Smart Grid Optimization through V2G System and Blockchain Transactions

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SMART GRID OPTIMIZATION
V2G SYSTEM AND BLOCKCHAIN TRANSITIONS

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Problem

The electrical system currently faces several challenges in efficiently integrating renewable energy sources due to their intermittent nature. Maintaining load stability and optimizing grids with mixed generation sources are significant hurdles. There is a need for decentralized energy storage solutions to support this integration. The increasing adoption of electric vehicles (EVs) adds further complications without a comprehensive charging management strategy, resulting in additional demand, power grid congestion, and higher energy import costs. Additionally, traditional energy market transactions lack transparency, often leading to high costs.

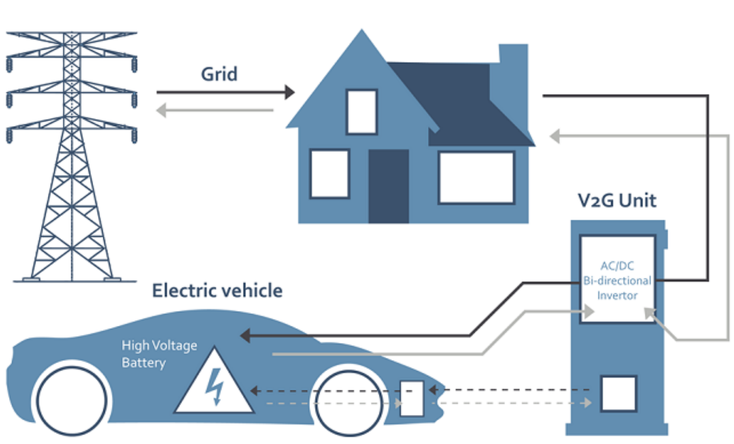
Introduction

Current solutions in the electrical system involve a diverse range of stakeholders, including citizens, businesses, energy consumers, electric vehicle owners, energy producers, and grid operators, all of whom rely on the power grid and participate in the energy market.

To address the problem stated, our project is based on the idea of **using EVs as possible power sources to supply the grid in a near future, using Vehicle To Grid (V2G)** technology, **while still providing value to the owners.** V2G technology allows **bidirectional electricity flow between EVs and the power grid**, transforming them from passive energy consumers into active participants in the energy system, benefiting both vehicle owners and grid operators.

Beneficiaries

- Citizens and businesses reliant on the power grid
- Energy market participants owners
- Energy producers
- Grid operators: Distribution System Operator (DSO) and Transmission System Operator (TSO)



Solution

Our solution focuses on **developing intelligent algorithms for managing EV charging** and **controlling energy and monetary flow** between the **EV** and the **grid** in V2G systems.

In simple terms, by **injecting power** from the EV during **periods of high price and consumption** and **charging** during **periods of low price and consumption**, we help **stabilize the grid** and **increase user savings** per vehicle charge.

How does it work?

1. ML models forecast the price, consumption, and production of energy;
2. An algorithm manages the EV charge and identifies the optimal periods for injection and charging, while respecting the user's needs;
3. The monetary transactions associated are quickly and transparently performed through Blockchain.

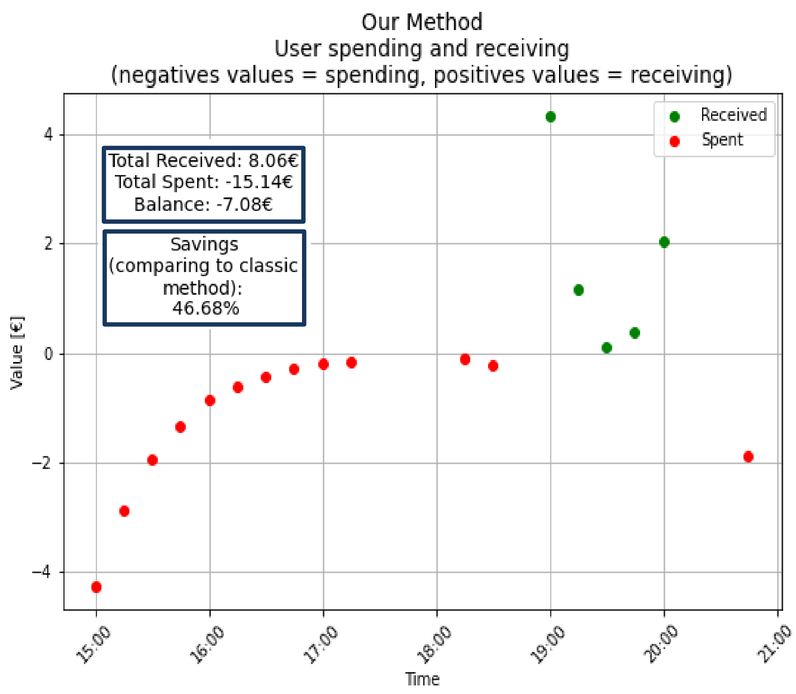


Figure 1. User´s monetary balance.

