

System and Method for Optimised Charging of Electric Vehicles

Field of the Invention

[0001] The field relates to systems and methods for charging electric vehicles, specifically focusing on managing the distribution of power from a limited power supply to multiple vehicles. This includes the intelligent allocation and control of electrical sockets to optimise charging efficiency while adhering to power supply constraints.

Background of the Invention

[0002] An electric vehicle recharging system is a network of infrastructure and technologies designed to replenish the energy stored in the batteries of electric vehicles (EVs). It allows EV owners to charge their vehicles, extending their driving range and promoting the adoption of electric transportation. There are various types of EV recharging systems, including home charging which involves installing a dedicated charging station at the EV owner's residence, typically connected to the electrical grid. Home charging is convenient and allows EVs to be charged overnight or during non-driving hours.

[0003] Alternatively, public charging stations have charging points installed in public places, such as parking lots, shopping centers, and along roadsides. Public charging stations offer EV owners an option to recharge their vehicles when away from home.

[0004] However, charging electric vehicles from a shared mains power supply of an apartment building complex or the like can present several challenges due to power supply limitations and difficulties in individual billing.

[0005] For example, the mains power supply of an apartment building complex may not be designed to handle the significant additional load that comes with simultaneous charging of multiple electric vehicles. Charging multiple EVs at high power levels could lead to overloading the electrical system, causing power outages or voltage fluctuations in the building.

[0006] Furthermore, the available power capacity might not be adequate to support fast charging for all EV users at the same time. As a result, charging times could

become excessively long, inconveniencing residents and reducing the practicality of owning an electric vehicle.

[0007] Also, residents' charging patterns may vary, with some preferring to charge during peak hours. This can create spikes in electricity demand, further straining the building's power supply and leading to higher electricity costs for both the residents and the building management.

[0008] Yet further, in a shared charging scenario, it becomes challenging to accurately measure and allocate electricity usage to individual EV users. Without proper metering and billing systems, it could result in disputes among residents or an unfair distribution of charging costs.

[0009] As such, to support the increased demand for EV charging, the building complex may require significant infrastructure upgrades, including electrical distribution systems and the installation of charging stations.

[0010] The present invention seeks to provide an electric vehicle recharging system, which will overcome or substantially ameliorate at least some of the deficiencies of the prior art, or to at least provide an alternative.

[0011] It is to be understood that, if any prior art information is referred to herein, such reference does not constitute an admission that the information forms part of the common general knowledge in the art, in Australia or any other country.

Summary of the Disclosure

[0012] A system is provided for charging electric vehicles from a limited power supply. The system comprises a plurality of electrical sockets connected to the power supply, each socket incorporating a processor that executes computer program code instructions, a data interface for communication with mobile devices, and a power switch that controls the connection between the power supply and the socket terminals. The system is configured to communicate with mobile devices to assign sockets to a pool of electric vehicles for charging. The system further individually controls the sockets to supply power, ensuring that only a subset of the sockets is active at any given time to effectively manage the distribution of power in accordance with the limitations of the power supply.

[0013] Optionally, the system may include the ability to control the sockets by switching off all sockets except for a first subset, followed by switching off all sockets except for a second subset. This sequential control of the sockets allows the system to maintain efficient power usage while ensuring that multiple vehicles can be charged within the constraints of the power supply.

[0014] The system may also be configured to measure the power supplied at each socket, enabling dynamic control of the subset size based on real-time power consumption. This feature allows the system to optimise the number of vehicles being charged simultaneously, further enhancing the efficiency of the power distribution.

[0015] Each socket may optionally be equipped with an ammeter to measure the power supplied during charging. The system can then record this data against a registered user account, facilitating accurate billing based on actual power consumption. This provides users with a transparent and fair charging experience.

[0016] The system may also include the capability to control the sockets according to a time period schedule. This feature allows users to charge their vehicles during specific times, such as off-peak periods, potentially reducing energy costs.

