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(54) **VEHICLE BATTERY LIFE MANAGEMENT FOR ENERGY SOLUTIONS**

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B60W 10/26	(2006.01)
B60W 50/08	(2020.01)
H02J 7/00	(2006.01)

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CPC ***B60W 10/26*** (2013.01); ***B60L 58/12*** (2019.02); ***B60L 58/16*** (2019.02); ***B60W 50/08*** (2013.01); ***H02J 7/0048*** (2020.01); ***H02J 7/005*** (2020.01); ***H02J 7/0063*** (2013.01)

(58) **Field of Classification Search**

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See application file for complete search history.

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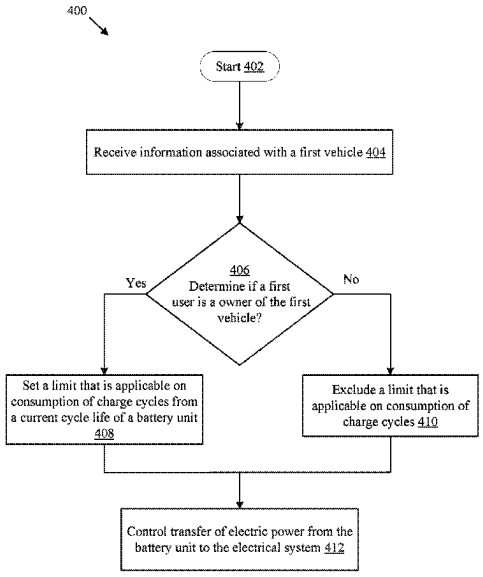
(57) **ABSTRACT**

A system and method for management of vehicle battery life is disclosed. The system is communicatively coupled to a vehicle and receives information associated with the vehicle. Based on the received information, the system determines a user of the vehicle as one of a lessee of the vehicle or an owner of the vehicle. The system sets a limit that is applicable on a consumption of charge cycles from a current cycle life of a battery unit of the vehicle. The limit is set based on the determination that the user is the owner of the vehicle. The system detects a connection of the vehicle with an electrical system of a built environment associated with the user and controls a transfer of electric power from the battery unit to the electrical system based on the detection and the set limit.

16 Claims, 5 Drawing Sheets



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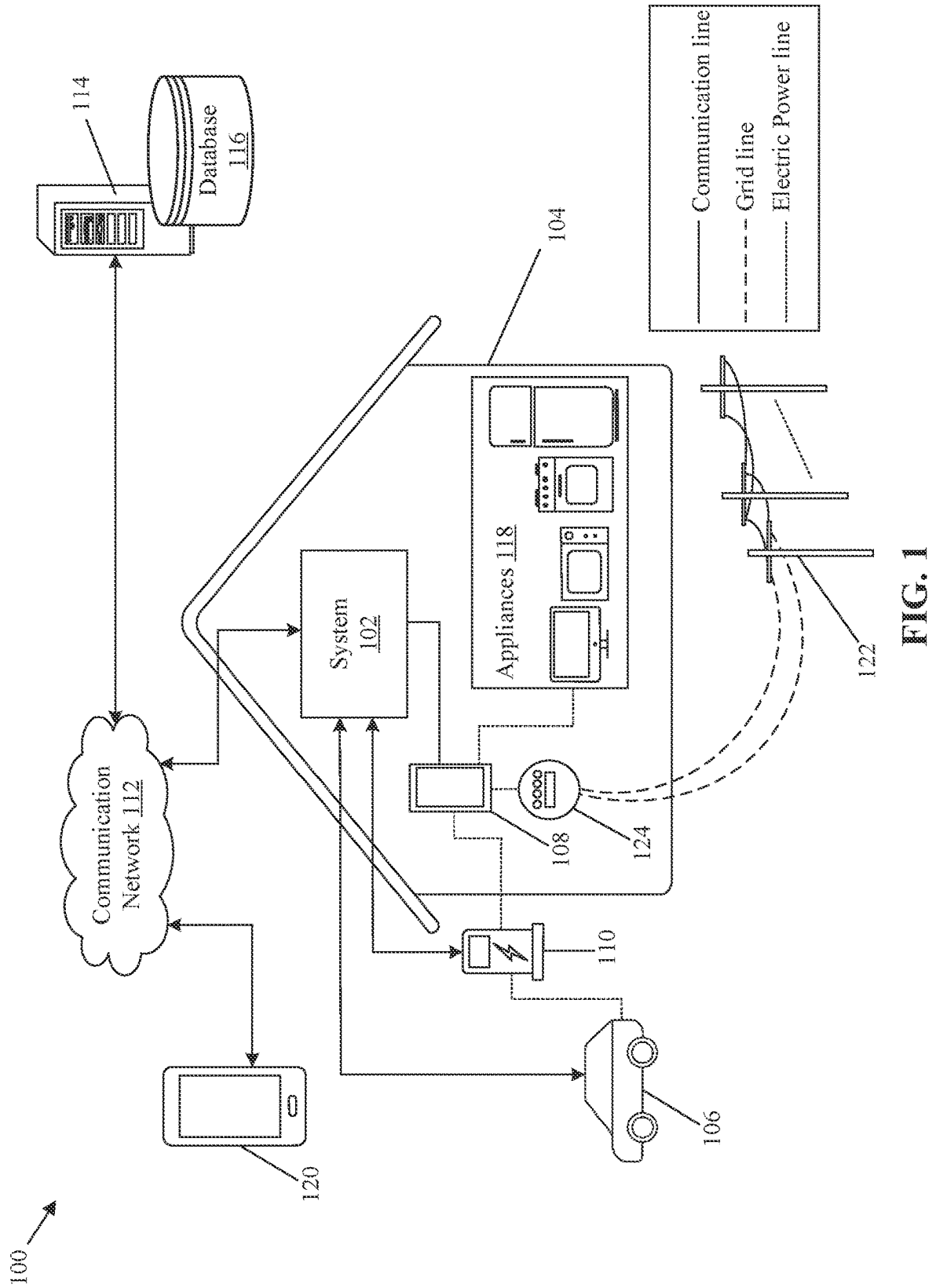
Communication line
Grid line
Electric Power line
114
Database 116
104
System 102
Appliances 118
Communication Network 112
108
124
122
110
120
106
100

FIG. 1

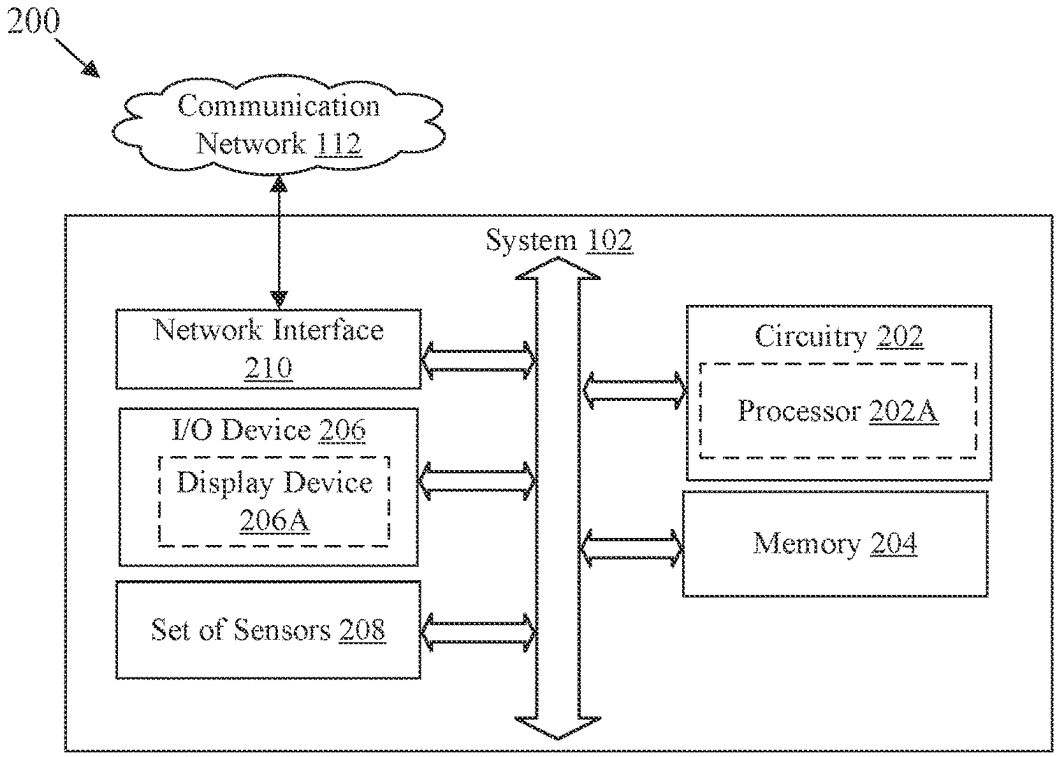
200
Communication Network 112
System 102
Network Interface 210
I/O Device 206
Display Device 206A
Set of Sensors 208
Circuitry 202
Processor 202A
Memory 204

FIG. 2

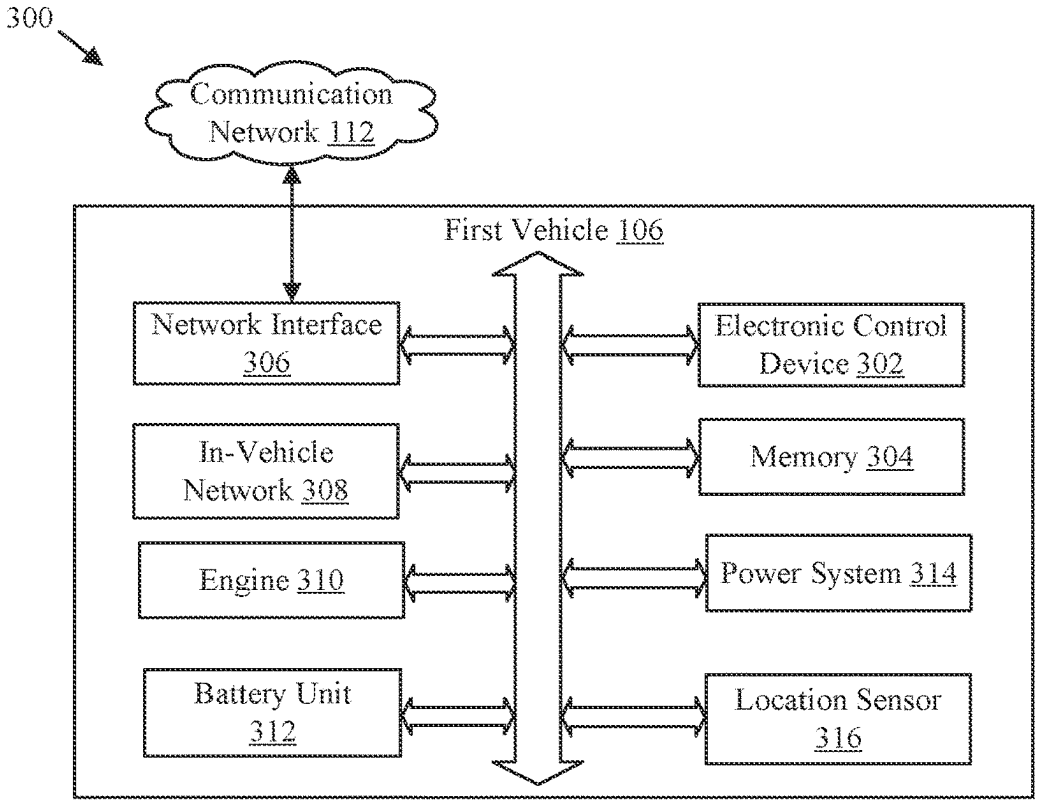
300
Communication Network 112
First Vehicle 106
Network Interface 306
In-Vehicle Network 308
Engine 310
Battery Unit 312
Electronic Control Device 302
Memory 304
Power System 314
Location Sensor 316

