IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Utility Patent Application (Provisional)

TITLE: Battery as a Service

INVENTOR: Bechir Ben Hassen Trabelsi

FIELD OF THE INVENTION

[0001] This invention relates to the field of Electrical automotives Vehicles, in particular the area of electric vehicles battery efficiency usage and range as well as charging network management.

BACKGROUND OF THE INVENTION

[0002] Lithium-ion batteries (LiBs) have become one of the most important components for the new generation of electrical automotives vehicles. Compared to traditional battery technology, Lithium-ion batteries have the advantage of a high voltage performance platform (such as high energy density), wide operating temperature range, low self-discharge rate, no memory effect, high efficiency and long-life cycle. Unfortunately, Pricing remains the biggest barrier to Electric vehicles adoption. Range anxiety and charging networks are the two other top reasons of slowing EV adoptions. One of the main limitations of Lithium-ions Batteries is the poor working environment of Electric Vehicles. In fact, to fulfill the requirements of high voltage, power and energy needed by EVs, large number of batteries are used through series and parallel connections. This requires high consistency among the battery pack hence increasing the cost of Lithium-ion batteries. Large working current, extreme current fluctuations and limited space inside the car increased the difficulty of assembly process as well as cooling ventilation of battery design. To cope with poor anti-abuse capabilities such as working in high/low temperature regularly for long time complex, advanced and hence costly technology for Battery Management Systems and charging infrastructure control systems have been developed. Finally, many predicted lithium dependences would lead to some nations' dominance like oil supplies.

On the other hand, Sodium-ion batteries have already an average price less than $80/KWh in 2023, and by 2030, it expected to get to $ 40/KWh which can solve the price barrier. The most significant advantage of Sodium (Salt) is the abundance of resources needed. Unfortunately, Sodium-based batteries are mainly used in stationary grids or low performance vehicles like two or three wheelers.

Thus, there remains a need for an improved solution that combines both types of batteries to address the top three main reasons to EV adoption: Affordability, range anxiety and charging infrastructure.

SUMMARY OF THE DISCLOSURE

[0003] The present disclosure describes a system and/or methods to offer Battery as a Service option to new EV adopters. It moves the Battery model from single power pack to a set of micro power packs or micro batteries that are removable swappable and smart. It allows to combine different types of batteries in the same vehicle, brings more flexible charging capabilities, like offline charging, reduces the complexity of assembly process and make sharing batteries among drivers possible.

The service provider owns a fleet/pool of Lithium based batteries and sodium-based batteries that can be used to provide per usage battery service. The idea behind this service is to allow new buyer to purchase a sodium-ion batteries-based Electric vehicles thus at a very affordable price. Then use this service to increase the capabilities of his car whenever needed by replacing part of the sodium-ion batteries by lithium-ion batteries for a specific period that can range from hours to weeks. The main function of this service is battery fleet management system and resource allocation. It provides the most efficient and optimal allocation of Lithium-ion battery portion and sodium-ion batteries to achieve the best quality of service while keeping the cost per KWH as low as possible.

Currently the lowest cost per KWH is 139$ for Lithium-ion batteries (LiBs) and 80$ for Sodium-ion batteries (Na-iBs). It is expected that a basic plan EV user achieves the optimal quality of service with 30% LiBs and 70% Na-iBs. This combination brings the total cost per KHW down to less than 98$. And since the Service Provider can negotiate a better price with Batteries makers (at least 10% discount) this will bring the total cost per KHW to less than 90$ which is impressive.

Thus, the current invention resolves the pricing barrier, eliminates the range anxiety thanks to the swappable micro batteries, reduces dependence on the Lithium and offers superior features like anti-abuse , power grid friendly and by design anti-theft capabilities.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] FIGS. 1A-1C illustrate exemplary block diagram of micro battery in electric vehicle. The micro battery can be removed swapped and charged individually.

[0005] FIGS. 2A-2B illustrate exemplary vehicle power pack system composed of a set of micro batteries. Pluggable, unpluggable, swappable, removable.

[0006] FIG. 2C illustrates an exemplary communication module inside as part of micro battery management system for communication with the cloud-based battery service.

[0007] FIGS. 3A-3B illustrate an exemplary battery swap station can be fixed or Mobile battery swap stations.

[0008] FIGS. 4A-4D illustrate exemplary call flow diagrams of advanced features offered by Battery as A Service Like trip scheduling, customized battery usage cost effective experience.

[0009] FIGS. 5A-5B illustrate exemplary functional call flows of is Power Grid friendly micro battery charging experience.

[0010] FIG. 6 illustrates exemplary anti-theft call flow diagram.

[0011] FIGS. 7A-7B illustrate exemplary anti-abuse call flow diagrams.

DETAILED DESCRIPTION OF THE INVENTION

[0021] In preferred embodiments, FIGS. 1A-1C illustrate an example of block diagram of micro-Battery or micro–Power Pack. The micro battery comprises a power module (a set of Lithium -ion Batteries or Sodium-ion Batteries), micro cooling system and micro battery management system (micro BMS). The outside case is an anti-heat, armored case and can be ejected in case of emergency like fire or accident.

