SUMMARY

In its most general form, the invention is a system or method for vehicle-side control of a multi-pile charging session, the system comprising: (a) a plurality of charging piles, each charging pile including a supply equipment communication controller (SECC); and (b) a vehicle electrical system for an electric vehicle with a master battery control unit (MBCU) in data communication with a plurality of battery control units (BCU). The MBCU is configured to coordinate two or more independent charging sessions through the BCUs during each multi-pile charging session. Each independent charging session is managed with an independent protocol message exchange through a BCU-to-SECC communication pathway.

In more detail, a first embodiment of the invention is a system for vehicle-side control of a multi-pile charging session, the system comprising: (a) a plurality of charging piles; and (b) a vehicle electrical system for an electric vehicle. Each charging pile comprises: (i) a power line electrically connected to a power connector at a first end and to a charging connector at a second end; and (ii) a supply equipment communication controller (SECC). The power line is connectable to a utility line. The power line includes a relay switch positioned between the power connector and the charging connector. A charging pile power line communication module (CP-PLC) is positioned adjacent the power line between the relay switch and the charging connector. The SECC is in data communication with the relay switch and the CP-PLC. Current is permitted to flow from the utility line to the charging connector through the power line, upon activation of the relay switch by the SECC. The vehicle electrical system includes: (i) a battery including a plurality of battery management units (BMUs) and a plurality of battery cells; (ii) a busbar relay in electrical connection to the battery cells via at least one busbar battery trunk; (iii) a plurality of charging ports; (iv) a plurality of busbar input trunks; and (v) a master battery control unit (MBCU). Each charging port is configured for electrical connection to the charging connector of one of the charging piles. The charging port is directly electrically connected to the charging connector or the charging port is indirectly electrically connected to the charging connector through an umbilical line. Each busbar input trunk is electrically connected to one of the charging ports at a first junction

pathway, from the BCU of the BCU-to-SECC communication pathway to the SECC of the BCU-to-SECC communication pathway, wherein each independent charging session includes an initiation stage, a charging stage, and a shutdown stage conducted through the associated BCU-to-SECC communication pathway. Each charging pile includes: (i) a power line electrically connected to a power connector at a first end and to a charging connector at a second end; and (ii) a supply equipment communication controller (SECC). The power line is connectable to a utility line. The power line includes a relay switch positioned between the power connector and the charging connector. A charging pile power line communication module (CP-PLC) is positioned adjacent the power line between the relay switch and the charging connector. The SECC is in data communication with the relay switch and the CP-PLC. Current is permitted to flow from the utility line to the charging connector through the power line, upon activation of the relay switch by the SECC. The vehicle electrical system includes: (i) a battery including a plurality of battery management units (BMUs) and a plurality of battery cells; and (ii) a busbar relay in electrical connection to the battery cells via at least one busbar battery trunk; (iii) a plurality of charging ports; (iv) a plurality of busbar input trunks; and (v) a master battery control unit (MBCU). Each charging port is configured for electrical connection to the charging connector of one of the charging piles. The charging port is directly electrically connected to the charging connector or the charging port is indirectly electrically connected to the charging connector through an umbilical line. Each busbar input trunk is electrically connected to one of the charging ports at a first junction and to the busbar relay at a second junction. Each busbar input trunk is in data communication with an electric vehicle power line communication module (EV-PLC) positioned adjacent the busbar input trunk between the charging port associated with the busbar input trunk and the busbar relay. The MBCU is in data communication with a plurality of battery control units (BCU), the BMUs of the battery, the busbar relay, and a user interface device. Each BCU is paired in data communication with one of the EV-PLCs to establish a BCU-to-SECC communication pathway for the BCU upon a connective pairing of the charging port associated with the BCU and one of the charging connectors. The BCU-to-SECC communication pathway for each BCU passes from the BCU to the EV-PLC associated with the BCU, to the busbar input trunk associated with the EV-PLC, to the connectively paired charging port associated with the busbar input

4-06 create a multi-pile charging plan from the sets of parameters received from each of the charging piles **10A**, the starting power storage and target storage of the battery **15**, and a set of safety limits for the vehicle electrical system

