CLAIMS

1. A method of balancing an electrical power distribution network, the method comprising:

   (a) Monitoring a level of charge (SoC), either directly or indirectly via a parameter that is a function of the SoC, stored in a storage battery connected to the network that, on charging, is adapted to withdraw power from the network and, on discharging, is adapted to add power to the network,

   (b) Responding to imbalances detected in the network by adding power to or withdrawing power from the network in accordance with the following:

      (i) If the battery SoC is within an optimal range, charging and discharging the battery to counteract imbalances in the network;

      (ii) If the battery SoC falls below a low threshold, selecting an alternative asset (low) that is adapted to increase power supplied to the network relative to that withdrawn from it and, in response to a critical low signal, switching on the alternative asset (low) such that it provides a balancing service to the network; and

      (iii) If the battery SoC rises above a high threshold, selecting an alternative asset (high) that is adapted to withdraw power from the network relative to that supplied to it and, in response to a critical high signal, switching on the alternative asset (high) such that it provides a balancing service to the network;

   wherein the low threshold is determined such that after generation of the critical low signal, the battery remains capable of discharging for a

lag time equivalent to a time taken for the selected asset (low) to reach its operational capacity; and

the high threshold is determined such that after generation of the critical high signal, the battery remains capable of charging for a lag time equivalent to a time taken for the selected asset (high) to reach its operational capacity.

2. The method as claimed in claim 1 wherein the alternative asset (low) has a first minimum operational time and the alternative asset (high) has a second minimum operational time, these being times for which the respective asset should remain operational after switching on and wherein the optimal range for battery-regulated balancing is determined such that:

after generation of the critical low signal, the battery has capacity to be charged for the first minimum operational time and at a power equivalent to the relative increase in power supplied to the network that results from operation of the alternative asset (low); and

after generation of the critical high signal, the battery has capacity to be discharged for the second minimum operational time and at a power equivalent to the relative reduction in power supplied to the network that results from operation of the alternative asset (high).

3. The method as claimed in claim 2, wherein in the event that:

asset (low) is providing balancing services to the network and time elapsed since generation of the critical low signal is less than the first minimum operational time; or

asset (high) is providing balancing services to the network and time elapsed since generation of the critical high signal is less than the second minimum operational time; then

if the battery SoC returns to the optimal range, the battery is charged or discharged as required to provide additional balancing services to the network.

4. The method as claimed in claim 1, wherein the low threshold is determined such that the battery remains capable of discharging throughout the lag time at its maximum contracted power.

5. The method as claimed in claim 1, wherein the high threshold is determined such that the battery remains capable of charging throughout the lag time at its maximum contracted power.

6. The method as claimed in claim 1, wherein at Step (b)(ii) of claim 1, the battery continues to counteract imbalances in the network for a period of time equivalent to the lag time associated with the selected asset (low).

7. The method as claimed in claim 6 wherein the battery discharges during the lag time at its maximum contracted power.

8. The method as claimed in claim 6 wherein the battery discharges at a varying power level during the lag time such that the effect of the selected asset (low) on network balance plus that of the battery is equivalent to that of the battery discharging at its maximum contracted power.

9. The method as claimed in claim 1, wherein at Step (b)(iii) of claim 1, the battery continues to counteract imbalances in the network for a period of time equivalent to the lag time associated with the selected asset (high).

10. The method as claimed in claim 9 wherein the battery charges during the lag time at its maximum contracted power.

11. The method as claimed in claim 9 wherein the battery charges at a varying power level during the lag time such that the effect of the selected asset (high) on network balance plus that of the battery is

equivalent to that of the battery charging at its maximum contracted power.

12. The method as claimed in claim 1, the method also including the step of monitoring a parameter of the network, the parameter having a nominal operating value, fluctuations from said nominal operating value being indicative of the imbalances in the network to which the method is responsive in Step (b).

13. The method as claimed in claim 12 in which the monitored parameter is network frequency.

14. The method as claimed in claim 1, in which the selected asset (low) comprises an aggregated set of assets, each of which contributes to the overall capability of the aggregated set to increase power supplied to the network relative to that withdrawn from it.

