Claims

1. A power supply apparatus comprising a battery assembly, control circuitries, and power circuitries;

wherein the control circuitries comprise a controller, a data communication frontend, a user-interface frontend, and battery management circuitries;

wherein the controller is configured to cooperate with the battery management circuitries to form a battery management system, to determine and collect battery parameters including state of charge of the battery assembly, and to select a power output scheme from a plurality of power output schemes available for outputting power from the apparatus;

wherein the power circuitries comprise:

- a power input circuitry comprising a first input circuitry (A) configured for connection to a first power source and a second input circuitry (B) configured for connection to a second power source, the first power source and the second power source being separate and independent power sources;
- a charging circuitry configured to receive power from the first input circuitry to charge the battery assembly; and
- a power output circuitry configured to output power from the apparatus;

wherein the power circuitries are operable to define a plurality of power output schemes by selective combination of a plurality of power components or selecting one power component form the plurality of power components for outputting power from the apparatus;

wherein the power circuitries are operable to combine two or more power components selected from a group of power components for power output from the apparatus upon receipt of a machine instruction containing a first charging speed, the group of power components comprising a first power component (P1) which is a power component due to the first power source, a second power component (P2) which is a power component due to the second power source, and a third power component (P3) which is a power component due to the battery assembly which is a stored energy source.

2. The apparatus according to claim 1, wherein the controller is configured to operate the power circuitries to select only the first power component for power output from the apparatus upon receipt of a machine instruction containing a second charging speed which is slower than the first charging speed.

3. The apparatus according to claims 1 or 2, wherein the power circuitries comprise a switchable power combiner which is operable in a plurality of switching states to selectively combine the plurality of power components for output from the apparatus, and wherein the first power component, the second power component and the third power component are selectively combinable by switched operations of the power combiner.

4. The apparatus according to any preceding claims, wherein the first input circuitry comprises a switchable power router which is operable in a plurality of routing states to define a plurality of power paths, the plurality of power paths comprising a first power path which connects the first input circuitry to the battery assembly, a second power path which connects the battery assembly to the power output circuitry, and a third power path which connects the first input circuitry to the power output circuitry.

5. The apparatus according to claim 4, wherein the first power component is to flow along the first power path and the second power component is to flow along the second power path.

6. The apparatus according to claims 4 or 5, wherein the controller is configured to operate the power router in a plurality of routing states, comprising a first routing state in which only the first power path is conductive, in a second routing state in which only the second power path is conductive, in a third routing state in which only the third power path is conductive, and a fourth routing state in which both the second and third power paths are conductive.

7. The apparatus according to any of claims 4 to 6, wherein the power circuitries comprise a power converter having a power input and the power router has a power output which is tied to the power input of the power converter, and wherein the power converter has a power output which is tied to a power input of the power output circuitry.

8. The apparatus according to any preceding claims, wherein the battery assembly and the first input circuitry are connected to a power converter, and wherein the first power component and the second power component are to pass through the power converter before entering the power output circuitry.

9. The apparatus according to any preceding claims, wherein the battery assembly has a battery assembly voltage, and the power circuitries comprise a power converter which is a DC-DC converter having an input side and an input voltage and an output side having an output voltage, and wherein the input voltage of the DC-DC converter is tied to the battery assembly

voltage.

10. The apparatus according to claim 9, wherein the second power source is at a second source voltage, and wherein the second source voltage is same as the output voltage of the DC-DC converter.

11. The apparatus according to any preceding claims, wherein the controller is configured to operate the apparatus in an idling state or in a power output state; wherein, in the idling state, the controller is to operate the power circuitries to charge the battery assembly only until the battery assembly is fully charged; and wherein, in the power output state, the controller is to operate the power circuitries to output power from the apparatus in response to a machine instruction containing a charging speed parameter.

12. The apparatus according to claim 11, wherein the controller is to initialize the apparatus in the idling state and to switch the apparatus from the idling state to the power output state upon receipt of a machine instruction, and wherein the controller is to generate the machine instruction in response to a request from the user-interface frontend or from the communication frontend.