[0022] The exemplary in FIGS. 2A-2B shows an example of a micro batteries architecture. The Auto Makers will provide the powertrain with proper design and wiring to safely store and swap a set of micro batteries. The battery service gateway module will integrate with the battery service provider to provide in-vehicle battery management features can be provided by the service provider as well. Instead of having one central complex BMS, Auto makers will be required to provide a gateway between individual micro BMS and the cloud-based battery service provider (Fig. 2B). This will reduce drastically the cost of Research and Development efforts, the complexity of car design and assembly process.

[0023] In FIG. 2C The exemplary micro BMS (battery management system) comes with a communication module to communicate directly with the cloud-based battery service provider. Communication with the cloud is needed to obtain authorization code whenever the battery is plugged in/out, during offline charging and at regular intervals for battery fleet monitoring purposes like diagnostics, telemetry and anti-abuse, anti-theft. Moving the complexity and intelligence from the vehicle's central BMS (battery management system) to the micro batteries simplifies the design and assembly process for auto makers.

[0024] FIGS. 3A-3B illustrate an exemplary battery swap station. The station can be fixed or Mobile. FIG. 3B illustrates an exemplary call flow diagram for swapping micro batteries. Based on data collected from the electric vehicle the service, the driver profile and optionally driver schedule computes the best possible route (shortest time, least costly) to swap the batteries.

[0025] FIGS. 4A-4D illustrate exemplary call flow diagrams where The Battery Service provider offers systems and/or methods to allow to EV drivers to customize their battery usage upfront in accordance with their driving habits and needs. E.g., a driver who spends 50% of his time telecommuting, 30% shopping and 20% trips and leisure can schedule in advance a battery usage profile that meets his requirements in term of performance and budget. In FIGS. 4A-4B, the exemplary call flows show a planning and scheduling procedure for monthly telecommute and vacation trip for a basic service driver. Daily telecommute requires between 15% and 30% of Lithium-ion batteries. The service provider cannot guarantee more than 15% but the driver can get up to 30% outside the peak usage hours. When planning a trip outside the city , the driver can request up to 50% of Lithium-ion batteries but the service provider cannot guarantee more than 30%. In FIGS. 4C-4D, the driver has a premium service. Hence, he has guaranteed Quality of Service i.e., he will get guaranteed 30% of Lithium-ion batteries for his daily telecommute as well as at least 50% of Lithium-ion batteries for his trip outside the city.

[0026] FIGS. 5A-5B illustrate exemplary functional call flows of power grid friendly micro battery charging experience. In FIG. 5A the exemplary shows a user trying to charge the micro battery in a peak usage period. User connects to charger via a charging App on his smart phone. The charger communicates to the cloud via smart phone charging App to send device and locations info and obtain an authorization code along with a charging profile. Since this is a period of peak usage, the cloud selects a soft slow charging profile to avoid saturating the Power Grid. On the other hand, FIG. 5B the cloud response is a fast-charging profile since the charging is happening in an off-peak usage period.

[0027] FIG. 6 illustrates an exemplary of anti-theft call flow diagram. After stealing the vehicle, the thief was locked out when trying to charge the micro battery. He could not authenticate to server to start a communication channel between the charger and the cloud. The cloud detected abnormal behavior and requested the user to re-authenticate. After few trials the whole battery system has been locked. And the car cannot restart anymore.

CLAIMS

What is claimed is:

1. A micro electric and smart battery swappable, rechargeable and pluggable.
2. A fully self-managed cloud-based battery service that owns and manage a fleet of micro batteries of claim 1. to offer an on demand pay as you go battery services including battery swap, upgrade, charging and other superior features like trip scheduling , emergency services, anti-theft and anti-abuse.

ABSTRACT

[0027] The present disclosure describes a system and/or methods to offer Battery as a Service option to new EV adopters. It moves the Battery model from single power pack to a set of micro power packs or micro batteries that are removable swappable and smart. It allows to combine different types of batteries in the same vehicle, brings more flexible charging capabilities, like offline charging, reduces the complexity of assembly process and make sharing batteries among drivers possible.

