CLAIMS

1. A water heating system comprising:
- an electrical heating device for heating water,
- a battery electrically coupled to the electrical heating device for powering the electrical heating device,
- a battery management system electrically coupled to the battery for charging the battery,
- a heat sink arrangement thermally coupled to the battery and configured to store and release thermal energy, and
- a thermally insulating shell enclosing the battery and the heat sink arrangement.

2. A water heating system according to claim 1, wherein the heat sink arrangement has a heat capacity that is sufficient to store all heat produced by charging the battery, without causing the battery damage through excessive thermal cycling.

3. A water heating system according to claim 1 or 2, wherein the heat sink arrangement is thermally coupled to the battery management system, and wherein the thermally insulating shell further encloses the battery management system.

4. A water heating system according to any preceding claim, wherein the heat sink arrangement comprises a heat exchanger configured to facilitate heat exchange between an interior of the insulating shell and water flowing to an inlet of the electrical heating device.

5. A water heating system according to any preceding claim, wherein the heat sink arrangement comprises a heat sink volume for holding a heat exchange fluid.

6. A water heating system according to claim 5, wherein the heat sink volume is fluidly coupled to an inlet of the electrical heating device.

7. A water heating system according to claim 5 or 6, wherein the heat sink arrangement comprises a heat exchanger for exchanging heat between a heat exchange fluid in the heat sink volume and water flowing to an inlet of the electrical heating device.

8. A water heating system according to claim 7, further comprising a pump for circulating the heat exchange fluid through the heat sink volume.

9. A water heating system according to any of claims 5 to 8, further comprising a controller operationally coupled to the battery management system and/or the electrical heating device, and a temperature sensor for measuring a temperature inside the thermally insulating shell, wherein the controller is operationally coupled to a device configured to initiate flow within the heat sink volume, such as a pump or a release valve fluidly coupled to the heat sink volume, the controller being operationally coupled to the temperature sensor and the device and configured to selectively initiate flow within the heat sink volume to reject heat from the heat sink volume in dependence on the temperature inside the thermally insulating shell.

10. A water heating system according to claim 9, further comprising a release valve fluidly coupled to the heat sink volume and configured to facilitate the release of heat exchange fluid from the heat sink volume, the controller being operationally coupled to the temperature sensor and the release valve and configured to open the release valve in dependence on the temperature inside the thermally insulating shell.

11. A water heating system according to claim 10, wherein the release valve is additionally fluidly coupled to an inlet of the electrical heating device and configured to allow drainage of water from the heat sink volume into the inlet of the electrical heating device.

12. A water heating system according to claim 9 and comprising a pump for circulating the heat exchange fluid through the heat sink volume, the controller being operationally coupled to the temperature sensor and the pump and configured to operate the pump in dependence on the temperature inside the thermally insulating shell.

13. A water heating system according to any preceding claim, further comprising a secondary heating device configured to be powered by mains electricity.

14. A water heating system according to claim 13, wherein the electrical heating device and the secondary heating device are provided on parallel fluid flow paths, the water heating system further comprising a controllable valve arrangement for controlling a fluid flow rate in each of the parallel fluid flow paths.

15. A water heating system according to any preceding claim, wherein the heat sink arrangement includes a phase change material.

16. A water heating system according to any preceding claim, wherein the battery comprises multiple modules each containing one or more individual cells, and wherein the heat sink arrangement comprises a frame with multiple compartments or fixings, each compartment or fixing arranged for holding one or more of the battery modules.

17. A water heating system according to claim 16, wherein the heat sink arrangement comprises a heat sink volume for holding a heat exchange fluid, and wherein the heat sink volume comprises heat exchange fluid channels that pass between and/or through respective battery modules.

18. A water heating system according to any preceding claim, further comprising a battery heating device that is enclosed in the thermally insulating shell.

19. A water heating system according to any preceding claim, further comprising an AC to DC power supply inside the insulating shell, the power supply being electrically coupled to at least one of the battery and/or battery management system to supply power to the battery, and the power supply being thermally coupled to the heat sink arrangement.