FIG. 3

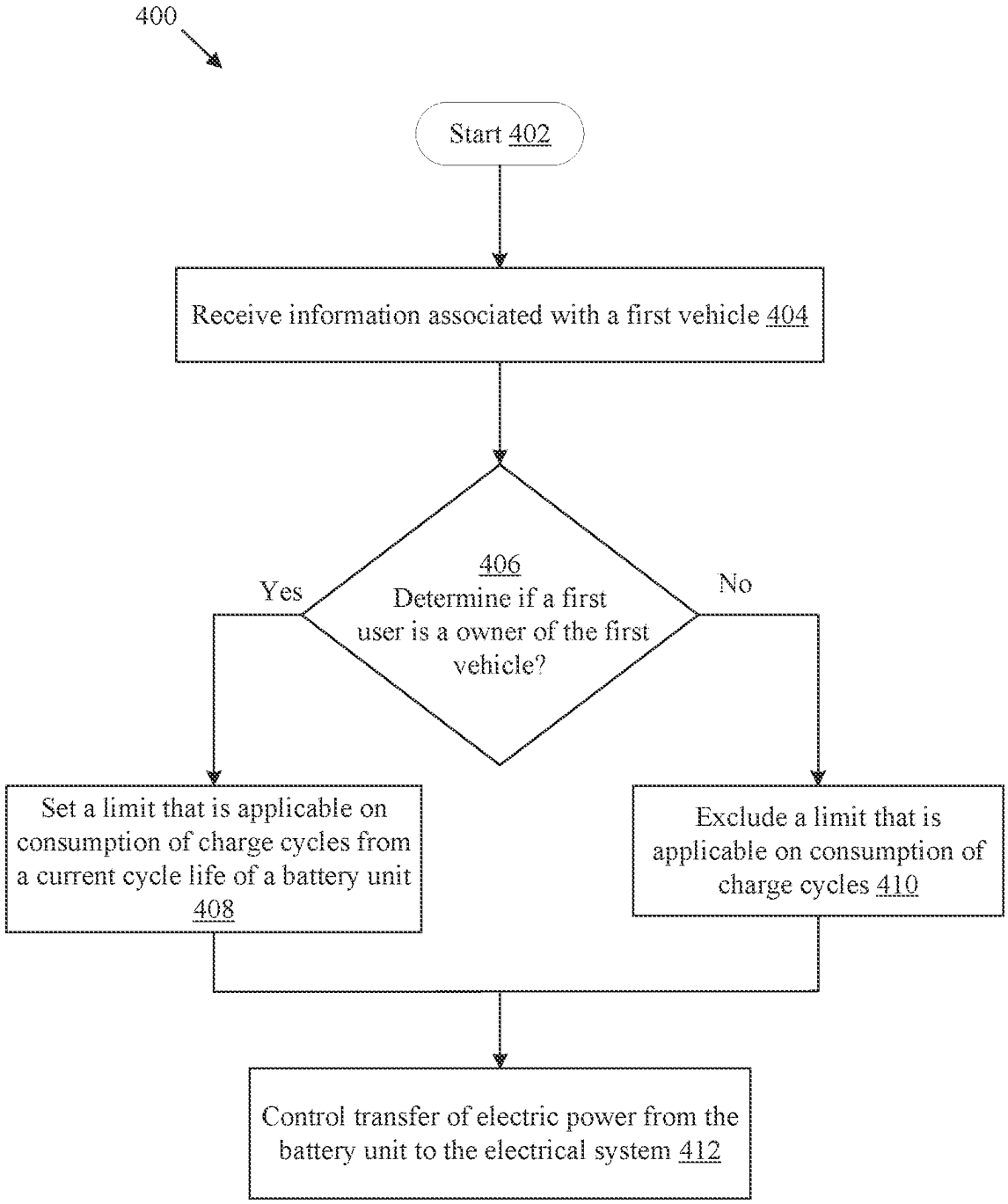
400
Start 402
Receive information associated with a first vehicle 404
406
Determine if a first user is a owner of the first vehicle?
Yes
No
Set a limit that is applicable on consumption of charge cycles from a current cycle life of a battery unit 408
Exclude a limit that is applicable on consumption of charge cycles 410
Control transfer of electric power from the battery unit to the electrical system 412

FIG. 4

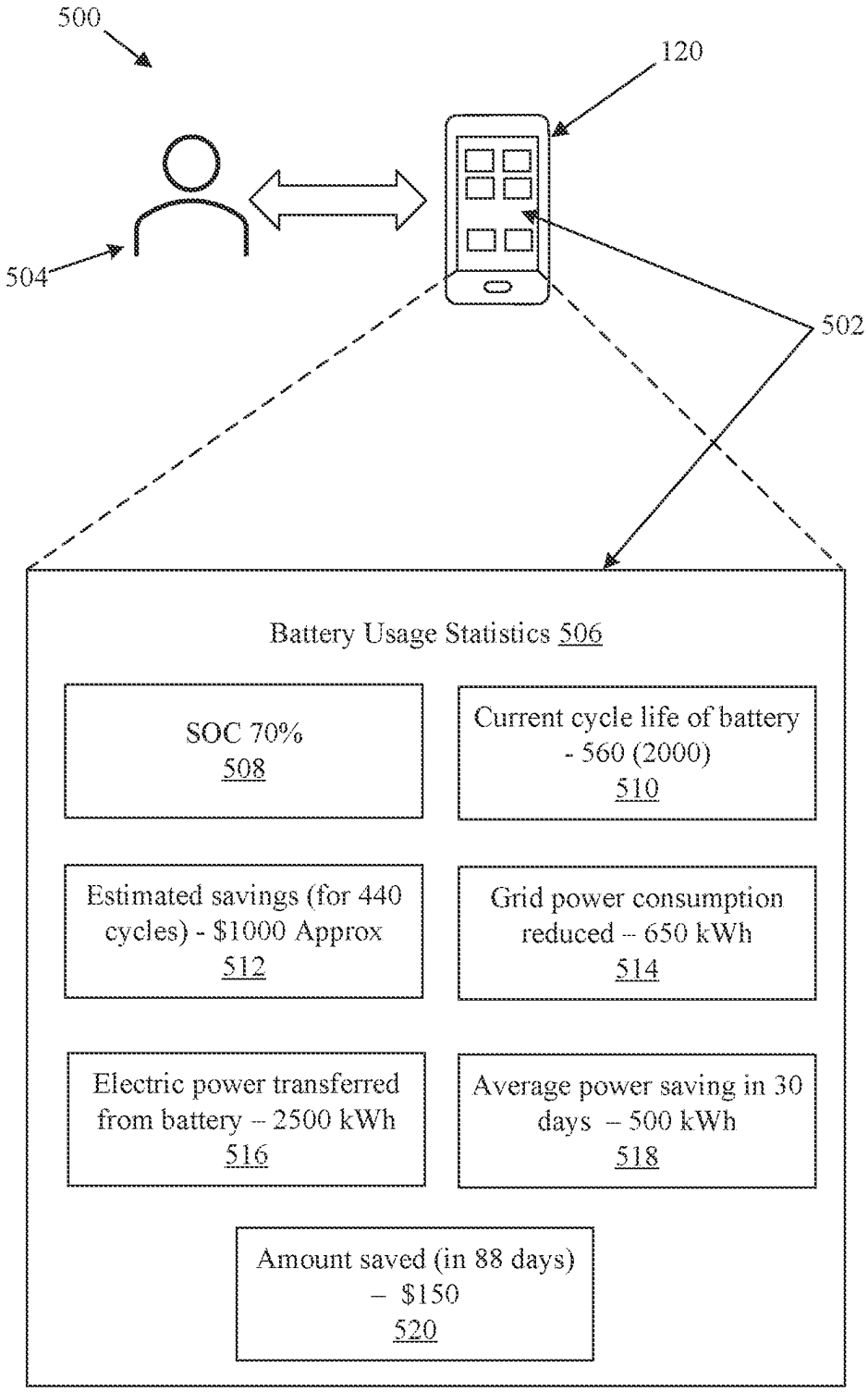
500
120
504
502
Battery Usage Statistics 506
SOC 70%
508
Current cycle life of battery - 560 (2000)
510
Estimated savings (for 440 cycles) - $1000 Approx
512
Grid power consumption reduced – 650 kWh
514
Electric power transferred from battery – 2500 kWh
516
Average power saving in 30 days – 500 kWh
518
Amount saved (in 88 days) – $150
520