[0017] In some configurations, the system may be adapted to control individual sockets based on user account settings. This enables personalised charging schedules, offering users greater flexibility and control over their charging needs.

[0018] The system may also be configured to charge vehicles to a predetermined charge state after a specified time period. This ensures that vehicles are charged efficiently, maximising the use of available power while meeting the charging requirements of multiple vehicles.

[0019] The predetermined charge state may be calculated by the system based on various factors, including the current limitations of the power supply, the number of vehicles in the charging pool, and the charge state of each vehicle. This calculation ensures that the system can distribute power effectively, even under varying conditions.

[0020] Additionally, the system may be designed to receive charge state readings from each vehicle and calculate the predetermined charge state accordingly. This

feature allows for precise control over the charging process, ensuring that each vehicle receives the appropriate amount of power.

[0021] The predetermined charge state may be uniform across all vehicles, simplifying the charging process and ensuring consistent power distribution. Alternatively, the system may allow for vehicle-specific charge states, where each vehicle is charged to a different level based on user preferences or other factors.

[0022] In some configurations, the vehicle-specific charge states may be configured according to user settings, providing a customised charging experience that caters to individual needs.

[0023] The system may also include the capability to draw power from a first electric vehicle connected to a first socket and supply it to a second electric vehicle connected to a second socket. This feature enables intra-vehicle power transfer, potentially reducing overall energy consumption and balancing the charge levels between vehicles.

[0024] The system may be configured to read the charge states of the first and second electric vehicles, allowing it to make informed decisions about when and how to transfer power between vehicles. This ensures that power is distributed efficiently and effectively between vehicles with differing charge levels.

[0025] The system may also be designed to draw power from one vehicle to another based on a predetermined charge state after a specified time period. This feature ensures that both vehicles reach the desired charge levels within the available time and power constraints.

[0026] A power conditioner may optionally be included between the first and second sockets to regulate the voltage and current during intra-vehicle power transfer. This ensures safe and efficient power transfer between vehicles, protecting both the vehicles and the system from potential electrical issues.

[0027] The system may be configured to draw power from one vehicle to another only during peak periods, thereby reducing energy costs by avoiding higher tariff rates. This feature offers users a cost-effective solution for vehicle charging, particularly during times of high energy demand.

[0028] Finally, the system may measure the current drawn and supplied during intra-vehicle power transfer and bill the account of the receiving vehicle while crediting the account of the supplying vehicle accordingly. This feature ensures fair and accurate billing for users, reflecting the actual power transfer between vehicles.

[0029] Other aspects of the invention are also disclosed.

Brief Description of the Drawings

[0030] Notwithstanding any other forms which may fall within the scope of the present invention, preferred embodiments of the disclosure will now be described, by way of example only, with reference to the accompanying drawings in which:

[0031] Figure 1 shows a system for charging electric vehicles from a limited mains power supply.

[0032] Figure 2 shows the socket in further detail.

[0033] Figure 3 shows a method for supplying power using the system.

[0034] Figure 4 shows a method for time-of-day recharging using the system.

[0035] Figure 5 shows a method for simultaneously charging electric vehicles using the system to obtain a predetermined charge state after a time period.

[0036] Figure 6 shows a method of intra-vehicle recharging wherein the system draws power from one vehicle to recharge another vehicle of the charging pool.

Description of Embodiments

[0037] Figure 1 illustrates a system 100 for charging electric vehicles 107 from a limited mains power supply 101. The power supply 101 may be a shared AC mains power supply, such as that of an apartment complex.

[0038] The system 100 comprises a plurality of electrical sockets 104 connected to the mains power supply 101. An AC/DC transformer 102 may interface between the mains power supply 101 and the sockets 104.

[0039] As will be described in further detail below, the sockets 104 may be allocated by the system 100 to a charging pool 103 to control the charging of electric vehicles 107 assigned to the charging pool 103.

