

The Hidden Complexity of EV Charging

Following a single EV charging session through the hidden layers of modern charging operations



TandemDrive



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A charging session looks simple

Every day, millions of EV drivers complete charging sessions without giving much thought to what happens behind the scenes. For the driver, the experience feels straightforward.

For the companies operating behind the scenes, however, that single charging session triggers dozens of operational, financial, and technical processes involving multiple organisations, systems, and commercial agreements.

As EV charging networks continue to scale, the complexity behind every charging session is growing rapidly. Every innovation that makes charging easier for drivers typically makes operations more complex behind the scenes.

The charging session is now the easy part. Managing everything around it is the challenge going forward.



The charging session begins

A driver sets out on their journey



They arrive at a charging station operated by a Charge Point Operator (CPO).



They start their session using a charging card issued by their Mobility Service Provider (MSP).



The session begins within seconds.



To the driver, the process appears seamless. What they don't see is that several companies are already exchanging information in the background. Systems are communicating, contracts are being checked, and commercial relationships are being activated before a single kilowatt-hour has been delivered.



The charging session has started. The multi-layered operational process has kicked into gear.

Layer 1

Authentication and roaming

Before charging can actually begin, the charging station needs to determine who the driver is and whether they are authorised to charge.

Depending on the charging network, this may involve communication between multiple parties:

- The charging station
- The CPO
- The MSP
- A roaming platform

What once involved a simple authorisation request has evolved into a highly interconnected process that depends on multiple organisations communicating reliably in real time.

For drivers, this process typically takes only a few seconds. For operators, it represents one of the first examples of how interconnected the charging ecosystem has become.

The industry has spent years solving connectivity. Today, most networks can connect, most of the time.

The challenge is ensuring everything continues to work reliably as charging volumes increase. Every new connection creates another operational relationship that needs to be managed.

Layer 2

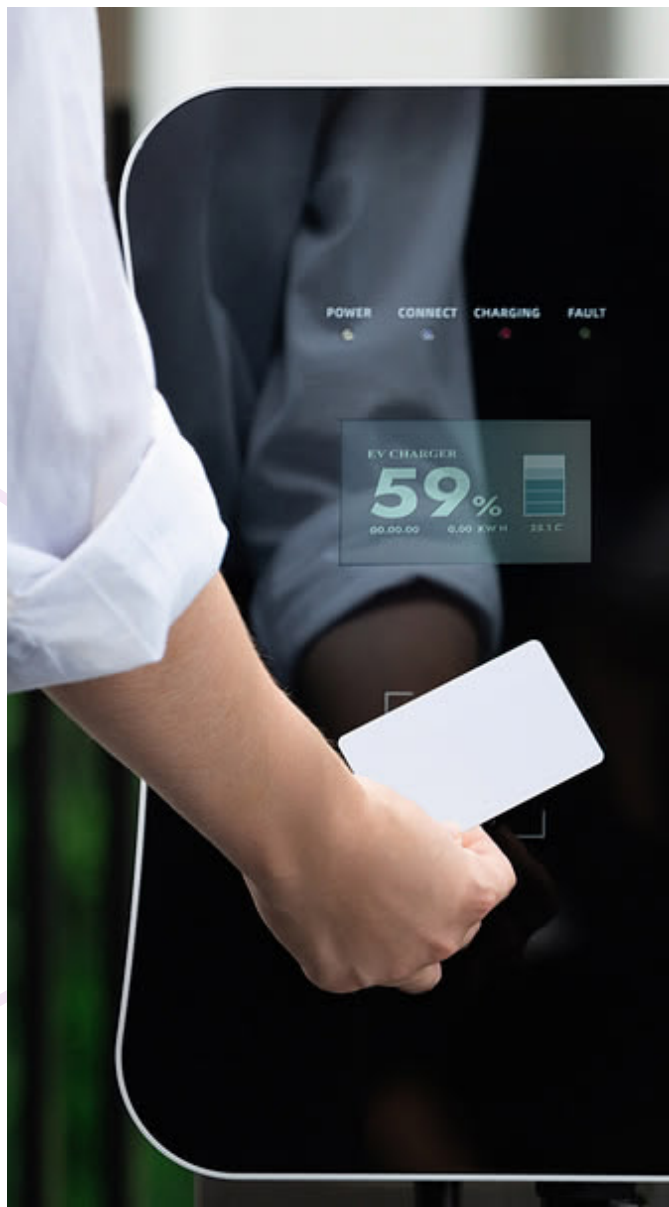
Pricing becomes more complicated

Now that charging has started, another question emerges: ***What is the actual price of this session?***

A decade ago, pricing was relatively straightforward. Today, operators may combine multiple pricing elements within a single charging session.

These can include:

- Energy-based pricing (€ per kWh)
- Time-based pricing
- Idle or blocking fees
- AC and DC specific rates
- Dynamic pricing
- Subscription discounts



What appears as a single price to the driver may actually be the result of several pricing rules working together.

Increasingly, pricing is also influenced by energy purchasing strategies. As operators align charging with wholesale electricity markets and renewable generation, commercial decisions made long before a driver plugs in can influence how a charging session is ultimately priced.