FIG. 5

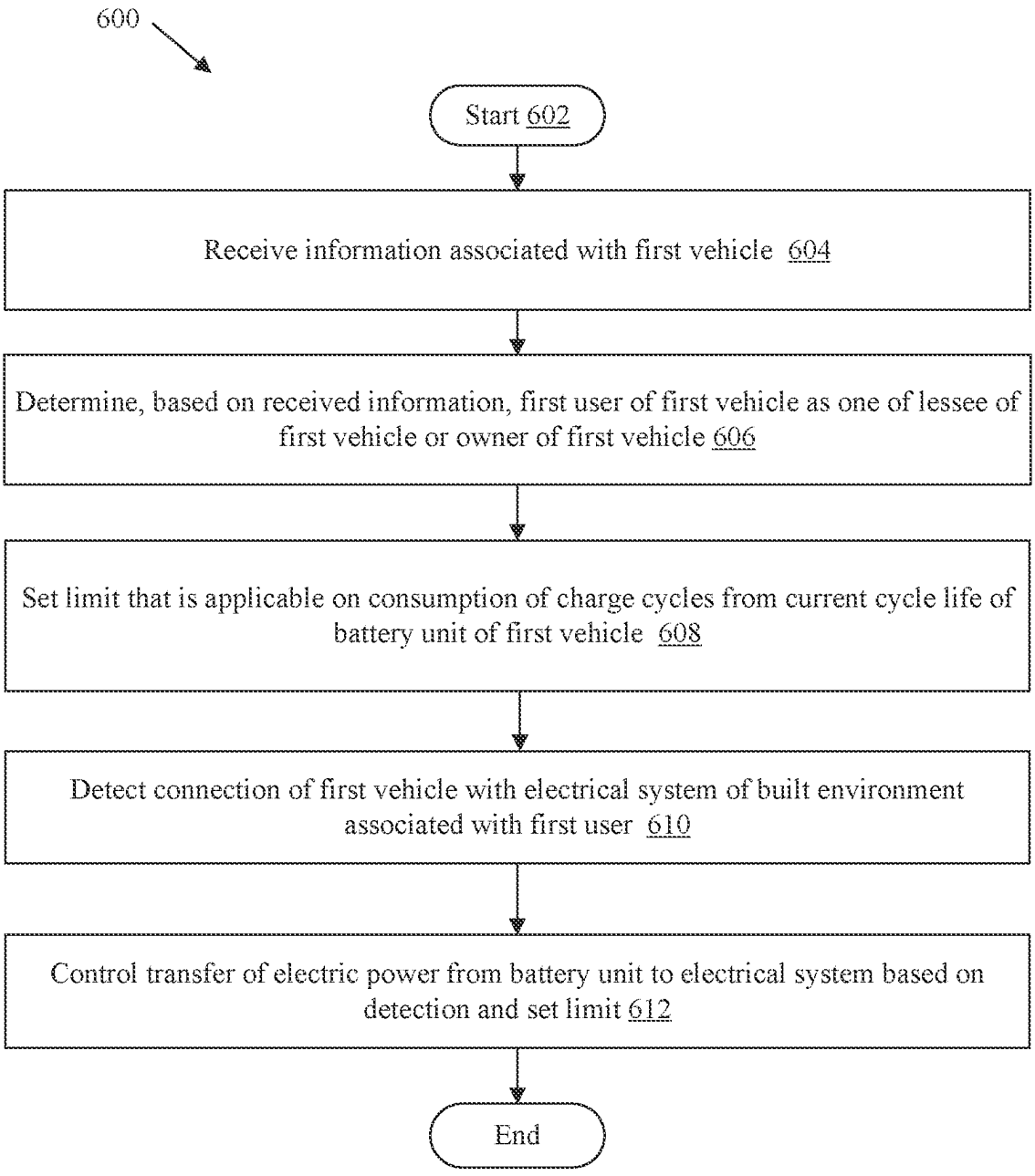
600
Start 602
Receive information associated with first vehicle 604
Determine, based on received information, first user of first vehicle as one of lessee of first vehicle or owner of first vehicle 606
Set limit that is applicable on consumption of charge cycles from current cycle life of battery unit of first vehicle 608
Detect connection of first vehicle with electrical system of built environment associated with first user 610
Control transfer of electric power from battery unit to electrical system based on detection and set limit 612
End

FIG. 6

VEHICLE BATTERY LIFE MANAGEMENT FOR ENERGY SOLUTIONS

BACKGROUND

Advancements in energy management have led to development of various solutions that improve energy consumption and utilization of energy sources (e.g., grid, solar, etc.) for various energy requirements of built environments such as home and office spaces. To balance demand and supply, many energy operators, especially electric utility companies follow demand-based pricing strategies and push for demand response programs that expect customers to reduce electricity usage during periods of higher demand. To avoid undesired power cuts or to reduce power consumption cost, it may be imperative for many consumers, especially homeowners to reduce their reliance on grid-based power supply, especially during hours of peak demand. An alternate power source such as a solar power unit is typically a common option to supply power to loads when the grid-based supply is inadequate or costly. However, solar power may not be reliable for many locations, especially colder regions or locations that don't receive adequate sunlight throughout the year. Another alternate source is an electric vehicle. Many electric vehicles have a battery pack with a decent battery capacity (e.g., up to 100 kWh) and a cycle rating (e.g., 2000 or more full cycles) that makes the battery last for at least a decade or more if used correctly. For many people, this presents a good option to utilize EV batteries for powering electrical loads at various locations, especially at home during a period when the vehicle is not in use or is parked. However, if used inappropriately, EV batteries may lose their cycle life due to poor power consumption practices. For example, if a battery is charged and deep discharged every day, the battery may lose a cycle every day from total cycle life, eventually reducing battery capacity and cycle life to less than what the battery is designed to be used for. Therefore, suitable battery life management may be required to maintain battery health while reducing reliance on grid-based power supply and meeting power requirements of an EV user.

Further limitations and disadvantages of conventional and traditional approaches will become apparent to one of skill in the art, through comparison of described systems with some aspects of the present disclosure, as set forth in the remainder of the present application and with reference to the drawings.

SUMMARY

According to an embodiment of the disclosure, a system for vehicle battery life management to provide energy solutions is disclosed. The system may include circuitry communicatively coupled to a first vehicle. The circuitry may receive information associated with the first vehicle and may determine a first user of the first vehicle as one of a lessee of the first vehicle or an owner of the first vehicle. The determination may be performed based on the received information. The circuitry may set a limit that may be applicable on a consumption of charge cycles from a current cycle life of a battery unit of the first vehicle. The limit may be set based on the determination that the first user is the owner of the first vehicle. The circuitry may detect a connection of the first vehicle with an electrical system of a built environment associated with the first user. Thereafter, the circuitry may control a transfer of electric power from the battery unit to the electrical system based on the detection and the set limit.

According to another embodiment of the disclosure, a method for vehicle battery life management to provide energy solutions is disclosed. The method may include receiving information associated with a first vehicle and determining a first user of the first vehicle as one of a lessee of the first vehicle or an owner of the first vehicle. The determination may be performed based on the received information. The method may include setting a limit that may be applicable on a consumption of charge cycles from a current cycle life of a battery unit of the first vehicle. The limit may be set based on the determination that the first user is the owner of the first vehicle. The method may include detecting a connection of the first vehicle with an electrical system of a built environment associated with the first user. Thereafter, the method may include controlling a transfer of electric power from the battery unit to the electrical system based on the detection and the set limit.

According to another embodiment of the disclosure, a non-transitory computer-readable medium is provided. The non-transitory computer-readable medium may have stored thereon computer implemented instructions that, when executed by a system, causes the system to execute operations. The operations may include receiving information associated with a first vehicle and determining a first user of the first vehicle as one of a lessee of the first vehicle or an owner of the first vehicle. The determination may be performed based on the received information. The operations may include setting a limit that may be applicable on a consumption of charge cycles from a current cycle life of a battery unit of the first vehicle. The limit may be set based on the determination that the first user is the owner of the first vehicle. The operations may further include detecting a connection of the first vehicle with an electrical system of a built environment associated with the first user. Thereafter, the operations may include controlling a transfer of electric power from the battery unit to the electrical system based on the detection and the set limit.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram that illustrates an exemplary network environment for vehicle battery life management, in accordance with an embodiment of the disclosure.

FIG. **2** is a block diagram that illustrates an exemplary system of FIG. **1**, in accordance with an embodiment of the disclosure.

FIG. **3** is a block diagram that illustrates an exemplary vehicle of FIG. **1**, in accordance with an embodiment of the disclosure.

FIG. **4** is a flowchart that illustrates exemplary control of electric power transfer from a battery unit of a vehicle to an electrical system of a built environment, in accordance with an embodiment of the disclosure.

FIG. **5** is a diagram that illustrates an exemplary user device of FIG. **1** to display usage statistics of a battery unit, in accordance with an embodiment of the disclosure.

FIG. **6** is a flowchart that illustrates exemplary operations for vehicle battery life management, in accordance with an embodiment of the disclosure, in accordance with an embodiment of the disclosure.

The foregoing summary, as well as the following detailed description of the present disclosure, is better understood when read in conjunction with the appended drawings. For the purpose of illustrating the present disclosure, exemplary

constructions of the preferred embodiment are shown in the drawings. However, the present disclosure is not limited to the specific methods and structures disclosed herein. The description of a method step or a structure referenced by a numeral in a drawing is applicable to the description of that method step or structure shown by that same numeral in any subsequent drawing herein.

DETAILED DESCRIPTION

The following described implementations may be found in the disclosed system and method for vehicle battery life management to provide energy solutions. Exemplary aspects of the disclosure may provide a system (such as Home Energy Management System (HEMS), Factory Energy Management System (FEMS), Building Energy Management System (BEMS), Vehicle ECU and so on) that may be communicatively coupled to a vehicle. During operation, the system may be configured to receive information (e.g., ownership details) associated with the vehicle. Based on the received information, the system may determine a user of the vehicle as one of a lessee of the vehicle or an owner of the vehicle. Upon determination, the system may set a limit that may be applicable on consumption of charge cycles from a current cycle life of a battery unit of the vehicle. By way of example, and not limitation, the limit may include a value such as a ceiling value on consumption of charge cycles (e.g., a maximum 10 cycles in a month), a ceiling value on a rate of consumption of charge cycles (e.g., 2.5 cycles per week), a ceiling on a state of charge (SOC) consumption (e.g., a maximum of 30% charge), or a ceiling over surplus power (e.g., a maximum of 2 kWh out of remaining 10 kWh). The limit may be set based on the determination that the user is the owner of the vehicle. In case the user is not the owner of the vehicle and is a lessee of the vehicle, the limit may not be set for the user of the vehicle.

At any time-instant, the system may detect a connection of the vehicle with an electrical system of a built environment (such as home, a rental property, a workshop, a business property (e.g., a restaurant owned by user), an office, or any other space) associated with the user. For example, the vehicle may be parked in a garage or at a parking lot near the built environment. Based on the detection and the set limit, the system may control a transfer of electric power from the battery unit of the vehicle to the electrical system of the built environment. While transferring, the system may perform load shedding to switch from grid-based power to power supplied by the battery unit of the vehicle. This may reduce load on the electrical grid line, especially during peak hours of demand.

Energy requirements of built environments such as homes and office spaces are typically fulfilled using power supplied from the electrical grid line. As more people will buy or lease electric vehicles (EV), energy requirements for built environments that will house such vehicles will increase. Many EV users have turned towards distributed or alternate energy sources such as solar to meet energy requirements of electrical systems of respective built environments. To manage electricity demand, respond to demand-side management, or optimize energy consumption, an energy management system may be installed in the built environment. During peak hours or in scheduled timeslots in a day or a specific period, the energy management system may support transfer of electrical power from various sources, such as from grid or off-grid sources such as solar or a battery unit of a vehicle (such as EV) connected to the electrical system of the built environment (such as a home or an office space) to reduce consumption of electric power from the electrical grid.

