



# Takers and Givers

Processing payments in Vehicle-to-Grid Markets

“Your true value is determined by how much more you give in value than you take in payment.”

– Bob Burg

# Vehicle-to-Grid Integration

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- V2G is a technology that enables energy to be pushed back to the power grid from the battery of an electric car.
- With vehicle-to-grid technology, a car battery can be charged and discharged based on different signals — such as energy production or consumption nearby.
- EVs can be applied to a wide range of applications, including load shifting, smoothing of renewable energy sources primary frequency control, secondary frequency control, etc.
- The main V2G parties are the Utility, the Aggregator, the EVSE and the EV
- The utility acts as a generator of control signals to the aggregators that in turn control a group of EV's through the EVSE





# Value in V2G networks

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- Privately owned vehicles remain parked for more than 95% of the time. During this time the EV's battery can be utilized in V2G scheme, providing storage capacity and flexibility in the recharging process to help balance power generation and demand in the grid.
- Surpluses from volatile renewable power generation can be stored in parked EV's batteries, which collectively provide substantial distributed energy storage.
- Conversely, energy stored in EVs can be used to mitigate peaks in demand and drops in generation.

# Payments in a V2G network

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- V2G networks are bidirectional, i.e. energy moves into and out of the EV, and value follows suit, therefore parts must be compensated accordingly.
- V2G networks heavily rely on incentives, so participation is usually based on monetary remunerations of some sort.
- Facilitating effortless payment for EV charging at the charger (EVSE) as well as rewards for ancillary services during the charging session while keeping transactions privacy-preserving, unidentifying, and unlinkable poses a big challenge.



“It is no longer a question of If, but rather When and How.”

# Security Challenges for Payments in a V2G network

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- Public and unattended PoS and related hardware represent particular challenges and are susceptible of multiple attack vectors.
- Robust encryption is required at every level of communication and wherever information is persisted

“Usability is about people and how they understand and use things, not about technology.”

– Steve Krug





## Usability Challenges for Payments in a V2G network

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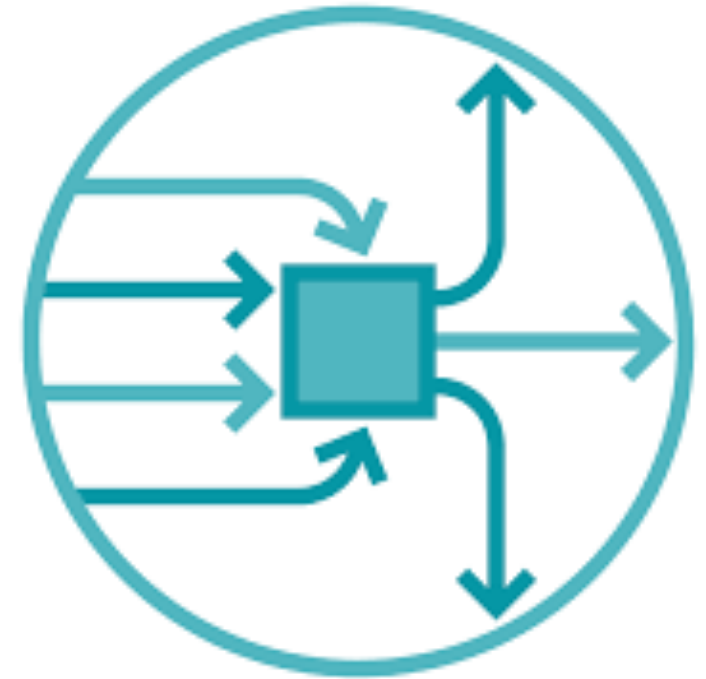
- Some transactions must be cleared immediately but others can be handled as post-payment systems where a users accumulates debt and rewards gets periodic, e.g., monthly, bills.
- Information required to take some decisions about charging/discharging an EV is too complex to be easily presented to final users, therefore convenient low-effort usability is hard to achieve.
- V2G models benefit from trustable and reliable users, this will allow for better or more efficient planification of the grid resources, therefore implementation of reputation programs might be necessary. Schemes that penalize bad actors are perhaps also required.

“Never trust a computer you can’t throw out a window.”  
– Steve Wozniak

# Technical Challenges for Payments in a V2G network

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- Clearance of transactions require the reconciliation of power measures and rates by disparate actors that utilize different hardware and communications protocols with different levels of accuracy, latency, units, etc.
- Lack of standardization have created multiple competing standards from different organizations such as OCPP (Open Charge Alliance), IEEE 2030.5, ISO-15118, and other organizations like SAE and IEC. This could make extra-network payments much more difficult.
- The securing of edge devices (e.g. EVSE, EV) that also behaves as a Point-of-Sale is technically complex and there are not stable standards for the implementation of IoT security for the V2G use cases.



“You only have to do a few things right in your life so long as you don’t do too many things wrong.”

– Warren Buffett



## Business Challenges for Payments in a V2G network

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- Contractual agreements between parts are complex and difficult to implement among a myriad of network participants at competitive and in some cases adversary.
- The potential integration of distinct networks would create a multiple-tier model for the processing of payment transactions that gets even more complex when aggregators and utilities get involved, this will probably give rise to the establishment of clearing houses and marketplaces.
- A significant part of the transactions will be of a small denomination, creating challenges for the charging of transaction fees specially when intermediation entities are present.