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DRAWINGS

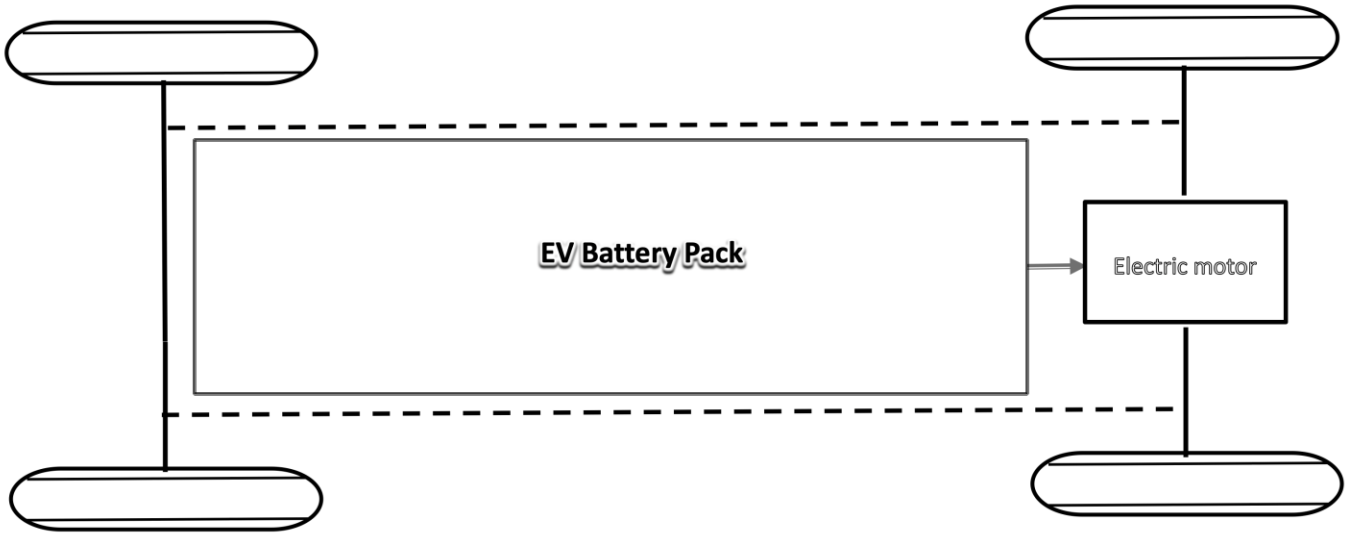


FIG. 1A conventional Electric Vehicle battery Pack

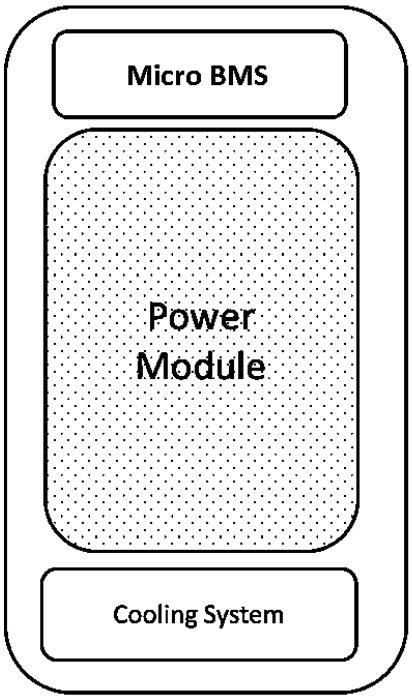


FIG. 1B

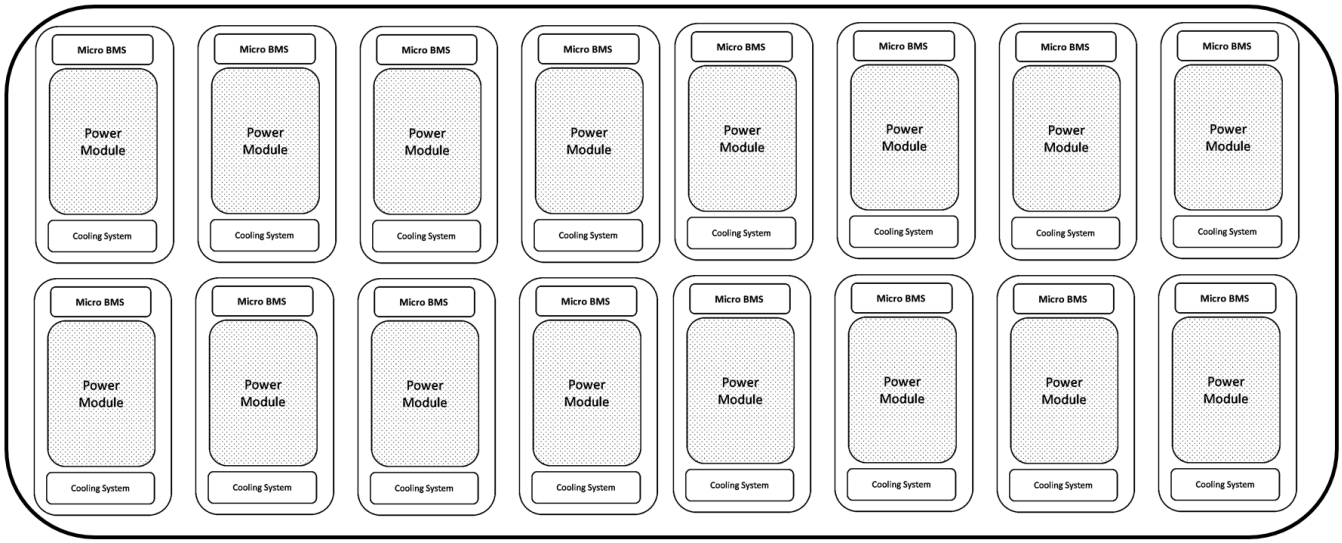


FIG. 1C

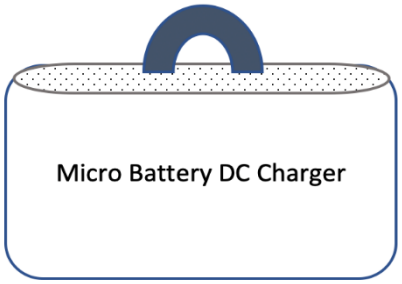

Micro Battery DC Charger