In some instances, a vehicle owner may overuse the battery unit for an extended period, eventually causing a deep discharge of the battery unit. In some other instances, a vehicle owner may connect too many loads at the same time, causing a quick discharge of the battery unit. If such habits are repeated frequently (e.g., daily), they may reduce the cycle life of the battery unit and force the owner to bear the cost of replacing the battery unit sooner than expected.

In contrast, the present disclosure may help to minimize poor battery usage habits by enforcing a limit on consumption of charge cycles from a current cycle life of the battery unit of the vehicle. The limit may be decided based on ownership of the EV. For example, a user may be owner of the EV or a lessee of the EV. If user is the owner of the vehicle, then any maintenance expenses (such as battery replacement, vehicle repairs etc.) may have to be paid by the owner throughout the duration of ownership. If user is a lessee, then the user may hold ownership of the EV for a limited period as per the lease agreement. To maintain battery health and to avoid incurring premature battery replacement-related expenses, the system may regulate the consumption of charge cycles of the battery unit to ensure that power from the battery unit is utilized optimally for powering electrical loads of the built environment and enough power is available for driving needs.

The present disclosure may promote energy demand management, also known as demand-side management (DSM) or demand-side response (DSR). DSM may be required to encourage a user to consume less electrical energy or use alternate source of electrical energy during periods of peak demand. By opting for load shedding and switching to battery power in place of grid-based power, the present disclosure may help to reduce consumption of power from electrical grid line and may reduce reliance of the built environment on the electrical grid. This may help electric utility companies to achieve targets for DSM. During peak hours when energy prices are high, any reduction in consumption of power from electrical grid line may help the user to reduce energy bills. Thus, techniques described in the present disclosure may encourage a user of an EV to reduce energy bills by reducing reliance on electric grid supply and adopting best practices that lead to optimal utilization of alternate energy sources, especially battery units of EVs.

Reference will now be made in detail to specific aspects or features, examples of which are illustrated in the accompanying drawings. Wherever possible, corresponding, or similar reference numbers will be used throughout the drawings to refer to the same or corresponding parts.

FIG. **1** is a block diagram that illustrates an exemplary network environment for vehicle battery life management, in accordance with an embodiment of the disclosure. With reference to FIG. **1**, there is shown a network environment **100**. The network environment **100** includes a system **102**, a built environment **104**, a first vehicle **106**, an electrical system **108**, an electric charger **110**, a communication network **112**, a server **114**, a database **116**, appliances **118**, a user device **120**, an electrical grid line **122**, and an electric power meter **124**. The system **102** may communicate with the user device **120** and the server **114** through the communication network **112**. The system **102** may be communicatively and electrically coupled with the first vehicle **106**, the electrical system **108**, and the electric charger **110**.

The system **102** may include suitable logic, circuitry, interfaces, and/or code that may be configured to measure

energy requirements of electrical loads such as the appliances **118** of the built environment **104**. Based on the requirements, the system **102** may control a transfer of electric power from a battery unit of the first vehicle **106** to the electrical system **108**. The transfer may be controlled based on whether the first user of the first vehicle **106** is an owner or a lessee of the first vehicle **106**. In some instances, the transfer may be controlled further based on a limit on a consumption of charge cycles from a cycle life of the battery unit. Examples of the system **102** may include, but are not limited to, Home Energy Management System (HEMS), Factory Energy Management System (FEMS), Building Energy Management System (BEMS), and an in-vehicle energy management device inside the first vehicle **106**. Other examples of the system **102** may include, but are not limited to, a computing device, a desktop, a personal computer, a laptop, a computer workstation, a tablet computing device, a smartphone, a cellular phone, a mobile phone, a consumer electronic (CE) device having a display, a wearable display, or an edge device connected to a user's home network or an organization's network.

The built environment **104** may be defined as a living space or a space that may be offered to people to perform social, cultural, religious, economic, or political activities. The built environment **104** may house the system **102**, the first vehicle **106**, the electrical system **108**, the electric charger **110**, the appliances **118**, and the electric power meter **124**. Examples of the built environment **104** may include, but are not limited to, a residential space (such as an apartment or a house), a rental property, a workshop, and a commercial space (such as an office space, a hotel room, a concert hall, or a restaurant owned by user).

The first vehicle **106** may be an electric vehicle that houses a battery unit such as a battery pack to power electrical components of the first vehicle **106**. The first vehicle **106** may be a two-wheeler vehicle, a three-wheeler vehicle, a four-wheeler vehicle, a vehicle with any number of wheels, or a vehicle that uses one or more distinct renewable power sources such as solar power or hydrogen-based fuel. Examples of the first vehicle **106** may include, but are not limited to, a hybrid electric vehicle (HEV), a battery electric vehicle (BEV), a plug-in hybrid electric vehicle (PHEV), or a vehicle with integrated photovoltaics or hydrogen fuel cells.

The electrical system **108** may be electrically coupled to the electric charger **110** and the appliances **118**. The electrical system **108** may include electric circuitry to connect various power sources such as the electrical grid line **122** and the electric charger **110** to electrical loads such as the appliances **118** to control a supply of the electric power. The electric power meter **124** may be connected to the electrical system **108** (or may be a part of the electrical system **108**) for measurement of power consumption. In an embodiment, the electrical system **108** may facilitate transfer of electric power from the battery unit of the first vehicle **106** to the electrical loads such as the appliances **118**. In another embodiment, the electric system **108** may facilitate transfer of the electric power from the electrical grid line **122** to the first vehicle **106**. Example implementations of the electrical system **108** may include, but are not limited to, a single phase, a two phase, or a three-phase circuit.

The electrical system **108** may be configured to operate in two modes, i.e., a first mode and a second mode. In the first mode, the electrical system **108** may allow a transfer of the electric power from the electrical grid line **122** or other alternate sources to the appliances **118** or to charge the battery unit of the first vehicle **106**. In the second mode, the electrical system **108** may allow the transfer of the electric power from the first vehicle **106** to the appliances **118**. While operating in the second mode, the system **102** may perform load shedding and supply of the electrical power from the electrical grid line **122** may be partially or wholly interrupted. For example, when the battery unit of the first vehicle **106** is used for powering the appliances **118**, the electrical power from the electrical grid line **122** may be completely interrupted or partially interrupted. In case the demand for electrical power (for electrical loads such as the appliances **118**) is more than what the first vehicle **106** may be able to supply, the electrical power from the electrical grid line **122** may be partially allowed to power some of the appliances **118**.

The electric charger **110** may include suitable logic, circuitry, and/or interfaces that may be configured to draw power from the electrical grid line **122** or alternate energy sources (such as a photovoltaic inverter or a fuel-based genset) and may charge the first vehicle **106** using the drawn power. The electric charger **110** may be configured to control, process, and/or monitor consumption of the power used for the charging of the first vehicle **106**. In some embodiments, the electric charger **110** may store the power received either from the electrical grid line **122** or the alternate energy sources and may transfer the power to the first vehicle **106**. In some other embodiments, the electric charger **110** may transfer electric power from the first vehicle **106** to electrical loads such as the appliances **118** of the built environment **104**. Examples of the electric charger **110** may include, but are not limited to, an electric vehicle (EV) charging station, an electric recharging point, an electronic charging station, an electric vehicle supply equipment (EVSE), a Direct Current (DC) fast charging station, a home electric charging station, a domestic electrical socket, a level 1 charging station, a level 2 charging station, or a level 3 charging station. The electric charger **110** may be present in a private location (such as a charging adapter located in a garage of the built environment **104**) or a location such as a parking lot or a roadside parking space.

In FIG. **1**, only one electric charger **110** is with the built environment **104**. However, the disclosure may not be limited to presence of one electric charger in the built environment **104**. In some embodiments, a plurality of electric chargers may be installed in the built environment **104**, without a departure from the scope of the disclosure.

The communication network **112** may include a communication medium through which the system **102**, the first vehicle **106**, the electrical system **108**, and the server **114** may communicate with each other. The communication network **112** may include one of a wired connection or a wireless connection. Examples of the communication network **112** may include, but are not limited to, the Internet, a cloud network, a Cellular or Wireless Mobile Network (such as a Long-Term Evolution and 5G New Radio), a Wireless Fidelity (Wi-Fi) network, a Personal Area Network (PAN), a Local Area Network (LAN), or a Metropolitan Area Network (MAN).

Various devices in the network environment **100** may be configured to connect to the communication network **112** in accordance with various wired and wireless communication protocols. Examples of such wired and wireless communication protocols may include, but are not limited to, at least one of a Transmission Control Protocol and Internet Protocol (TCP/IP), User Datagram Protocol (UDP), Hypertext Transfer Protocol (HTTP), File Transfer Protocol (FTP), Zig Bee, EDGE, IEEE 802.11, light fidelity (Li-Fi), 802.16, IEEE 802.11s, IEEE 802.11g, multi-hop communication,

wireless access point (AP), device to device communication, cellular communication protocols, and Bluetooth (BT) communication protocols.

The server **114** may include suitable logic, circuitry, interfaces, and/or code that may be configured to receive information associated with the first vehicle **106** and usage statistics of the battery unit of the first vehicle **106**. The server **114** may provide the information and the usage statistics to the user device **120**. The information may be provided upon reception of requests from the user device **120** or the system **102**. The server **114** may execute operations through web applications, cloud applications, HTTP requests, repository operations, file transfer, and the like. Example implementations of the server **114** may include, but are not limited to, a database server, a file server, a web server, an application server, a mainframe server, a cloud computing server, or a combination thereof.

In at least one embodiment, the server **114** may be implemented as a plurality of distributed cloud-based resources by use of several technologies that are well known to those ordinarily skilled in the art. A person with ordinary skill in the art will understand that the scope of the disclosure may not be limited to the implementation of the server **114** and the user device **120** or the server **114** and the system **102** as two separate entities. In certain embodiments, the functionalities of the server **114** can be incorporated in its entirety or at least partially in the user device **120** or the system **102**, without a departure from the scope of the disclosure.

The database **116** may include suitable logic, interfaces, and/or code that may be configured to store the information associated with the first vehicle **106**, the usage statistics of the battery unit of the first vehicle **106**, limits that may be applicable on a consumption of charge cycles of the battery unit, and a current cycle life of the battery unit. The database **116** may be derived from data off a relational or non-relational database or a set of comma-separated values (csv) files in conventional or big-data storage. In an embodiment, the database **116** may be stored or cached on a device, such as the server **114** or the user device **120**. The device storing the database **116** may be configured to receive a query for the information associated with the usage of the first vehicle **106** from the user device **120** and/or the set of user devices **120**. In response, the server **114** of the database **116** may be configured to retrieve and provide the queried information associated with the usage of the first vehicle **106** and the information associated with limits that is applicable on a consumption of charge cycles, and current cycle life of the battery unit of the first vehicle **106**.