As pricing models become more sophisticated, maintaining transparency and consistency becomes increasingly important. The challenge is no longer creating tariffs. It is managing them at scale.

Layer 3

The charging session creates data

While energy is flowing into the driver's vehicle, data is flowing between systems. Every charging session generates information that operators rely on for settlement, billing, reporting, and customer support.

This include:

- Session duration
- Energy consumed
- Location information
- Tariff references
- Connector information
- Timestamps

These records eventually form the basis of the Charge Detail Record (CDR), one of the most important pieces of data in the charging ecosystem.

As networks become larger and more interconnected, ensuring data quality becomes increasingly critical. Every new service, integration, or business model generates more operational data that must remain accurate throughout the charging lifecycle.

If data is inaccurate, everything that follows becomes more difficult.



Layer 4

The charging session ends. The work does not.

The driver disconnects their vehicle and continues the journey. From their perspective, the process is complete. Operationally, however, several important processes are only just beginning.

Session data now moves through multiple systems. Costs are calculated, commercial partners exchange information, and settlement processes begin.

Questions still need to be answered:

- What was the final session cost?
- Which parties are involved?
- What needs to be invoiced?
- Who pays whom?

The charging session may be finished.
The transaction lifecycle is not.





Layer 5

Financial correctness

As charging ecosystems become more sophisticated, financial correctness becomes increasingly important. The issue now is not simply processing charging sessions. It is ensuring that every participant arrives at the same financial outcome.

This can become surprisingly difficult when multiple pricing models, roaming relationships, and systems are involved.

Operators increasingly need confidence that:

- Tariffs were interpreted correctly
- Session data is accurate
- Settlement calculations align
- Reimbursements are handled properly

At low volumes, discrepancies can often be investigated manually. At scale, manual processes quickly become expensive and difficult to maintain. Complexity itself is not the problem.

The challenge is managing that complexity consistently as charging volumes continue to grow.

This is one of the reasons operational excellence is becoming such an important differentiator within the industry.

Now multiply by million

One charging session is manageable. A million charging sessions is something entirely different.

Every additional charging session creates more data, more financial transactions, more exceptions, and more opportunities for discrepancies to occur.

As EV adoption continues to accelerate, operators are increasingly facing a challenge that looks less like infrastructure management and more like operational orchestration.

The industry's future challenge is not simply connecting systems. It is maintaining control, visibility, and financial correctness across increasingly complex charging ecosystems.

The organisations that manage complexity effectively will be best positioned to scale.

Why specialised operational expertise matters

To the untrained eye, a charging session appears simple. Behind the scenes it involved authentication, roaming, pricing, data generation, settlement, and financial validation across multiple systems and organisations.

The complexity described throughout this eBook is only the beginning. Dynamic tariffs, smart charging, vehicle-to-grid services, AI-driven charging optimisation, and increasingly sophisticated commercial models will all introduce new operational layers. The challenge facing operators is no longer whether complexity exists, but how effectively it can be managed.

The operators that thrive over the next decade are unlikely to be those with the largest charging networks alone. They will be the organisations that can scale operations without allowing complexity to scale alongside them.

None of these developments are a bad thing. They are signs of a maturing industry. However, they do increase the need for specialised operational expertise and tools capable of managing complexity at scale. The next phase of EV charging will not be defined solely by infrastructure. It will be defined by how effectively the industry manages everything happening behind the plug.

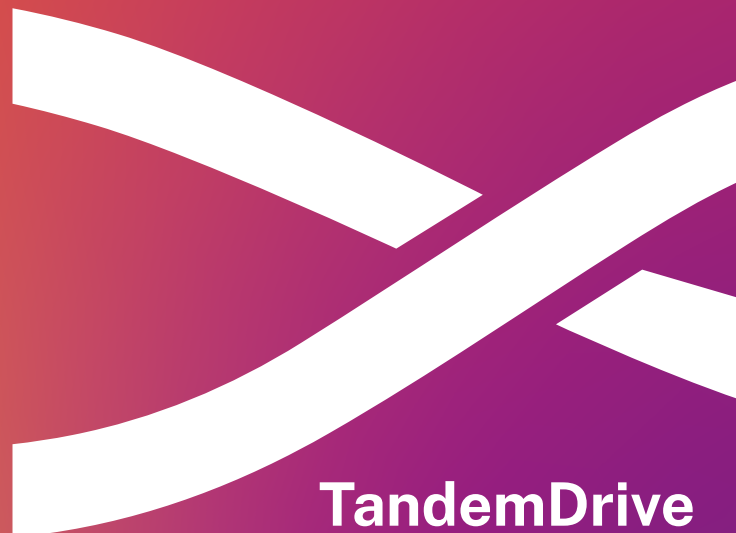


About TandemDrive

TandemDrive helps EV charging operators manage the growing operational complexity of modern charging ecosystems.

From roaming and settlement to tariff management, transaction validation, and financial correctness, we help ensure charging operations remain accurate, scalable, and ready for the next phase of the industry's evolution.

At TandemDrive, we believe the future of EV charging won't be defined by who builds the most infrastructure, but by who manages its complexity best.



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