FIG. 2A

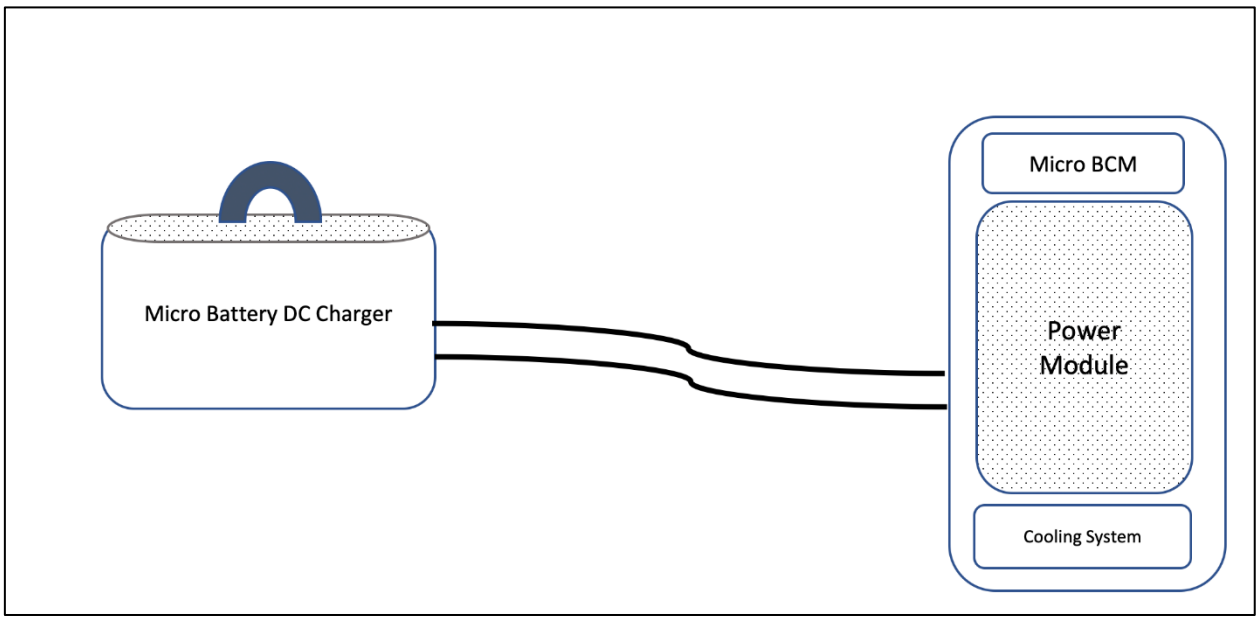
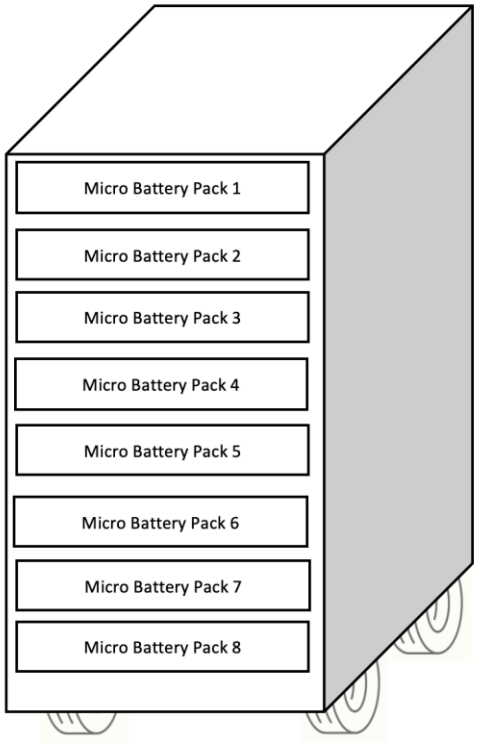

Micro Battery DC Charger
Micro BCM
Power Module
Cooling System

FIG. 2B



Mobile micro-Batteries Rack used to swap temporarily store batteries. Can be used in gas stations, malls, schools. As part of the batteries swap station.