In some embodiments, the database **116** may be hosted on a plurality of servers stored at same or different locations. Operations of the database **116** may be executed using hardware including a processor, a microprocessor (e.g., to perform or control performance of one or more operations), a field-programmable gate array (FPGA), or an application-specific integrated circuit (ASIC). In some other instances, the database **116** may be implemented using software.

The appliances **118** may include small appliances, major appliances, or consumer electronics. Small appliances may include small household electrical machines. Another category may include kitchen appliances such as juicers, electric mixers, meat grinders, coffee grinders, deep fryers, herb grinders, food processors, electric kettles, coffee makers, blenders and dough blenders, rice cookers toasters and exhaust hoods, and the like. The major appliances may include air conditioners, dishwashers, clothes dryers, drying cabinets, freezers, refrigerators, kitchen stoves, water heaters, washing machines, trash compactors, microwave ovens, and induction cookers, and the like. Consumer electronics may include devices intended for entertainment, communications, recreation, and the like. The consumer goods may be meant for housekeeping tasks, such as washing machines and refrigerators. Some of the appliances include home electronics, radio receivers, TV sets, CD, VCRs and DVD players, digital cameras, camcorders, still cameras, clocks, alarm clocks, computers, video game consoles, HiFi and home cinema, and the like.

The user device **120** may include suitable logic, circuitry, interfaces, and/or code that may be configured to display a user interface (UI) that renders usage statistics of the battery unit of the first vehicle **106**. By way of example, and not limitation, the usage statistics may include at least one of a current State of Charge (SOC) of the battery unit of the first vehicle **106**, a current cycle life of the battery unit of the first vehicle **106**, a saving estimate in terms of charge cycles of the battery unit of the first vehicle **106**, a reduction in a consumption of grid power due to the transfer of the electric power to the electrical system **108**, an amount of the electric power that may be transferred to the electrical system **108** from the battery unit, an average power saving for the built environment **104** over a period, or a monetary saving value associated with at least one of the saving estimate, the reduction in the consumption of the grid power, or the average power saving. Examples of the user device **120** may include, but are not limited to, a computing device, a desktop, a personal computer, a laptop, a computer workstation, a tablet computing device, a smartphone, a cellular phone, a mobile phone, a consumer electronic (CE) device having a display, a television (TV), a wearable display, a head mounted display, a digital signage, a digital mirror (or a smart mirror), a video wall (which consists of two or more displays tiled together contiguously or overlapped in order to form one large screen), or an edge device connected to a user's home network or an organization's network.

The electrical grid line **122** may be configured to supply electric power from a power generation unit (such as a power plant) to electrical devices (such as the electric charging facility device or other electrical appliances). The electrical grid line **122** may be a managed network of high voltage (HV) power transmission lines, sub-stations, low voltage (LV) distribution lines, and generation facilities (such as power plants). The electrical grid line **122** may include multiple components, such as high-voltage power lines and low-voltage power lines with distribution transformer that may connect one or more power plants to the built environment **104** across a pre-defined area (such as a state or a country).

The electric power meter **124** (or energy meter) may be used for measuring electrical power (in kilowatt hour (kWh)) consumed by electrical loads such as the appliances **118** and the first vehicle **106**. Electric utilities may use the electric power meter **124** for billing and monitoring purposes (such as power consumption). The electrical grid line **122** may be directly connected to the electric power meter **124**. Through the electrical system **108**, the electric power may be distributed to the electric charger **110** or the appliances **118**.

During operation, the system **102** may receive information associated with the first vehicle **106** (such as ownership details of the first vehicle **106**). Based on the received information, the system **102** may determine if the first user of the first vehicle **106** is the lessee of the first vehicle **106** or the owner of the first vehicle **106**. Details pertaining to the

determination of the user as the lessee or the owner of the first vehicle **106** are further provided, for example, in FIG. **4**.

The system **102** may set a limit that may be applicable on a consumption of charge cycles from a current cycle life of the battery unit of the first vehicle **106**. The limit may be set based on the determination that the first user is the owner of the first vehicle **106**. By way of example, and not limitation, the limit may include a value such as a ceiling value on consumption of charge cycles (e.g., a maximum 10 cycles in a month), a ceiling value on a rate of consumption of charge cycles (e.g., 2.5 cycles per week), a ceiling on a state of charge (SOC) consumption (e.g., a maximum of 30% charge), or a ceiling over surplus power (e.g., a maximum of 2 kWh out of remaining 10 kWh). In case the user is not the owner of the first vehicle **106** and is determined to be a lessee of the first vehicle **106**, the limit may not be set for the user of the first vehicle **106**. Details pertaining to the limit applicable on the consumption of charge cycles are further provided, for example, in FIG. **4**.

At any time, the system **102** may detect a connection of the first vehicle **106** with the electrical system **108** of the built environment **104** (such as home, a rental property, a workshop, a business property (e.g., a restaurant owned by user), an office, or any other space) associated with the user. For example, the first vehicle **106** may be parked in a garage or at a parking lot associated with the built environment **104**. Based on the detection and the set limit, the system **102** may control a transfer of electric power from the battery unit to the electrical system **108** of the built environment **104**.

FIG. **2** is a block diagram that illustrates an exemplary system of FIG. **1**, in accordance with an embodiment of the disclosure. FIG. **2** is explained in conjunction with elements from FIG. **1**. With reference to FIG. **2**, there is shown a block diagram **200** of the system **102**. The system **102** may include circuitry **202**, a memory **204**, an input/output (I/O) device **206**, a display device **206**A, a set of sensors **208**, and a network interface **210**. In at least one embodiment, the I/O device **206** may also include a display device **206**A. The circuitry **202** may also include a processor **202**A. The circuitry **202** may be communicatively coupled to the memory **204**, the I/O device **206**, a set of sensors **208**, and the network interface **210** through wired or wireless communication of the system **102**.

A person of ordinary skill in the art will understand that the block diagram **200** of the system **102** may also include other suitable components or systems, in addition to the components or systems which are illustrated herein to describe and explain the function and operation of the present disclosure. Detailed description of such components or systems has been omitted from the disclosure for the sake of brevity.

The processor **202**A may include suitable logic, circuitry, and/or interfaces code that may be configured to execute program instructions associated with different operations to be executed by the system **102**. The processor **202**A may include any suitable special-purpose or general-purpose computer, computing entity, or processing device including various computer hardware or software modules and may be configured to execute instructions stored on any applicable computer-readable storage media. For example, the processor **202**A may include a microprocessor, a microcontroller, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), a Field-Programmable Gate Array (FPGA), or any other digital or analog circuitry configured to interpret and/or to execute program instructions and/or to process data. The processor **202**A may include any number of processors configured to, individually or collectively, perform or direct performance of any number of operations of the user device **120**, as described in the present disclosure. Examples of the processor **202**A may include a Central Processing Unit (CPU), a Graphical Processing Unit (GPU), an x86-based processor, an x64-based processor, a Reduced Instruction Set Computing (RISC) processor, a Complex Instruction Set Computing (CISC) processor, and/or other hardware processors.

The memory **204** may include suitable logic, circuitry, interfaces, and/or code that may be configured to store the program instructions executable by the processor **202**A. In at least one embodiment, the memory **204** may be configured to store the information associated with the first vehicle **106**. The memory **204** may be further configured to store ownership information of the first vehicle **106** (e.g., whether the first user of the first vehicle **106** is a lessee of the first vehicle **106** or an owner of the first vehicle **106**). The memory **204** may be also configured to store values such as a limit that may be applicable on a consumption of charge cycles from the current cycle life of a battery unit of the first vehicle **106**. The memory **204** may be also configured to store usage statistics of the battery unit. Example implementations of the memory **204** may include, but are not limited to, Random Access Memory (RAM), Read Only Memory (ROM), Hard Disk Drive (HDD), a Solid-State Drive (SSD), a CPU cache, and/or a Secure Digital (SD) card.

The I/O device **206** may include suitable logic, circuitry, interfaces, and/or code that may be configured to receive an input and provide an output based on the received input. The I/O device **206** may include one or more input and output devices that may communicate with different components of the system **102**. For example, the I/O device **206** may receive user inputs to trigger execution of program instructions associated with different operations to be executed by the user device **120**. Examples of the I/O device **206** may include, but are not limited to, a touch screen, a keyboard, a mouse, a joystick, a microphone, the display device **206**A, and a speaker.

The network interface **210** may include suitable logic, circuitry, and interfaces that may be configured to facilitate communication between the system **102**, the first vehicle **106**, the server **114**, and the user device **120** via the communication network **112**. The network interface **210** may be implemented by use of various known technologies to support wired or wireless communication of the server **114** with the communication network **112**. The network interface **210** may include, but is not limited to, an antenna, a radio frequency (RF) transceiver, one or more amplifiers, a tuner, one or more oscillators, a digital signal processor, a coder-decoder (CODEC) chipset, a subscriber identity module (SIM) card, or a local buffer circuitry. The network interface **210** may be configured to communicate via wireless communication with networks, such as the Internet, an Intranet, or a wireless network, such as a cellular telephone network, a wireless local area network (LAN), and a metropolitan area network (MAN). The wireless communication may be configured to use one or more of a plurality of communication standards, protocols and technologies, such as Global System for Mobile Communications (GSM), Enhanced Data GSM Environment (EDGE), wideband code division multiple access (W-CDMA), Long Term Evolution (LTE), 5th Generation (5G) New Radio (NR), code division multiple access (CDMA), time division multiple access (TDMA), Bluetooth, Wireless Fidelity (Wi-Fi) (such as IEEE 802.11a, IEEE 802.11b, IEEE 802.11g or IEEE 802.11n), voice over Internet Protocol (VoIP), light fidelity (Li-Fi), Worldwide

Interoperability for Microwave Access (Wi-MAX), a near field communication protocol, a wireless pear-to-pear protocol, a protocol for email, instant messaging, and a Short Message Service (SMS).

The I/O device **206** may include the display device **206**A. The display device **206**A may include suitable logic, circuitry, and interfaces that may be configured to receive inputs from the processor **202**A to render, on a display screen, usage statistics of the battery unit of the first vehicle **106**. The display device **206**A may include suitable logic, circuitry, and interfaces that may be configured to receive, via the UI, a user preference associated with a usage of the battery unit of the first vehicle **106** for the electrical system **108** of the built environment **104**, and wherein the limit may be set further based on the user preference. The user preference may include a state of charge (SOC) value that is to be left in the battery unit of the first vehicle **106** after the transfer of the electric power to the electrical system **108**. The limit may be set further based on the SOC value and the current cycle life of the battery unit of the first vehicle **106**. The display device **206**A may be realized through several known technologies such as, but not limited to, at least one of a Liquid Crystal Display (LCD) display, a Light Emitting Diode (LED) display, a plasma display, or an Organic LED (OLED) display technology, or other display devices.

