding Role in Financial Inclusion, 30 July 2025, <https://mobileecosystemforum.com/2025/07/30/the-global-findex-2025-mobile-moneys-expanding-role-in-financial-inclusion/>
- [Ministry of Roads and Transport, 2026] Ministry of Roads and Transport, NATIONAL ELECTRIC MOBILITY POLICY, 2026, <https://www.transport.go.ke/sites/default/files/Emobility%20Policy%20Final.pdf>
- [OCPP 2.1] Open Charge Alliance, *OCPP 2.1*, <https://openchargealliance.org/protocols/open-charge-point-protocol/>
- [OCPP 2.1 Part 4 JSON over WebSockets] Open Charge Alliance, *OCPP 2.1*, <https://openchargealliance.org/protocols/open-charge-point-protocol/>
- [OCA OCPP-Lite, 2025] Open Charge Alliance, *OCPP 2.Lite - OCPP for Resource-Constrained Devices*, Version 2, July 2025, <https://openchargealliance.org/ocpp-info-whitepapers/ocpp-2-lite-ocpp-for-resource-constrained-devices/>
- [OCA MPesa, 2025] Open Charge Alliance, *OCPP & M-PESA mobile payments*, October 2025, <https://openchargealliance.org/ocpp-info-whitepapers/ocpp-m-pesa-mobile-payments/>
- [OCA UPI, 2025] Open Charge Alliance, *OCPP & UPI mobile payments*, October 2025, <https://openchargealliance.org/ocpp-info-whitepapers/ocpp-upi-mobile-payments>
- [PCMI, 2026] Payments & Commerce Market Intelligence (PCMI), 4 Major Trends in Global Payment Methods, April 2026, <https://paymentscmi.com/insights/top-global-payment-methods/>
- [RFC 7692] IETF, RFC 7692, *Compression Extensions for WebSocket*, December 2015, <https://www.rfc-editor.org/rfc/rfc7692>
- [OCA Uptime, 2024] Open Charge Alliance, *Improving Uptime Monitoring with OCPP*, Version 1.1, April 2024, <https://openchargealliance.org/ocpp-info-whitepapers/>
- [World Bank, 2025] World Bank, Firms experiencing electrical outages (% of firms), Accessed 1 September 2026, <https://data.worldbank.org/indicator/IC.ELC.OUTG.ZS?end=2025&start=2025&type=shaded&view=map&year=2025>
- [World Bank, 2026] World Bank, Who moves up and why? A closer look at the 2026-2027 release of the World Bank Group Country Income Classifications, 2026, <https://blogs.worldbank.org/en/opendata/who-moves-up-and-why--a-closer-look-at-the-new-world-bank-group->