FIG. 3A

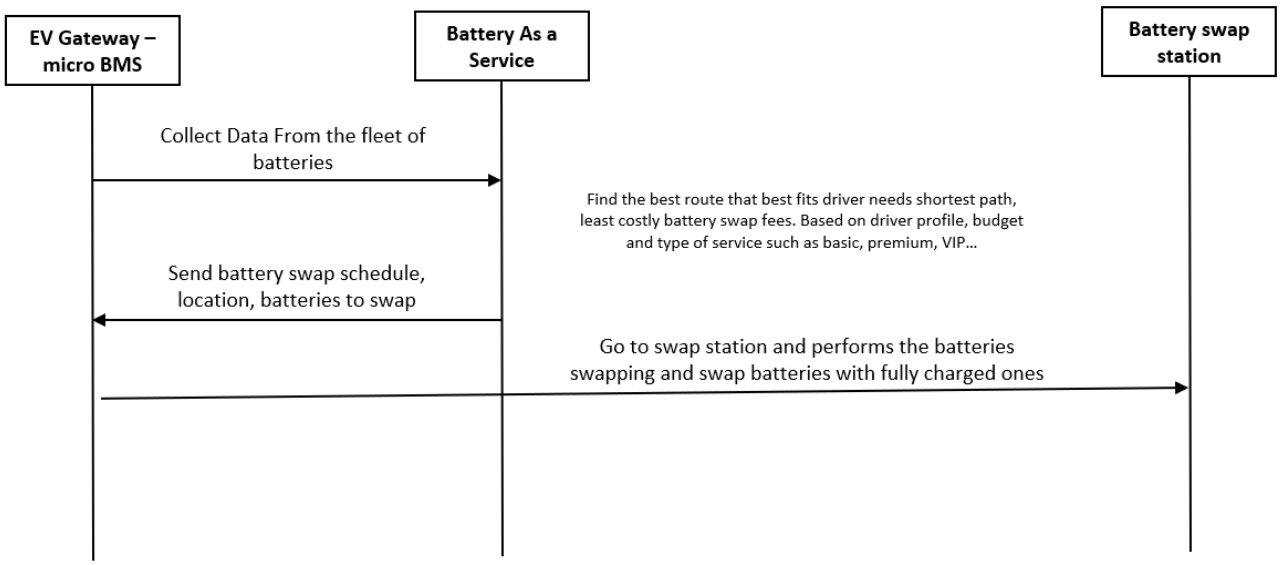

EV Gateway – micro BMS
Battery As a Service
Battery swap station
Collect Data From the fleet of batteries
Find the best route that best fits driver needs shortest path, least costly battery swap fees. Based on driver profile, budget and type of service such as basic, premium, VIP...
Send battery swap schedule, location, batteries to swap
Go to swap station and performs the batteries swapping and swap batteries with fully charged ones

FIG. 3B

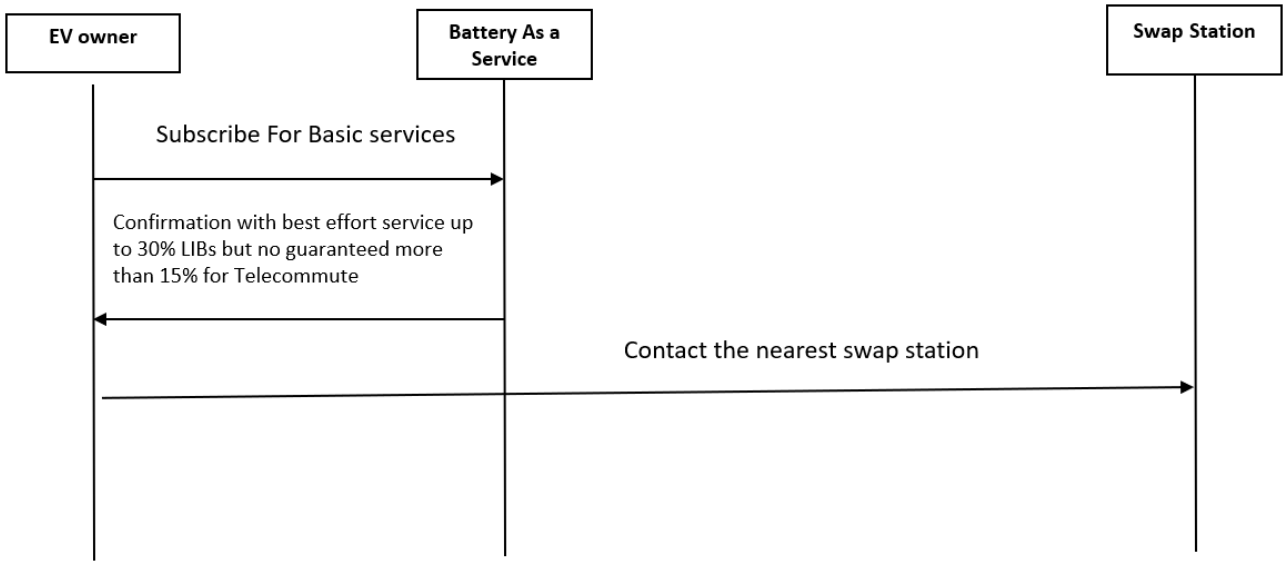

EV owner
Battery As a Service
Swap Station
Subscribe For Basic services
Confirmation with best effort service up to 30% LIBs but no guaranteed more than 15% for Telecommute
Contact the nearest swap station