The set of sensors **208** may include suitable logic, circuitry, and interfaces that may be configured to monitor the appliances **118** and the electrical system **108**. Example of such sensors may include, but is not limited to, voltage and current sensors; temperature sensor, proximity sensor, accelerometer, IR sensor (infrared sensor), pressure sensor, light sensor, ultrasonic sensor, smoke, gas and alcohol sensor, touch sensor, color sensor, humidity sensor, position sensor, magnetic sensor (hall effect sensor), microphone (sound sensor), tilt sensor, flow sensor, level sensor, PIR sensor, touch sensor, and strain and weight sensor.

FIG. **3** is a block diagram that illustrates an exemplary vehicle of FIG. **1**, in accordance with an embodiment of the disclosure. FIG. **3** is explained in conjunction with elements from FIG. **1** and FIG. **2**. With reference to FIG. **3**, there is shown a block diagram **300** of the first vehicle **106**. The first vehicle **106** may include an electronic control device **302**, a memory **304**, a network interface **306**, an in-vehicle network **308**, an engine **310**, a battery unit **312**, a power system **314**, and a location sensor **316**.

The electronic control device **302** may include suitable logic, circuitry, interfaces, and/or code that may be configured to monitor usage of the first vehicle **106**. The electronic control device **302** may be a specialized electronic circuitry that may include an electronic control unit (ECU) processor to control different functions, such as, but not limited to, engine operations, communication operations, and data acquisition of the first vehicle **106**. The electronic control device **302** may store information associated with the first vehicle **106** and may transmit such information to the system **102** based on requirements. In an embodiment, the electronic control device **302** may determine usage statistics associated with the battery unit **312** of the first vehicle **106** One example implementation of the electronic control device **302** can be a microprocessor. Other examples of the electronic control device **302** may include, but are not limited to, a vehicle control system, an in-vehicle infotainment (IVI) system, an in-car entertainment (ICE) system, an automotive Head-up Display (HUD), an automotive dashboard, an embedded device, a smartphone, a human-machine interface (HMI), a computer workstation, a handheld computer, a cellular/mobile phone, a portable CE device, a server, and other computing devices.

The memory **304** may include suitable logic, circuitry, interfaces, and/or code that may be configured to store a set of instructions executable by the electronic control device **302**. In at least one embodiment, the memory **304** may be configured to store the information associated with the first vehicle **106** and usage statistics associated with the battery unit **312** of the first vehicle **106**. Examples of implementation of the memory **204** may include, but are not limited to, RAM, ROM, a HDD, an SSD, a CPU cache, and/or a SD card.

The network interface **306** may include suitable logic, circuitry, and interfaces that may be configured to facilitate communication between the electronic control device **302** and the various devices or components of the network environment **100** (such as the user device **120** and the server **114**), via the communication network **112**. The network interface **306** may be implemented by use of various known technologies to support wired or wireless communication of the first vehicle **106** with the communication network **112**. The network interface **306** may include, but is not limited to, an antenna, a RF transceiver, one or more amplifiers, a tuner, one or more oscillators, a digital signal processor, a CODEC chipset, a SIM card, or a local buffer circuitry. The network interface **306** may be configured to communicate via wireless communication with networks, such as the Internet, an Intranet, or a wireless network, such as a cellular telephone network, a wireless LAN, and a MAN. The wireless communication may be configured to use one or more of a plurality of communication standards, protocols, and technologies, such as GSM, EDGE, W-CDMA, LTE, 5G NR, CDMA, TDMA, Bluetooth, Wi-Fi (such as IEEE 802.11a, IEEE 802.11b, IEEE 802.11g or IEEE 802.11n), VoIP, Li-Fi, Wi-MAX, a protocol for email, instant messaging, and a SMS.

The in-vehicle network **308** may include a medium through which the electronic control device **302**, the memory **304**, the engine **310**, the battery unit **312**, the power system **314**, and the location sensor **316** may communicate with each other. In accordance with an embodiment, in-vehicle communication of audio/video data may occur by use of Media Oriented Systems Transport (MOST) multimedia network protocol of the in-vehicle network **308** or other suitable network protocols for vehicle communication. The MOST-based network may be a separate network from the controller area network (CAN). The MOST-based network may use a plastic optical fiber (POF) medium. In accordance with an embodiment, the MOST-based network, the CAN, and other in-vehicle networks may co-exist in a vehicle, such as the first vehicle **106**. The in-vehicle network **308** may facilitate access control and/or communication between the electronic control device **302** and other ECUs, such as ECM or a telematics control unit of the first vehicle **106**.

Various devices or components in the first vehicle **106** may connect to the in-vehicle network **308**, in accordance with various wired and wireless communication protocols. Examples of the wired and wireless communication protocols for the in-vehicle network **308** may include, but are not limited to, cellular Vehicle-to-Everything (C-V2X) communication, Dedicated Short-Range Communication (DSRC), a vehicle area network (VAN), a CAN bus, Domestic Digital Bus (D2B), Time-Triggered Protocol (TTP), FlexRay, IEEE 1394, Carrier Sense Multiple Access With Collision Detection (CSMA/CD) based data communication protocol, Inter-Integrated Circuit (I^2C), Inter Equipment Bus (IEBus), Soci-

ety of Automotive Engineers (SAE) J1708, SAE J1939, International Organization for Standardization (ISO) 11992, ISO 11783, MOST, MOST25, MOST50, MOST150, Plastic optical fiber (POF), Power-line communication (PLC), Serial Peripheral Interface (SPI) bus, and/or Local Interconnect Network (LIN).

The engine **310** may operate only on stored electricity and may include one or more electric motors (either alternating current [AC] or direct current [DC]), and a controller to manage the power electronics. Compared with ICEs, which deliver their peak torque within a limited range of engine rpm, the electric motor can deliver a constant and high torque over a broad range of speeds from zero mph; thus, most EVs neither need a reduction gearbox nor do they require the increasingly complex engine management systems that have been added to ICEs and their transmissions to comply with emissions legislation while retaining drivability. As a result, the complete EV drivetrain may be less complex compared to conventional vehicles with ICE. A description of various parts of the engine **310** has been omitted from the disclosure for the sake of brevity.

The battery unit **312** may be a source of electric power for one or more electric circuits or loads in the first vehicle **106**. For example, the battery unit **312** may be a source of electrical power to the electronic control device **302**, the memory **304**, the network interface **306**, the in-vehicle network **308**, the engine **310**, the power system **314**, and the location sensor **316**. The battery unit **312** may correspond to a battery pack that includes a specific arrangement of multiple batteries. Such batteries are typically surrounded by a suitable coolant and a charge controller. Examples of the battery unit **312** may include, but are not limited to, a lead acid battery, a nickel cadmium battery, a nickel—metal hydride battery, a lithium-ion battery, a sodium ion battery, and other forms of rechargeable batteries.

The power system **314** may include suitable logic, circuitry, interfaces, and/or code that may be configured to control output of electric power to various electric circuits and loads of the first vehicle **106**. The power system **314** may utilize the battery to provide the electric power to perform various electrical operations of the first vehicle **106**. The power system **314** may provide the electric power for functioning of different components (such as the electronic control device **302**, the memory **304**, the network interface **306**, the in-vehicle network **308**, the engine **310**, the battery unit **312**, the power system **314**, and the location sensor **316**) of the first vehicle **106**. In some instances, the power system **314** may be configured to receive control signals from the electronic control device **302** to control the various electric circuits and loads of the first vehicle **106**. The power system **314** may be configured to control the charging and the discharging of the battery unit **312** based on the received control signals. Examples of the power controller may include, but are not limited to, an electric charge/discharge controller, a charge regulator, a battery regulator, a battery management system, an electric circuit breaker, a power electronic drive control system, an Application-Specific Integrated Circuit (ASIC) processor, and/or other power-control hardware processors.

The location sensor **316** may include suitable logic, circuitry, and/or interfaces that may be configured to determine a current geo-location of the first vehicle **106**. Examples of the location sensor **316**, may include, but are not limited to, a Global Navigation Satellite System (GNSS)-based sensor of the first vehicle **106**. Examples of the GNSS-based sensor may include, but are not limited to, global positioning sensor (GPS), Global Navigation Satellite System (GLONASS), or other regional navigation systems or sensors.

FIG. **4** is a flowchart that illustrates exemplary control of electric power transfer from a battery unit of a vehicle to an electrical system of a built environment, in accordance with an embodiment of the disclosure. FIG. **4** is explained in conjunction with elements from FIG. **1**, FIG. **2**, and FIG. **3**. With reference to FIG. **4**, there is shown an exemplary flowchart **400** that provides operations from **404** to **412**, as described herein. The operations may start at **402** and proceed to **404**.

At **404**, information associated with the first vehicle **106** may be received. The first vehicle **106** may be communicatively coupled with the processor **202**A. The processor **202**A may be configured to receive the information associated with the first vehicle **106**. The information associated with the first vehicle **106** may include, for example, vehicle identifiers such as vehicle registration number, vehicle identification number (VIN), a unique code assigned to the first vehicle **106** to uniquely identify the vehicle model and a technical specification of the first vehicle **106**. Additionally, or alternatively, the information may include ownership or lease details of the first vehicle **106**. Such details may help to identify whether the current user of the first vehicle **106** is an owner, co-owner, a lessee, or a co-lessee of the first vehicle **106**.

At **406**, it may be determined whether the first user is the owner of the first vehicle **106** or the lessee of the first vehicle **106**. The determination may be performed based on the received information. By way of example, and not limitation, the processor **202**A may compare the received information associated with the first vehicle **106** with ownership data that may be stored on the server **114** (i.e., the database **116**). The comparison may be performed to identify whether the first user is the owner or the lessee (i.e., whether the first vehicle **106** is on lease or not). The ownership data may include unique identifiers associated with different vehicles and respective users. Additionally, or alternatively, the ownership data may include a list of vehicles, owner or lessee information for the vehicles, and details such as an ownership period, a lease period, a date of purchase or lease, license and registration details, insurance details, and usage data (e.g., average number of miles traveled per day or in a defined period, a charging frequency, and the like). In some instances, load requirements (in terms of kWh or units) and energy usage pattern for a day or a particular duration in day may be identified for the built environment **104**. The load requirements and the energy usage pattern may be required to identify a schedule that may be used to execute load shedding (of grid-based power supply) for the electrical system **108** of the built environment **104** and to switch to power supply from the battery unit **312** of the first vehicle **106**.

In an exemplary scenario, a query may be sent by the processor **202**A to the server **114** to determine if the first user is the owner of the first vehicle **106**. The query may include identifiers of the first user and the first vehicle **106** (extracted from the received information associated with the first vehicle **106**). Based on the query, a database search may be performed to lookup ownership details of the first user in the database **116**. The result of the search may indicate whether a record pertaining to ownership or lease of the first vehicle **106** exists in the database **116** and whether the first user is a legal owner or a legal lessee of the first vehicle **106**.

In case it is determined that the first user is the owner of the first vehicle **106**, control may pass to **408**. Otherwise, control may pass to **410**.