[0040] Users may interact with the sockets 104 using their respective mobile devices 106, which may be mobile communication devices with a software application downloaded and installed.

[0041] The socket 104 may be in operable communication with a data server 108, which controls the sockets 104 to intelligently supply power to the electric vehicles 107.

[0042] A power regulator 105 may interface with pairs of sockets 104 so that, as will be described in further detail below, the system 100 can draw power from a first electric vehicle 107 to supply power to a second electric vehicle 107.

[0043] Figure 2 provides a more detailed view of the socket 104. In this embodiment, the socket 104 comprises a microprocessor 201 for processing digital data. A memory device 202, which may be a RAM or ROM-type memory, is in operable communication with the microprocessor 201 via a system bus.

[0044] The memory device 202 is configured to store digital data, including computer program code instructions. During operation, the microprocessor 201 fetches these instructions and associated data from the memory device 202 for interpretation and execution, thereby implementing the control functionality described herein.

[0045] The socket 104 may have a data interface 203 for communication with the mobile device 106, allowing users to interact with the user interface 204 of the mobile device 106 to control the socket 104.

[0046] The data interface 203 may be a short-range communication interface, such as NFC or Bluetooth. Users can tap or pair their mobile devices 106 with the socket 104 to obtain power.

[0047] The data interface 203 may also be configured to communicate across a wide area network (such as the Internet) with the aforementioned server 108.

[0048] The socket 104 comprises a switch 205 for connecting the terminals 207 to the mains power supply 101.

[0049] Additionally, the socket 104 may include an ammeter 206 to measure power consumption during recharging.

[0050] The socket 104 may also feature an interchangeable socket plate 208 with different pin configurations to accommodate various countries.

[0051] Figure 3 outlines a method 300 for supplying power using the system 100.

[0052] At step 301, users of the system 100 register user accounts with the system, with the information stored on the server 108. Specifically, users install a software application on their mobile devices 106 and register a user account with the server 108, including billing details.

[0053] When power is required, a user parks their electric vehicle 107 adjacent to a socket 104 and connects the vehicle to the terminals 207 of the socket 104.

[0054] The user then uses their mobile device 106 to communicate with the socket 104. If the data interface 203 is an NFC beacon, the user may tap their mobile device 106 against the socket 104. NFC is preferred for its ability to facilitate bidirectional communication.

[0055] Alternatively, the socket 104 may include a read-only RFID chip, allowing the mobile device 106 to read the socket's identifier and communicate with the server 108, which controls the switch 205 of the socket 104. A QR code may serve a similar function, enabling the mobile device 106 to interact with the socket 104.

[0056] In another embodiment, where the data interface 203 is a Bluetooth interface, the user may pair their mobile device 106 with the socket 104.

[0057] The user can then request power from the socket 104 and specify additional charging settings, as described in further detail below.

[0058] Multiple users may connect their electric vehicles 107 to respective sockets 104 for charging during a given time period. For example, the system 100 may include 20 sockets, with 15 users connecting their electric vehicles 107 simultaneously.

[0059] At step 302, the system 100 forms a charging pool 103 of these electric vehicles 107 to be recharged.

[0060] At step 303, the system 100 individually controls the sockets 104 to supply power such that only a subset of the sockets 104 supplies power simultaneously, adhering to the limitations of the power supply 101. For instance, if the power supply

101 has a maximum rating of 30 A and each electric vehicle 107 draws up to 7 A, the system 100 may charge no more than four vehicles 107 simultaneously.

[0061] Once these four vehicles 107 are partially or fully charged, the system 100 switches off their respective sockets 104 to begin recharging the next four vehicles 107.

[0062] The switching may be rolling, where one socket 104 is switched in as another is switched out, or subset-based, where one subset of sockets is switched out as another is switched in.