FIG. 4A

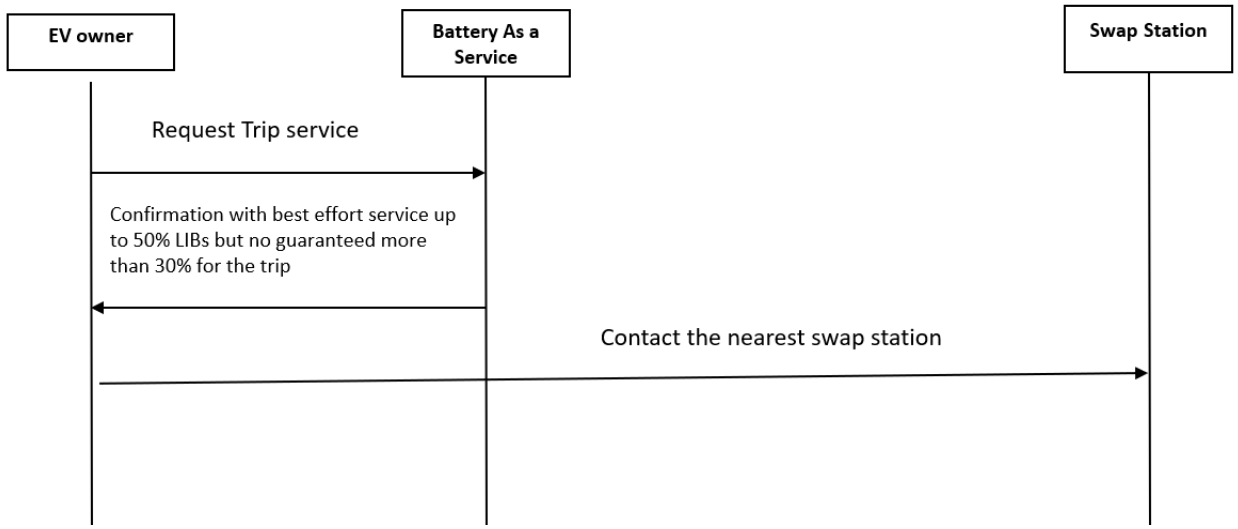

EV owner
Battery As a Service
Swap Station
Request Trip service
Confirmation with best effort service up to 50% LIBs but no guaranteed more than 30% for the trip
Contact the nearest swap station

FIG. 4B

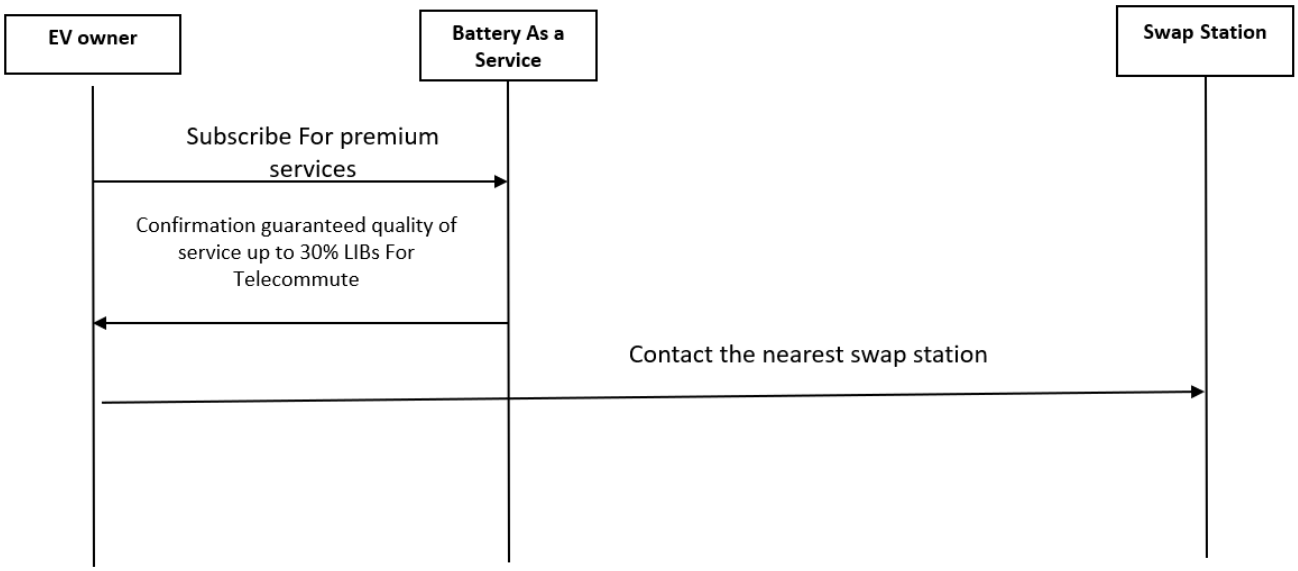

EV owner
Battery As a Service
Swap Station
Subscribe For premium services
Confirmation guaranteed quality of service up to 30% LIBs For Telecommute
Contact the nearest swap station