At **408**, a limit may be set on usage of the battery unit **312** of the first vehicle **106** for applications such as a Vehicle-to-Home (V2H) application, a Vehicle-to-Load (V2L), or a Vehicle-to-Grid (V2G) application. In some instances, the built environment **104** may be equipped with a bidirectional charging equipment that may control transfer of electric power to and from the battery unit **312** of the first vehicle **106**. In such instances, the limit may be set to control operations of such a charging equipment and the electrical system **108** of the built environment **104**. The limit may be applicable on a consumption of charge cycles from a current cycle life of the battery unit **312** of the first vehicle **106**. Based on a determination that the first user is the owner of the first vehicle **106**, the processor **202**A may set a limit such as a ceiling value on the consumption of charge cycles (e.g., a maximum of 100 cycles out of a cycle rating of 3000 cycles), a ceiling value on a rate of consumption (e.g., a maximum of 2 cycles per week), a ceiling on a state of charge (e.g., a maximum of 30% charge consumption while keeping a minimum balance charge of 30% at any time), or a ceiling over surplus power (e.g., a maximum of 2 kWh out of remaining 10 kwh of usable battery capacity).

At **410**, the limit applicable on the consumption of the charge cycles may be excluded for the first user. The set limit may be excluded based on the determination that the first user is the lessee. If the first vehicle **106** is on lease, the cost of battery maintenance or battery replacement may be covered under lease agreement. In some cases, the lessee may not be liable or responsible to bear charges of battery maintenance or replacement. Therefore, it may not be imperative or desirable to set any limit on the consumption of charge cycles from a current cycle life of the battery unit **312**. In an embodiment, an option may be provided to the lessee to request a limit on consumption of charge cycles for powering electrical loads (other than vehicle components) of the built environment **104**.

At **412**, a transfer of electric power from the battery unit **312** to the electrical system **108** may be controlled. Based on the limit set on consumption of charge cycles, the processor **202**A may control transfer of electric power from the battery unit **312** of the first vehicle **106** to the electrical system **108**.

Before the transfer, the processor **202**A may signal one or more components of the electrical system **108** to execute load shedding fora defined duration (e.g., 1 hour). In that duration, any transfer of power from the electrical grid line **122** to the electrical system **108** may be limited to few loads or completely interrupted. During load shedding, the transfer may be controlled by signaling the first vehicle **106** to enable power transfer to electrical loads (includes the appliances **118**) via the electrical system **108**. In an embodiment, the transfer may occur via the electric charger **110** (with bidirectional charging capability) that may convert DC output of the battery unit **312** to AC output which meets standard power supply requirements. Alternatively, the conversion may be performed by an inverter system integrated into the first vehicle **106**

The processor **202**A may be configured to control or signal the electric charger **110** to manage transfer of electric power between the battery unit **312** and the electrical system **108**. For example, the processor **202**A may control the electric charger **110** to transfer the electric power from the battery unit **312** to the electrical system **108** from the electrical system **108** to the battery unit **312**. Alternatively, the processor **202**A may control the electrical charger **110** and the electrical system **108** to selectively transfer the electric power from the battery unit **312** to specific electrical loads of the built environment **104**. For instance, while the battery unit **312** may power lighter devices such as lighting fixtures and display devices, a portion of grid-based power may be supplied to heavier loads such as air conditioners or electric heaters. The processor **202**A may also control the electric charger **110** to interrupt transfer of the electric power to certain loads, if required.

In accordance with an embodiment, the first ceiling value may be checked for setting a limit, based on determination that the first user is the owner of the first vehicle **106**. The first ceiling value may be applicable over a consumption of the charge cycles from the current cycle life of the battery unit **312** of the first vehicle **106**. The first ceiling value may be selected to ensure that the value remains less than the current cycle life of the battery unit **312**. During operation, the first ceiling value may be compared with the consumption of charge cycle of the battery unit **312**. Based on the comparison, the transfer of the electric power from the battery unit **312** to the electrical system **108** may be controlled such that the consumption of the charge cycles remains less than or equal to the first ceiling value. For example, the first ceiling value may be determined to be 20 cycles out of current cycle life of 2000 cycles. If it is determined that the consumption of the charge cycle is 15 cycles (5 less than the ceiling value of 20 cycles), the transfer of electric power from the battery unit **312** to the electrical system **108** may not be interrupted. When the consumption of the charge cycle reaches or almost breaches the first ceiling value, the transfer of electric power from the battery unit **312** to the electrical system **108** may be interrupted.

In accordance with an embodiment, the second ceiling value may be checked for setting a limit, based on a determination that the first user is the owner of the first vehicle **106**. The second ceiling value may be applicable over a rate of consumption of the charge cycles from the current cycle life of the battery unit **312** of the first vehicle **106**. During operation, the second ceiling value may be compared with a current rate of consumption of the charge cycle of the battery unit **312**. Based on the comparison, the transfer of the electric power from the battery unit **312** to the electrical system **108** may be controlled such that the rate of consumption of the charge cycles remains less than or equal to the second ceiling value. For example, the processor **202**A may determine or set the second ceiling value as 2 cycles per week from a current cycle life of 200 cycles. If current rate of consumption of the charge cycle is 1.5 cycles per week, then the transfer of electric power from the battery unit **312** to the electrical system **108** may not be interrupted. While allowing the transfer, the system **102** may ensure that the first vehicle **106** is not deep discharged and SOC (% charge) of the battery unit **312** remains above a threshold (e.g., 30% or above) at any time instant. If the rate of consumption of the charge cycle reaches or almost breaches the second ceiling value, then the transfer of electric power from the battery unit **312** to the electrical system **108** may be interrupted.

In accordance with an embodiment, the third ceiling value may be checked for setting a limit, based on a determination that the first user is the owner of the first vehicle **106**. The third ceiling value may be applicable over a surplus amount of electric power that may be left in the battery unit **312** of the first vehicle **106** at any time instant. During operation, the third ceiling value may be compared with the surplus amount of electric power and the transfer of electric power

from the battery unit **312** to the electrical system **108** may be controlled based on the comparison. The control may be performed such that the surplus amount of electric power in the battery unit **312** remains less than or equal to the third ceiling value at any time instant. For example, the processor **202**A may be configured to determine the third ceiling value as 10 kWh per day from a surplus of 30 kWh that may be left in the battery (rated at 100 kWh). If it is determined that the surplus amount of electric power in the battery unit **312** is 15 kWh at a time-instant, the transfer of electric power from the battery unit **312** to the electrical system **108** may not be interrupted. When the surplus amount of electric power in reaches or almost breaches the third ceiling value, the transfer of electric power from the battery unit **312** to the electrical system **108** may be interrupted.

In accordance with an embodiment, the fourth ceiling value may be checked for setting a limit, based on a determination that the first user is the owner of the first vehicle **106**. The fourth ceiling value may correspond to a residual state of charge (SOC) that may be left in the battery unit **312** of the first vehicle **106**. The fourth ceiling value may be compared with the residual SOC that may be left in the battery unit **312** of the first vehicle **106**. Based on the comparison, the transfer of the electric power from the battery unit **312** to the electrical system **108** may be controlled such that the residual SOC in the battery unit **312** of the first vehicle **106** remains less than or equal to the fourth ceiling value. For example, the processor **202**A may determine the fourth ceiling value as 40% (which must be remain available for next trip). If, while supplying power to electrical system **108**, the residual SOC is determined to be 45% in the battery unit **312** (i.e., less than the fourth ceiling value), then the transfer of electric power from the battery unit **312** to the electrical system **108** may not be interrupted. When the residual SOC reaches or almost breaches the fourth ceiling value, the transfer of the electric power from the battery unit **312** to the electrical system **108** may be interrupted. Setting of the limit, as described in the foregoing description, may help to ensure that the battery unit **312** is not overused for transferring electric power to the electrical loads such as the appliances **118** and the battery unit **312** remains healthy or usable for a defined duration (e.g., a battery life (in years) or a warranty period for battery packs).

In an embodiment, the processor **202**A may be communicatively coupled to a second vehicle (not shown). The second vehicle may be an electric vehicle that a second user may own. Both the second vehicle and the first vehicle **106** may be parked inside a parking space of the built environment **104** and may be capable of delivering of power to electrical system **108** at same or different time durations. During operation, the processor **202**A may determine the second user of the second vehicle as one of a lessee of the second vehicle or an owner of the second vehicle. Upon determination that the second user is the owner of the second vehicle, the processor **202**A may set a limit that may be applicable on a consumption of charge cycles from a current cycle life of a battery unit of the second vehicle. The limit may be set based on a determination that the second user is the owner of the second vehicle. Thereafter, the processor **202**A may control a transfer of electric power from the battery unit **312** to the electrical system **108** based on the detection and the set limit. In accordance with an embodiment, the processor **202**A may determine a current cycle life of a battery unit of the second vehicle. Based on the current cycle life, the limit on consumption of charge cycles from battery units of both vehicles (i.e., first and second vehicles) may be set.

FIG. **5** is a diagram that illustrates an exemplary user device of FIG. **1** to display usage statistics of a battery unit, in accordance with an embodiment of the disclosure. FIG. **5** is explained in conjunction with elements from FIG. **1**, FIG. **2**, FIG. **3**, and FIG. **4**. With reference to FIG. **5**, there is shown diagram **500** of an exemplary UI that displays battery usage statistics.

During operation, the processor **202**A may control the user device **120** to display a UI **502** that includes battery usage statistics **506** of the battery unit **312** of the first vehicle **106**. The battery usage statistics **506** may include a current SOC **508** of the battery unit **312** of the first vehicle **106**. As shown, for example, 70% SOC' may correspond to a current residual SOC that may be left in the battery unit **312**. The battery usage statistics **506** may further include a current cycle life **510** of the battery unit **312** of the first vehicle **106**. For example, a value of '560 (2000)' on the UI **502** is shown to indicate that the battery unit **312** of the first vehicle **106** has a cycle life of 560 cycles and a total cycle life (i.e., a cycle rating) of the battery unit **312** may be 2000 cycles (i.e., 2000 full discharge to full charge cycles).

The battery usage statistics **506** may further include an estimated saving **512** i.e., a saving estimate in terms of charge cycles of the battery unit **312** of the first vehicle **106**. For example, an estimated saving of 440 cycles is shown on the UI **502** to indicate a reduction in consumption of power supplied by the electrical grid line **122**. The reduction may be equivalent to a monetary saving of roughly 1000 USD. The battery usage statistics **506** may also include a statistic to indicate a reduction in grid power consumption **514**. The reduction in consumption of the electrical grid line **122** power may be due to controlled load shedding and transfer of the electric power from the battery unit **312** to the electrical system **108** for a duration of the load shedding. For example, a value of 650 kWh is shown on the UI **502** to encourage the first user to continue using the battery unit for power requirements of the built environment **104**.