4-07 after review, authorized the multi-pile charging plan and commence the charging stage for each charging pile **10A**, each charging pile **10A** conducting an independent charging session

4-08 commence a shutdown stage for each independent charging session and disconnect umbilical lines **10G**

A first embodiment of the invention is a system for vehicle-side control of a multi-pile charging session, the system comprising: (a) a plurality of charging piles **10A**; and (b) a vehicle electrical system for an electric vehicle. Each charging pile **10A** comprises: (i) a power line **10H** electrically connected to a power connector **10D** at a first end and to a charging connector **10F** at a second end; and (ii) a supply equipment communication controller (SECC) **10B**. The power line **10H** is connectable to a utility line (**UL_0**, **UL_1**, **UL_2**). The power line **10H** includes a relay switch **10C** positioned between the power connector **10D** and the charging connector **10F**. A charging pile power line communication module (CP-PLC) **10E** is positioned adjacent the power line **10H** between the relay switch **10C** and the charging connector **10F**. The SECC **10B** is in data communication with the relay switch **10C** and the CP-PLC **10E**. Current is permitted to flow from the utility line (**UL_0**, **UL_1**, **UL_2**) to the charging connector **10F** through the power line **10H**, upon activation of the relay switch **10C** by the SECC **10B**. The vehicle electrical system includes: (i) a battery **15** including a plurality of battery management units (BMUs) **15A** and a plurality of battery cells **15C**; (ii) a busbar relay **16** in electrical connection to the battery cells **15C** via at least one busbar battery trunk **16A**; (iii) a plurality of charging ports (**CP_0**, **CP_1**, **CP_2**); (iv) a plurality of busbar input trunks (**BIT_0**, **BIT_1**, **BIT_2**); and (v) a master battery control unit (MBCU) **18**. Each charging port (**CP_0**, **CP_1**, **CP_2**) is configured for electrical connection to the charging connector **10F** of one of the charging piles **10A**. The charging port (**CP_0**, **CP_1**, **CP_2**) is directly electrically connected to the charging connector **10F** or the charging port (**CP_0**, **CP_1**, **CP_2**) is indirectly electrically connected to the charging connector **10F** through an umbilical line **10G**. Each busbar input trunk (**BIT_0**, **BIT_1**, **BIT_2**) is electrically connected

The charging port (**CP_0**, **CP_1**, **CP_2**) is directly electrically connected to the charging connector **10F** or the charging port (**CP_0**, **CP_1**, **CP_2**) is indirectly electrically connected to the charging connector **10F** through an umbilical line **10G**. Each busbar input trunk (**BIT_0**, **BIT_1**, **BIT_2**) is electrically connected to one of the charging ports (**CP_0**, **CP_1**, **CP_2**) at a first junction and to the busbar relay **16** at a second junction. Each busbar input trunk (**BIT_0**, **BIT_1**, **BIT_2**) is in data communication with an electric vehicle power line communication module (EV-PLC) (**PLC_0**, **PLC_1**, **PLC_2**) positioned adjacent the busbar input trunk (**BIT_0**, **BIT_1**, **BIT_2**) between the charging port (**CP_0**, **CP_1**, **CP_2**) associated with the busbar input trunk (**BIT_0**, **BIT_1**, **BIT_2**) and the busbar relay **16**. The MBCU **18** is in data communication with a plurality of battery control units (BCU) (**BCU_0**, **BCU_1**, **BCU_2**), the BMUs **15A** of the battery **15**, the busbar relay **16**, and a user interface device **17**. Each BCU (**BCU_0**, **BCU_1**, **BCU_2**) is paired in data communication with one of the EV-PLCs (**PLC_0**, **PLC_1**, **PLC_2**) to establish a BCU-to-SECC communication pathway **22** for the BCU (**BCU_0**, **BCU_1**, **BCU_2**) upon a connective pairing of the charging port (**CP_0**, **CP_1**, **CP_2**) associated with the BCU (**BCU_0**, **BCU_1**, **BCU_2**) and one of the charging connectors **10F**. The BCU-to-SECC communication pathway **22** for each BCU (**BCU_0**, **BCU_1**, **BCU_2**) passes from the BCU (**BCU_0**, **BCU_1**, **BCU_2**) to the EV-PLC (**PLC_0**, **PLC_1**, **PLC_2**) associated with the BCU (**BCU_0**, **BCU_1**, **BCU_2**), to the busbar input trunk (**BIT_0**, **BIT_1**, **BIT_2**) associated with the EV-PLC (**PLC_0**, **PLC_1**, **PLC_2**), to the connectively paired charging port (**CP_0**, **CP_1**, **CP_2**) associated with the busbar input trunk (**BIT_0**, **BIT_1**, **BIT_2**), to the connectively paired charging connector **10F** associated with the connectively paired charging port (**CP_0**, **CP_1**, **CP_2**), to the power line **10H** associated with the connectively paired charging connector **10F**, to the CP-PLC **10E** associated with the power line **10H**, and to the SECC **10B** associated with the CP-PLC **10E**.