FIG. 4C

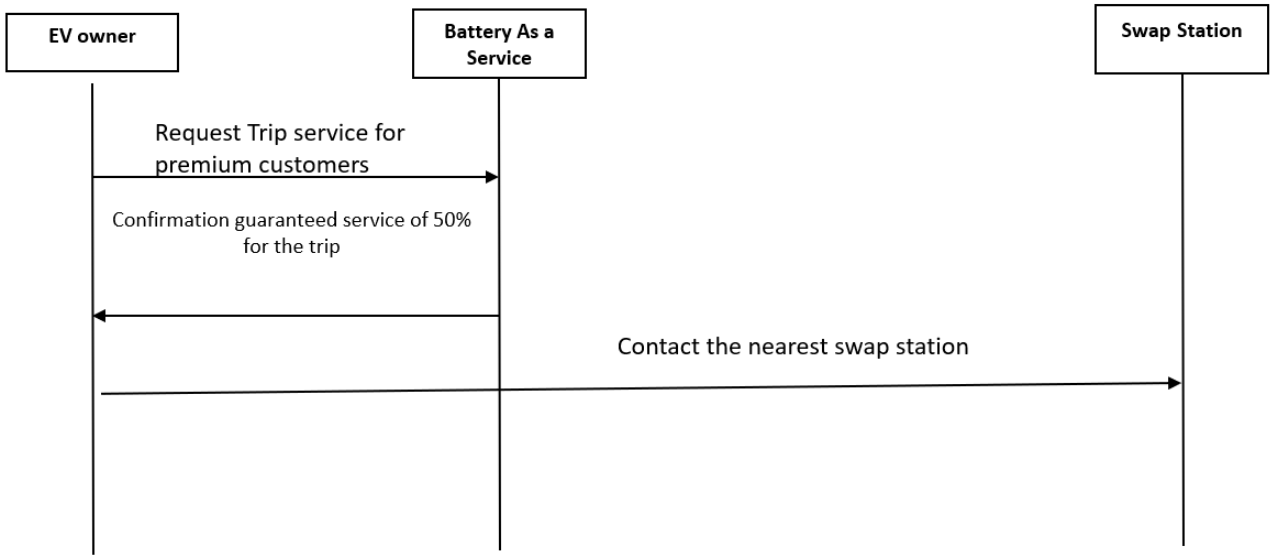

EV owner
Battery As a Service
Swap Station
Request Trip service for premium customers
Confirmation guaranteed service of 50% for the trip
Contact the nearest swap station

FIG. 4D

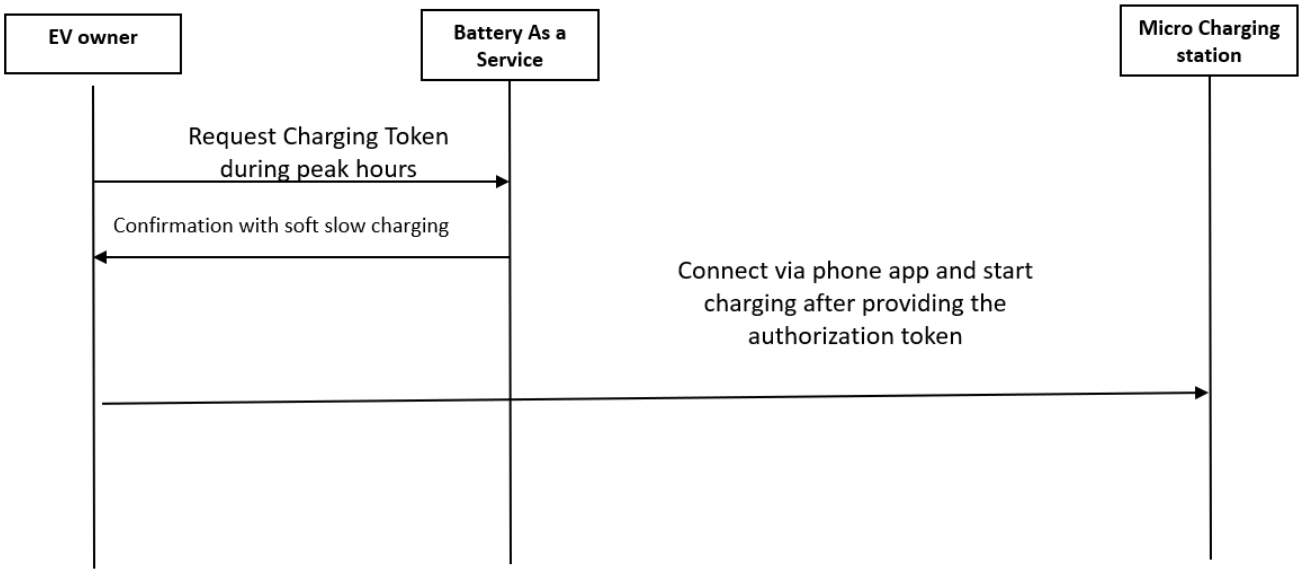

EV owner
Battery As a Service
Micro Charging station
Request Charging Token during peak hours
Confirmation with soft slow charging
Connect via phone app and start charging after providing the authorization token