[0063] At step 303, the socket 104 measures current draw using the ammeter 206, allowing the system 100 to dynamically adjust the size of the subset based on power requirements. For example, an electric vehicle 107 may draw 7 A during initial charging but only 2 A during final stage charging. By monitoring power draw dynamically using the ammeter 206, the system 100 can charge more vehicles 107 simultaneously as they reach lower power-draw stages.

[0064] The ammeter 206 may also be used to measure power consumption at step 304. Following recharging, the system 100 bills individual users at step 305 based on their billing details and the applicable tariff. As described further below, multiple tariffs may be used depending on the time of day, such as peak and off-peak charging periods.

[0065] Figure 4 illustrates a method 400 for time-of-day recharging using the system 100. At step 401, a user joins a pool 103 of vehicles 107 to be recharged as previously described.

[0066] At step 402, the system 100 determines a setting for the user. For example, the user may specify via the user interface 204 whether they wish to charge during peak periods (for prioritised, more expensive recharging) or off-peak periods (for less prioritised, less expensive recharging).

[0067] In this example, the user has chosen to recharge during off-peak periods. The system 100 keeps the switch 205 of the socket 104 open, and at step 403, the system 100 determines whether the current time is within the off-peak period.

[0068] If it is, at step 404, the system 100 closes the switch 205 of the socket 104 to recharge the vehicle 107 until step 405, when it determines that the off-peak period has ended, after which the system 100 opens the switch 205 to cease charging.

[0069] Figure 5 depicts a method 500 for simultaneously charging electric vehicles 107 using the system 100 to achieve a predetermined charge state after a set time period.

[0070] For example, if the system 100 cannot recharge 15 vehicles 107 to 100% capacity overnight, method 500 may be used to recharge each of the 15 vehicles 107 to 80% capacity.

[0071] At step 501, the vehicles 107 join the charging pool 103. At step 502, the system 100 reads the battery charge state of each vehicle 107. In some embodiments, the terminals 207 of the socket 104 include data terminals to read the charge state from the vehicle management system of the electric vehicle 107. Alternatively, the user may manually input the charge state into the user interface 204.

[0072] At step 503, the system 100 determines the predetermined charge state. This charge state is calculated based on the current limitations of the power supply 101, the number of vehicles 107, their respective charge states, and other parameters. In this example, the system 100 has determined that it can recharge the vehicles 107 in the charging pool 103 to 80% capacity.

[0073] The user may then begin charging a subset of the vehicles 107 in the charging pool 103. At step 504, the system 100 continuously adjusts the subset to achieve the predetermined charge state at step 505.

[0074] The predetermined charge state may be uniform across all vehicles 107. For example, method 500 may aim to recharge each vehicle 107 to 80% capacity. Alternatively, method 500 may allow for individual charge states, where, for instance, one user specifies a desired charge state of 90% while another specifies 60%.

[0075]

[0076] Method 500 may also be configured to recharge vehicles 107 based on a specific amount of electricity. For example, one user may specify a recharge of three dollars' worth of electricity, while another specifies eight dollars' worth. The system

100 would control the sockets 104 and monitor power consumption using the respective ammeters 206 to achieve this outcome.

[0077] Figure 6 illustrates a method 600 of intra-vehicle recharging, where the system 100 draws power from one vehicle 107 to recharge another vehicle 107 in the charging pool 103.

[0078] At step 601, multiple vehicles 107 join the charging pool 103.

[0079] At step 602, the system 100 reads the charge state of each vehicle 107 as previously described.

[0080] For example, a first vehicle may be charged to 80%, while a second vehicle is at 20%.

[0081] The system 100 then controls the switches 104 to draw power from the first vehicle 107 at step 604 to supply the second vehicle 107 at step 605, until, for instance, both vehicles reach a charge state of 60%.

[0082] The power regulator 105 mentioned earlier may regulate voltage and current between the vehicles 107.

[0083] In some embodiments, method 600 may only be employed during peak periods to reduce energy costs at higher tariff rates.