While not illustrated in **FIGs. 1** and **2**, sensor information from the battery sensors **15B** can be collected by the BMUs **15A**.

In an alternate embodiment of the first and second embodiment, the user interface device **17** is integrated into a vehicle control unit of the electric vehicle. The vehicle control unit would of a ferry **14**, for instance, would typically be on the bridge of the ferry **14**.

CLAIMS

1. A system for vehicle-side control of a multi-pile charging session, the system comprising:

(a) a plurality of charging piles, each charging pile comprising:

(i) a power line electrically connected to a power connector at a first end and to a charging connector at a second end,

(1) wherein the power line is connectable to a utility line;

(2) wherein the power line includes a relay switch positioned between the power connector and the charging connector; and

(3) wherein a charging pile power line communication module (CP-PLC) is positioned adjacent the power line between the relay switch and the charging connector;

(ii) a supply equipment communication controller (SECC),

(1) wherein the SECC is in data communication with the relay switch and the CP-PLC; and

(2) wherein current is permitted to flow from the utility line to the charging connector through the power line, upon activation of the relay switch by the SECC; and

(b) a vehicle electrical system for an electric vehicle including:

(i) a battery including a plurality of battery management units (BMUs), and a plurality of battery cells;

(ii) a busbar relay in electrical connection to the battery cells via at least one busbar battery trunk;

(iii) a plurality of charging ports,

(1) wherein each charging port is configured for electrical connection to the charging connector of one of the charging piles; and

(2) wherein the charging port is directly electrically connected to the charging connector or the charging port is indirectly electrically connected to the charging connector through an umbilical line;

(iv) a plurality of busbar input trunks,

11. A computer-implemented method for vehicle-side control of a multi-pile charging session, the method comprising the steps of:

(a) maintaining a plurality of charging piles, each charging pile comprising:

(i) a power line electrically connected to a power connector at a first end and to a charging connector at a second end,

(1) wherein the power line is connectable to a utility line;

(2) wherein the power line includes a relay switch positioned between the power connector and the charging connector; and

(3) wherein a charging pile power line communication module (CP-PLC) is positioned adjacent the power line between the relay switch and the charging connector; and

(ii) a supply equipment communication controller (SECC),

(1) wherein the SECC is in data communication with the relay switch and the CP-PLC; and

(2) wherein current is permitted to flow from the utility line to the charging connector through the power line, upon activation of the relay switch by the SECC;

(b) maintaining a vehicle electrical system for an electric vehicle including:

(i) a battery including a plurality of battery management units (BMUs), and a plurality of battery cells;

(ii) a busbar relay in electrical connection to the battery cells via at least one busbar battery trunk;

(iii) a plurality of charging ports,

(1) wherein each charging port is configured for electrical connection to the charging connector of one of the charging piles; and

(2) wherein the charging port is directly electrically connected to the charging connector or the charging port is indirectly electrically connected to the charging connector through an umbilical line;

(iv) a plurality of busbar input trunks,

(1) wherein each busbar input trunk is electrically connected to one of the charging ports at a first junction and to the busbar relay at a second junction; and