13. The apparatus according to any preceding claims, wherein the controller is configured to output information state of charge information of the battery assembly through the data communication frontend upon receipt of polling signals.

14. The apparatus according to any preceding claims, wherein the first power source is configured to deliver power at a first power rate P_1 and the second power source is configured to deliver power at a second power rate P_2; and wherein $P_2 \geq jP_1$ and j is a natural number larger than or equal to 1.

15. The apparatus according to any preceding claims, wherein the first power source is configured to deliver power at a first power rate P_1 and the battery assembly is configured to deliver stored power at a third power rate P_3, and wherein $P_3 > kP_1$ and k is a natural number larger than or equal to 1.

16. The apparatus according to any preceding claims, wherein the first power source is configured to deliver power at a first power rate P_1 and the battery assembly has an energy storage capacity $\boldsymbol{E}$ and $\boldsymbol{E} \geq qP_1$, wherein q is a natural number preferably larger than 2 and smaller than 10, and has a unit of time in hours.

17. The apparatus according to any preceding claims, wherein the first power source is a running power supply.

18. The apparatus according to any preceding claims, wherein the power output circuitry comprises a first output circuitry and a second output circuitry, and wherein the first output circuitry comprises an output connector which is configured to detachably connect to a mobile load to facilitate power transfer from the apparatus to the mobile load.

19. A power supply network comprising a plurality of networked apparatus in data communication with a network controller, each networked apparatus being a power supply apparatus according to any preceding claims, wherein the plurality of networked apparatus are power connected such that one networked apparatus is configured as ~~a~~the second power source of another networked apparatus or other networked apparatuses, wherein the network controller is configured to collect state of charge information from each member apparatus of the network, to provide available charging speed options for user selection for each networked apparatus, and to select ~~a~~one of the plurality of power output scheme~~s~~ according to the charging speed option selected and the state of charge information.

20. A network according to claim 19, wherein the network controller is configured to operate the power circuitries of the plurality of networked apparatuses to devise a plurality of power output ~~modes~~schemes, and wherein the power circuitries are operable to combine two or more power components selected from ~~a~~the group of power components ~~comprising a first power component which is a power component due to the first power source, a second power component which is a power component due to the second power source, and a third power component which is a power component due to the battery assembly which is a stored energy source~~.

21. A method of operating a plurality of power supply apparatuses connected to a network controller and forming a cluster of charging stations, wherein each power supply apparatus is a power supply apparatus according to any of claims 1 to 18, which is a member apparatus comprising a battery assembly, power circuitries and control circuitries; wherein the power circuitries comprises a first power input connected to a first power source to receive a first power component at a first power rate, a second power input connected to a second power source to receive a second power component at a second power rate, and the ~~power storage~~battery assembly has a stored energy level and is configured to output a third power component at a third power rate when the stored energy level is above an output threshold; and wherein the method

comprises the network controller selecting a power output mode from a plurality of power output modes for outputting power from a power output of a member apparatus, and wherein the plurality of power output modes comprises at least an output mode in which the output power is due to a combination of the first power component, the second power component, and/or the third power component.

22. The method according to claim 21, wherein the method comprises the network selecting a power output mode according to a received charging speed option instruction and with reference to the stored energy level of the battery assembly, the first power rate, and/or the second power rate.

23. The method according to claims 21 or 22, wherein the power circuitries comprise a power input circuitry and a power output circuitry, and wherein the method comprises the network controller operating the power input circuitry and the power output circuitry to change from one power output mode to another power output mode.

24. The method according to any of claims 21 to 23, wherein the method comprises the network controller collecting data on stored energy levels of the ~~power storage~~battery assemblies of the member apparatuses, computing stored energy available for output from the network, and providing a plurality of charging speed options for user selection and/or change from one power output mode to another power output according to the stored energy available.

25. The method according to any of claims 21 to 24, wherein the method comprises the network controller operating the ~~power storage~~battery assembly to output the third power component at a third power rate which is at least two times the first power rate.