15. The method as claimed in claim 1, wherein the step of selecting an alternative asset (low) at Step (b)(ii) includes the step of selecting at least one asset (low) from a portfolio of assets (low), each of said assets (low) within the portfolio first having an respective lag time and secondly being adapted to increase power supplied to the network relative to that withdrawn from it.

16. The method as claimed in claim 15 wherein the low threshold is determined such that the battery remains capable of discharging throughout the longest of the respective lag times of the assets (low) within the portfolio (low).

17. The method as claimed in claim 1, in which the selected asset (high) comprises an aggregated set of assets, each of which contributes to the overall capability of the aggregated set to reduce power supplied to the network relative to that withdrawn from it.

18. The method as claimed in claim 1, wherein the step of selecting an alternative asset (high) at Step (b)(iii) includes the step of selecting at least one asset (high) from a portfolio of assets (high), each of said assets (high) within the portfolio first having an respective lag time and secondly being adapted to reduce power supplied to the network relative to that withdrawn from it.

19. The method as claimed in claim 18 wherein the high threshold is determined such that the battery remains capable of charging throughout the longest of the respective lag times of the assets (high) within the portfolio (high).

20. The method as claimed in claim 1, wherein in the event that either asset (high) or asset (low) are providing the balancing service to the network, the method includes the additional step of charging or discharging the battery for such time as required to bring its SoC to within the optimal range.

21. A system for providing balancing services to an electrical power distribution network to which it is connected, the system comprising:
a storage battery with a detector adapted to monitor, either directly or indirectly, its state of charge (SoC);
at least one non-battery asset (low) that is adapted to increase power supplied to the network relative to that withdrawn from it;
at least one non-battery asset (high) that is adapted to increase power withdrawn from the network relative to that supplied to it; and
a central controller adapted to be responsive to imbalances detected in the network, to receive information from the SoC detector and to generate signals for controlling operation of the battery and the assets;
wherein the central controller is further arranged to respond to imbalances as follows:

(a) By charging and discharging the battery to counter the imbalances when information received from the SoC detector indicates that the battery SoC is within an optimal range, the optimal range extending between a predetermined low threshold and a predetermined high threshold;

(b) By operating asset (low) to increase power supplied to the network relative to that withdrawn from it when information received from the SoC detector indicates that the battery SoC is below the predetermined low threshold; and

(c) By operating asset (high) to increase power withdrawn from the network relative to that supplied to it when information received from the SoC detector indicates that the battery SoC is above the predetermined high threshold;

Wherein the low and high thresholds are determined such that:
with SoC at the low threshold, the battery remains capable of discharging for a lag time equivalent to a time taken for the selected asset (low) to reach its operational capacity; and
with SoC at the high threshold, the battery remains capable of charging for a lag time equivalent to a time taken for the selected asset (high) to reach its operational capacity.

22. A method of selecting non-battery assets from a portfolio of non-battery assets to supplement balancing services to a network provided by a battery, the battery having a detector adapted to monitor, either directly or indirectly, its state of charge (SoC) and, if the detector indicates the battery SoC exceeds a high threshold or falls below a low threshold, method includes the steps of:

(a) Identifying a number of combinations of aggregated assets from

the portfolio, wherein:

(i) If the method is triggered by exceeding the high threshold, each asset is operable to provide a balancing response equivalent to withdrawal of power from the network;

(ii) If the method is triggered by falling below the low threshold, each asset is operable to provide a balancing response equivalent to supply of power to the network; and

(iii) Each combination includes at least one asset and has a respective lag time, this lag time being a time taken for the respective combination of aggregated assets to reach its operational capacity;

(b) For each of the combinations of aggregated assets identified, verifying that:

(i) The combination is capable of operating at a power level sufficient to match that of the battery when carrying out its balancing service; and

(ii) The battery threshold at which this method is triggered is such that the battery is capable of continuing either its charging or discharging balancing function without reaching either full capacity or full depletion for the lag time of the respective combination;

(c) For all verified combinations found at Step (b), identifying the lowest-cost combination, taking into account operational costs and those associated with asset degradation;

(d) Switching on the lowest-cost combination of aggregated assets

identified and Step (c); and

(e) After a delay of the lag time associated with this lowest-cost combination, and if the battery SoC has not returned to a level between the low and high threshold values, switching off the balancing service provided by the battery.