FIG. 5A

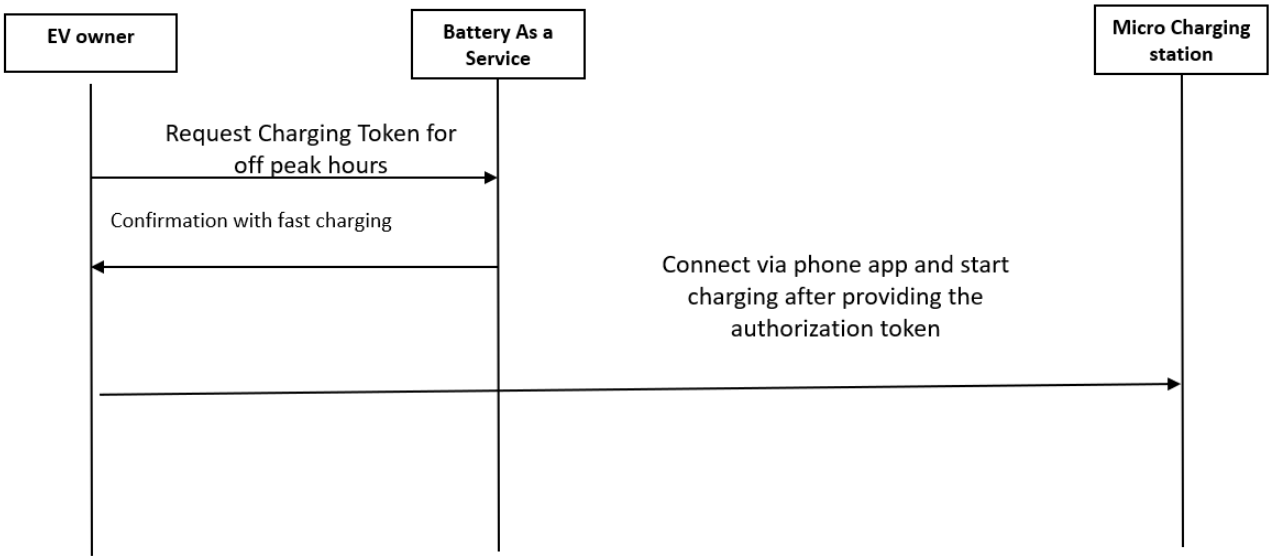

EV owner
Battery As a Service
Micro Charging station
Request Charging Token for off peak hours
Confirmation with fast charging
Connect via phone app and start charging after providing the authorization token

FIG. 5B

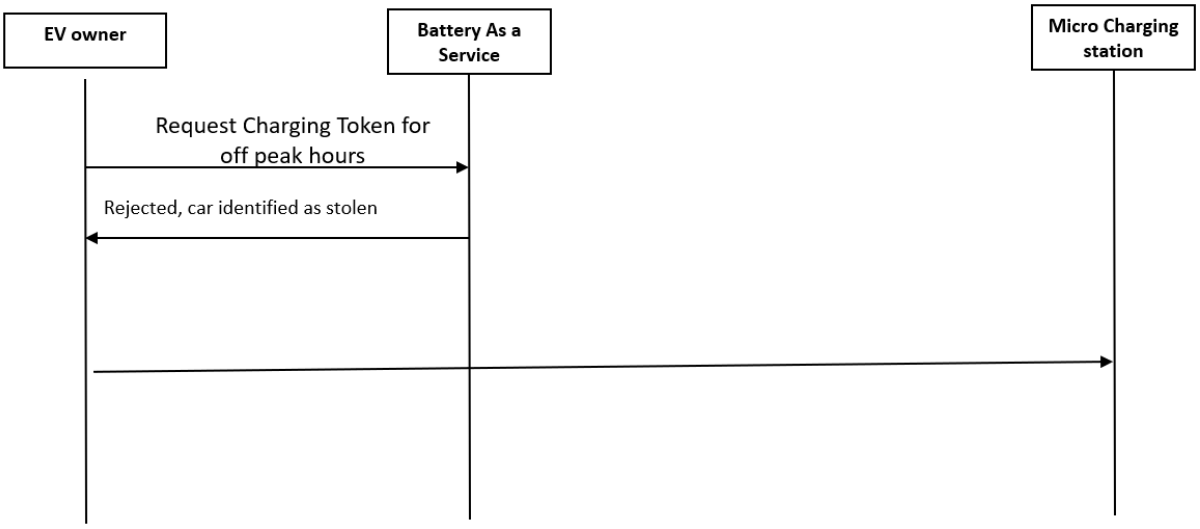

EV owner
Battery As a Service
Micro Charging station
Request Charging Token for off peak hours
Rejected, car identified as stolen

FIG. 6