The battery usage statistics **506** may further include a value to indicate an amount of electric power transferred from battery unit to the electrical system **108**. An example value **516** of 2500 kWh of electric power is shown on the UI **502**. The battery usage statistics **506** may also include an average power saving for a period **518** such as last 30 days. As shown, an average power saving for the built environment **104** over the period **518** (i.e., last 30 days) may be 500 kWh. The battery usage statistics **506** may also include a saving amount **520**. Therefore, "Amount saved (in 88 days)—$150" may mean that a total of $150 amount is saved over a period of 88 days.

During operation, the processor **202**A may receive a preference of a user **504**. The preference may be associated with a usage of the battery unit **312** of the first vehicle **106** for the electrical system **108** of the built environment **104**. The user preference may be received via the UI **502** of the user device **120**. By way of example, and not limitation, the user preference may include an SOC value that must remain in the battery unit **312** of the first vehicle **106** after the transfer of the electric power to the electrical system **108** through the electric charger **110**. The limit may be set based on the SOC value specified in the user preference and a current cycle life of the battery unit **312** of the first vehicle **106**.

FIG. **6** is a flowchart that illustrates exemplary operations for vehicle battery life management, in accordance with an embodiment of the disclosure. With reference to FIG. **6**, there is shown a flowchart **600**. The flowchart **600** is described in conjunction with FIGS. **1**, **2**, **3**, **4**, **5**, and **6**. The

operations from **602** to **612** may be implemented, for example, by the system **102** of FIG. **1** or the processor **202**A of FIG. **2**. The operations of the flowchart **600** may start at **602** and proceed to **604**.

At **604**, information associated with the first vehicle **106** may be received. In one or more embodiment, the processor **202**A may be configured to receive the information associated with the first vehicle. Details about the receiving of the information associated with first vehicle **106** are provided, for example, in FIG. **4** (at **404**).

At **606**, a user of the first vehicle **106** may be determined as a lessee of the first vehicle **106** or an owner of the first vehicle **106**. In one or more embodiments, the processor **202**A may be configured to determine if the first user of the first vehicle **106** is the lessee of the first vehicle **106** or the owner of the first vehicle **106**, based on the received information.

At **608**, a limit applicable on a consumption of charge cycles from a current cycle life of a battery unit **312** of the first vehicle **106** may be set. The limit may be set based on the determination that the first user is the owner of the first vehicle **106**. In one or more embodiments, the processor **202**A may be configured to set the limit. Details about the setting of the limit are provided, for example, in FIG. **5**.

At **610**, a connection of the first vehicle **106** with the electrical system **108** of the built environment **104** may be detected. In one or more embodiments, the processor **202**A may detect the connection of the first vehicle **106** with the electrical system **108** of the built environment **104**.

At **612**, the transfer of electric power from the battery unit **312** to the electrical system **108** may be controlled based on the detection and the set limit. In one or more embodiments, the processor **202**A may control the transfer of electric power from the battery unit **312** to the electrical system **108**, based on the detection and the set limit. Details about the transfer of electric power from the battery unit **312** to the electrical system **108** are provided, for example, in FIG. **4** (at **410**). Control may pass to end.

The present disclosure may be realized in hardware, or a combination of hardware and software. The present disclosure may be realized in a centralized fashion, in at least one computer system, or in a distributed fashion, where different elements may be spread across several interconnected computer systems. A computer system or other apparatus adapted for carrying out the methods described herein may be suited. A combination of hardware and software may be a general-purpose computer system with a computer program that, when loaded and executed, may control the computer system such that it carries out the methods described herein. The present disclosure may be realized in hardware that includes a portion of an integrated circuit that also performs other functions. It may be understood that, depending on the embodiment, some of the steps described above may be eliminated, while other additional steps may be added, and the sequence of steps may be changed.

The present disclosure may also be embedded in a computer program product, which includes all the features that enable the implementation of the methods described herein, and which when loaded in a computer system is able to carry out these methods. Computer program, in the present context, means any expression, in any language, code or notation, of a set of instructions intended to cause a system with an information processing capability to perform a particular function either directly, or after either or both of the following: a) conversion to another language, code or notation; b) reproduction in a different material form. While the present disclosure has been described with reference to certain embodiments, it will be understood by those skilled in the art that various changes may be made, and equivalents may be substituted without departing from the scope of the present disclosure. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the present disclosure without departing from its scope. Therefore, it is intended that the present disclosure is not limited to the particular embodiment disclosed, but that the present disclosure will include all embodiments that fall within the scope of the appended claims.

What is claimed is:

1. A system, comprising:

circuitry communicatively coupled to a first vehicle, wherein the circuitry:

receives information associated with the first vehicle;

determines, based on the received information, a first user of the first vehicle as one of a lessee of the first vehicle or an owner of the first vehicle;

controls a user device to display a user interface (UI);

receives, via the UI, a user preference associated with a usage of a battery unit of the first vehicle for an electrical system of a built environment;

sets a limit that is applicable on a consumption of charge cycles from a current cycle life of the battery unit of the first vehicle,

wherein the limit is set based on the determination that the first user is the owner of the first vehicle and based on the user preference;

excludes the set limit that is applicable on the consumption of the charge cycles, wherein the set limit is excluded based on the determination that the first user is the lessee;

detects a connection of the first vehicle with the electrical system of the built environment associated with the first user; and

controls a transfer of electric power from the battery unit to the electrical system based on the detection and the set limit.

2. The system according to claim **1**, wherein the limit includes a first ceiling value over the consumption of the charge cycles from the current cycle life,

wherein the first ceiling value is less than the current cycle life, and the transfer of the electric power is controlled such that the consumption of the charge cycles is less than or equal to the first ceiling value.

3. The system according to claim **1**, wherein the limit includes a second ceiling value over a rate of the consumption of the charge cycles from the current cycle life of the battery unit, and

wherein the transfer of the electric power is controlled such that the rate of consumption is less than or equal to the second ceiling value.

4. The system according to claim **1**, wherein the limit includes a third ceiling value over a surplus amount of electric power that is left in the battery unit of the first vehicle at a time-instant, and

wherein the transfer of the electric power to the electrical system is controlled such that an amount of the electric power that is transferred to the electrical system is less than or equal to the third ceiling value.

5. The system according to claim **1**, wherein the limit includes a fourth ceiling value over a residual state of charge (SOC) that is left in the battery unit of the first vehicle, and

wherein the transfer of the electric power to the electrical system is controlled such that the transfer of the electric power reduces the residual SOC to a value is less than or equal to the fourth ceiling value.

6. The system according to claim 1, wherein the circuitry further controls the user device to display the UI that further includes usage statistics of the battery unit of the first vehicle.

7. The system according to claim 6, wherein the usage statistics include at least one of:

a current State of Charge (SOC) of the battery unit of the first vehicle,

the current cycle life of the battery unit of the first vehicle,

a saving estimate in terms of charge cycles of the battery unit of the first vehicle,

a reduction in a consumption of grid power due to the transfer of the electric power to the electrical system,

an amount of the electric power that is transferred to the electrical system from the battery unit,

an average power saving for the built environment over a period, or

a monetary saving value associated with at least one of the saving estimate,

the reduction in the consumption of the grid power, or the average power saving.

8. The system according to claim 1, wherein the user preference includes a state of charge (SOC) value that is to be left in the battery unit of the first vehicle after the transfer of the electric power to the electrical system, and

wherein the limit is set further based on the SOC value and the current cycle life of the battery unit of the first vehicle.

9. The system according to claim 1, wherein the circuitry further:

determines a second user as an owner of a second vehicle or a lessee of the second vehicle;

detects a connection of the second vehicle with the electrical system of the built environment; and

determines a current cycle life of a battery unit of the second vehicle,

wherein the limit is set further based on the current cycle life of the battery unit of the second vehicle and the determination that the second user is the owner of the second vehicle.

10. A method, comprising:

receiving information associated with a first vehicle;

determining, based on the received information, a first user of the first vehicle as one of a lessee of the first vehicle or an owner of the first vehicle;

controlling a user device to display a user interface (UI);

receiving, via the UI, a user preference associated with a usage of a battery unit of the first vehicle for an electrical system of a built environment;

setting a limit that is applicable on a consumption of charge cycles from a current cycle life of the battery unit of the first vehicle,

wherein the limit is set based on the determination that the first user is the owner of the first vehicle and based on the user preference;

excludes the set limit that is applicable on the consumption of the charge cycles, wherein the set limit is excluded based on the determination that the first user is the lessee;

detecting a connection of the first vehicle with the electrical system of the built environment associated with the first user; and

controlling a transfer of electric power from the battery unit to the electrical system based on the detection and the set limit.

11. The method according to claim 10, wherein the limit includes a first ceiling value over the consumption of the charge cycles from the current cycle life,

wherein the first ceiling value is less than the current cycle life, and

the transfer of the electric power is controlled such that the consumption of the charge cycles is less than or equal to the first ceiling value.

12. The method according to claim 10, wherein the limit includes a second ceiling value over a rate of the consumption of the charge cycles from the current cycle life of the battery unit, and

wherein the transfer of the electric power is controlled such that the rate of consumption is less than or equal to the second ceiling value.

13. The method according to claim 10, wherein the limit includes a third ceiling value over a surplus amount of electric power that is left in the battery unit of the first vehicle at a time-instant, and

wherein the transfer of the electric power to the electrical system is controlled such that an amount of the electric power that is transferred to the electrical system is less than or equal to the third ceiling value.

14. The method according to claim 10, wherein the limit includes a fourth ceiling value over a residual state of charge (SOC) that is left in the battery unit of the first vehicle, and

wherein the transfer of the electric power to the electrical system is controlled such that the transfer of the electric power reduces the residual SOC to a value is less than or equal to the fourth ceiling value.

15. The method according to claim 10, further comprising controlling the user device to display the UI that further includes usage statistics of the battery unit of the first vehicle.

16. A non-transitory computer-readable medium having stored thereon computer implemented instructions that, when executed by a system, causes the system to execute operations, the operations comprising:

receiving information associated with a first vehicle;

determining, based on the received information, a first user of the first vehicle as one of a lessee of the first vehicle or an owner of the first vehicle;

controlling a user device to display a user interface (UI);

receiving, via the UI, a user preference associated with a usage of a battery unit of the first vehicle for an electrical system of a built environment;

setting a limit that is applicable on a consumption of charge cycles from a current cycle life of the battery unit of the first vehicle,

wherein the limit is set based on the determination that the first user is the owner of the first vehicle and based on the user preference;

excludes the set limit that is applicable on the consumption of the charge cycles wherein the set limit is excluded based on the determination that the first user is the lessee;

detecting a connection of the first vehicle with the electrical system of the built environment associated with the first user; and

controlling a transfer of electric power from the battery unit to the electrical system based on the detection and the set limit.

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