[0084] The system 100 uses the ammeters 206 to measure the current drawn and supplied. At step 605, the system 100 may bill the account of the second vehicle 107 and credit the account of the first vehicle 107 accordingly.

[0085] The foregoing description, for purposes of explanation, used specific nomenclature to provide a thorough understanding of the invention. However, it will be apparent to one skilled in the art that specific details are not required in order to practise the invention. Thus, the foregoing descriptions of specific embodiments of the invention are presented for purposes of illustration and description. They are not intended to be exhaustive or to limit the invention to the precise forms disclosed as obviously many modifications and variations are possible in view of the above teachings. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, thereby enabling others skilled in the art to best utilize the invention and various embodiments with various

modifications as are suited to the particular use contemplated. It is intended that the following claims and their equivalents define the scope of the invention.

Claims

1. A system for charging electric vehicles from a limited power supply, comprising:
 - a plurality of electrical sockets connected to the power supply, each socket comprising:
 - a processor;
 - executing computer program code instructions;
 - being in operable communication with a data interface for interfacing with a respective mobile device; and
 - controlling a power switch to switch power between the power supply and socket terminals,
 - wherein the system is configured to:
 - communicate with mobile devices to assign the sockets to a pool of electric vehicles to be charged; and
 - individually control the sockets to supply power so that only a subset of the sockets supplies power simultaneously to meet limitations of the power supply.
2. The system as claimed in claim 1, wherein individually controlling the sockets to supply power so that only a subset of the sockets supplies power simultaneously to meet limitations of the power supply comprises:
 - switching off all the sockets except for a first subset of the sockets; then
 - switching off all the sockets except for a second subset of the sockets.
3. The system as claimed in claim 1, wherein the system is configured to measure supplied power at each socket to dynamically control the size of the subset accordingly.
4. The system as claimed in claim 1, wherein each socket comprises an ammeter configured to measure supplied power during charging, and wherein the system is configured to record the supplied power against a registered user account associated with each socket.

5. The system as claimed in claim 1, wherein the system is configured to control the sockets according to a time period schedule.
6. The system as claimed in claim 5, wherein the system is configured to control a socket according to the time period schedule depending on a user account setting.
7. The system as claimed in claim 1, wherein the system is configured to control the sockets so that the vehicles are charged to a predetermined charge state after a time period.
8. The system as claimed in claim 7, wherein the system is configured to calculate the predetermined charge state according to at least one of current limitations of the power supply, a number of vehicles in the charging pool, and a charge state of each vehicle.
9. The system as claimed in claim 7, wherein the system is configured to receive charge state readings from each vehicle and calculate the predetermined charge state accordingly.
10. The system as claimed in claim 7, wherein the predetermined charge state is uniform across all vehicles.
11. The system as claimed in claim 7, wherein the predetermined charge state is vehicle-specific.
12. The system as claimed in claim 11, wherein the predetermined charge state specific to each vehicle is configured according to a respective user setting.

13. The system as claimed in claim 1, wherein the system is configured to draw power from a first electric vehicle connected to a first socket to supply power to a second electric vehicle connected to a second socket.
14. The system as claimed in claim 13, wherein the system is configured to read charge states from the first and second electric vehicles.
15. The system as claimed in claim 13, wherein the system is configured to draw power from the first electric vehicle connected to the first socket to supply power to the second electric vehicle connected to the second socket depending on a predetermined charge state after a time period.
16. The system as claimed in claim 13, further comprising a power conditioner between the first and second sockets.
17. The system as claimed in claim 13, wherein the system is configured to draw power from the first electric vehicle connected to the first socket to supply power to the second electric vehicle connected to the second socket only during peak periods to save on energy costs at a higher tariff rate.
18. The system as claimed in claim 13, wherein the system measures at least one of drawn current and supplied current and bills an account of the second vehicle and credits an account of the first vehicle accordingly.