CLAIMS

1. Hybrid battery charging device (10) comprising
   - input terminals (40, 41) for connecting a photovoltaic panel,
   - first battery connections (44, 45) for connecting a lead-acid battery (12),
   - second battery connections (46, 47) for connecting a high-cycle chemical battery (6),
   - a two-way DC/DC converter (17), wherein a first set of terminals of the two-way DC/DC converter (17) is connected with the second battery connections (46, 47), and wherein a second set of terminals of the two-way DC/DC converter (17) is connected with the first battery connections (44, 45),
   - a charge and discharge control system (14), which is connected to the DC/DC converter (17) via respective control lines,
   - output terminals (42, 43) for connecting a load (19), wherein an input to the output terminals is derived from the first battery connections (44, 45).

2. Hybrid battery charging device (10) according to claim 1, further comprising
   - a control device (13) which is connected to the charge and discharge control system (14), wherein input terminals of the control device (13) are connected to the input terminals (40, 41), and wherein output terminals of the control device (13) are connected to input terminals of the DC/DC converter (17).

3. Hybrid battery charging device (10) according to claim 2, wherein the control device (13) comprises a pulse width modulation.

4. Hybrid battery charging device (10) according to claim 2 or claim 3, wherein the control device (13) comprises a maximum power point tracker.

5. Hybrid battery charging device (10) according to claim 2 or claim 3, wherein the control device (13) comprises a controllable switch (13').

6. Hybrid battery charging device (10) according to claim 2 or claim 3, wherein the control device (13) comprises a DC/DC converter (13').

7. Hybrid battery charging device (10) according to one of the preceding claims, wherein the two-way DC/DC converter (17) comprises a buck-boost converter, a buck converter, a boost converter or another converter topology.

8. Hybrid battery charging device (10) according to one of the preceding claims, wherein the two-way DC/DC converter (17) comprises at least two semiconductor switches (29, 30), wherein respective input connections of the transistors (29, 30) are connected to the charge control system (14) via respective control lines.

9. Hybrid battery charging device (10) according to one of the preceding claims, comprising

- first voltage measuring connections for connecting a first voltage sensor, the first voltage sensor being connected to terminals of the lead-acid battery (12) and

the first voltage measuring connections being connected to the charge and discharge control system (14),

- second voltage measuring connections for connecting a second voltage sensor, the second voltage sensor being connected to terminals of the high-cycle chemical battery and the second voltage measuring connections being connected to the charge and discharge control system (14).

10. Hybrid battery charging device (10) according to claim 1 or claim 2, comprising a separate battery management system for the high-cycle chemical battery, the separate battery management system (18) being connected to the charge and discharge control system (14).

11. Hybrid storage system (5) with a hybrid charging device (10) according to one of the preceding claims, further comprising a high-cycle chemical battery (6) which is connected to the second battery connections (46, 47).

12. Hybrid storage system (5) according to claim 11, wherein the high-cycle chemical batter (6) comprises a lithium battery (6).

13. Hybrid storage system (5) according to claim 11, further comprising a capacitor which is connected in parallel to the high-cycle chemical battery (6).

14. Hybrid storage system (5) according to one of the claims 11 to 13, further comprising a lead-acid battery (12), the lead acid battery (12) being connected to the first battery connections (44, 45).

15. Hybrid storage system (5) according to one of the claims 11 to 14, further comprising a
- a first voltage sensor which is connected to a terminal of the first battery (12) and to the charge and discharge control system (14),
- a second voltage sensor which is connected to a terminal of the second voltage battery (6) and to the charge and discharge control system (14).

16. Method for charging a lead-acid battery (12) and a high-cycle chemical battery (6) of a hybrid storage system (5) by an electric power source (11),
- charging the lead-acid battery (12) in a first battery charging phase until the lead-acid battery (12) has reached a first pre-determined state of charge,
- charging the lead-acid battery (12) and the high-cycle chemical battery (6) in a topping/boost/equalization phase until the lead-acid battery (12) has reached a second pre-determined state of charge,
- charging the high-cycle chemical battery (6) in a third battery charging phase during which an essentially constant system voltage is applied to system terminals of the lead-acid battery (12) and the system voltage is converted, especially up-converted, into a charging voltage at terminals of the high-cycle chemical battery (6).

17. Method according to claim 16, the equalization phase further comprising applying a voltage at the lead-acid battery that oscillates between a pre-determined lower voltage and a predetermined upper voltage

18. Method for charging a hybrid storage system (5) according to claim 16 or claim 17, further comprising main-

taining a mean voltage at terminals of the lead-acid battery (12) at an end-of-charge voltage of the lead-acid battery (12) during the equalization phase.

19. Method for charging a hybrid storage system (5) according to one of claims 16 to 18, wherein, during the equalization phase, a system voltage at terminals of the lead acid battery is controlled to be constant such that a charge current to the lead-acid battery decreases and a remaining charging power is transferred to the high-cycle chemical battery (6).

20. Method for charging a hybrid storage system (5) according to one of claims 16 to 19, wherein the essentially constant system voltage that is applied to the system terminals during the charging of the high-cycle chemical battery (6) in the third battery charging phase is equal to a maximum open circuit voltage V_Pb_maxOC of the lead-acid battery (12).

21. Method for charging a hybrid storage system (5) according to one of claims 16 to 20, wherein a decision for starting the equalization phase and a decision for starting the third battery charging phase is taken depending on a system voltage at terminals of the lead-acid battery.

22. Method for discharging a lead-acid battery (12) and a high-cycle chemical battery (6) of a hybrid storage system (5) the method comprising
- supplying a load (19) with power by discharging a high-cycle chemical battery (6) via system terminals of a lead-acid battery (12) and maintaining the voltage at

the system terminals essentially equal to a maximum open circuit voltage of the lead-acid battery (12), until the output voltage of the high-cycle chemical battery (6) has reached an end-of-discharge voltage of the high-cycle chemical battery (6),

- discharging the lead-acid battery (12) until the voltage of the lead-acid battery (12) has reached an end-of-discharge voltage of the lead-acid battery (12).

23. Method according to claim 22, wherein the steps of discharging the high-cycle chemical battery (6) and of discharging the lead-acid battery (12) are executed in parallel.

24. Hybrid battery charging device (10) according to one of claims 1 to 8, wherein the charge and discharge control system (14) comprises means for executing the steps of a method according to one of the claims 16 to 23.