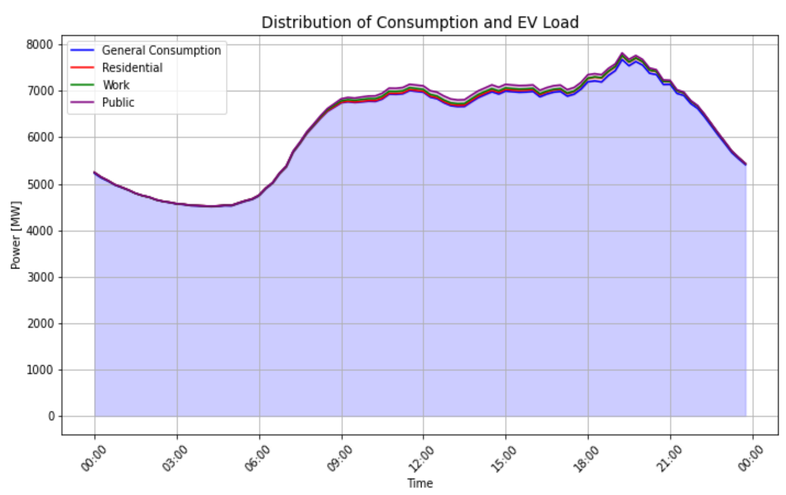


Figure 3. Before load management algorithm

Results

From our simulations, we have concluded that in general, our method allows a user to **save from 6% to 50%** of their money while charging their vehicle using our algorithm instead of the classic method.

Once the **optimal transaction times** are found by the algorithm, our prototype simulates these transactions using **blockchain transactions (**Figure [2]).

The user's expenses and gains for the same scenario are represented in the Figure [1] in conjunction with the user's savings, in percentage, when compared to the classic, static, charging method.

Our results indicate a clear **"flattening**" of the curve and a **shift of the peak consumption** hours, meaning that the grid becomes more **stable overall**: Figure [3], [4].

BLOCK 11	MINED ON 2024-06-05 22:35:56	GAS USED 21000	1 TRANSACTION
BLOCK 10	MINED ON 2024-06-05 22:35:55	GAS USED 21000	1 TRANSACTION
BLOCK 9	MINED ON 2024-06-05 22:35:54	GAS USED 21000	1 TRANSACTION
BLOCK 8	MINED ON 2024-06-05 22:35:52	GAS USED 21000	1 TRANSACTION
BLOCK 7	MINED ON 2024-06-05 22:35:51	GAS USED 21000	1 TRANSACTION
BLOCK 6	MINED ON 2024-06-05 22:35:49	GAS USED 21000	1 TRANSACTION
BLOCK 5	MINED ON 2024-06-05 22:35:48	GAS USED 21000	1 TRANSACTION
BLOCK 4	MINED ON 2024-06-05 22:35:47	GAS USED 21000	1 TRANSACTION
BLOCK 3	MINED ON 2024-06-05 22:35:45	GAS USED 21000	1 TRANSACTION
BLOCK 2	MINED ON 2024-06-05 22:35:44	GAS USED 21000	1 TRANSACTION
BLOCK 1	MINED ON 2024-06-05 22:35:42	GAS USED 21000	1 TRANSACTION
BLOCK 0	MINED ON 2024-06-05 22:28:16	GAS USED 0	NO TRANSACTIONS

Figure 2. Blockchain Transactions

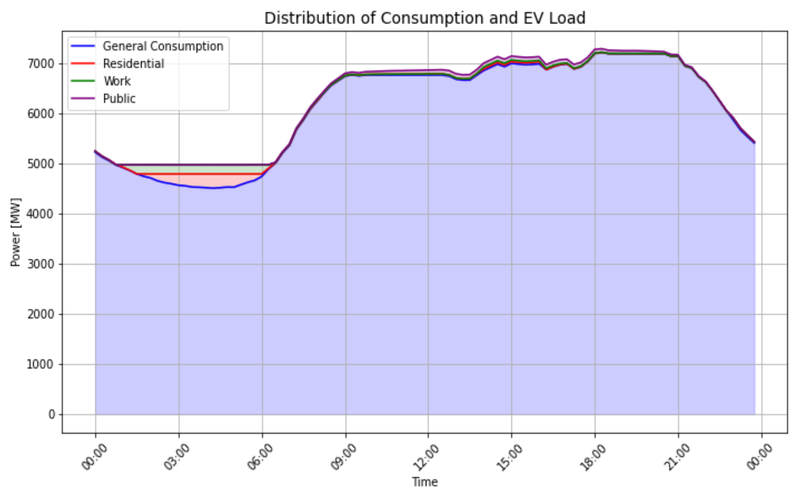


Figure 4. After load management algorithm

Conclusions

Our prototype showcases the promising future of V2G technology and how it could be used to the benefit of both EV owners and energy suppliers, by allowing the owners to make use of the batteries that already come with their vehicles to save money and by helping stabilize the power curve as the number of EVs continues to rise. Additionally, the predicative models and management algorithms developed could be used to manage micro grids. In general, these would have more predictable consumption and power need trends, as well as a smaller number of connected EVs, making the impact of each more noticeable. These microgrids could be managed recursively by a similar algorithm, allowing for easier management of larger grids.

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