WHAT IS CLAIMED IS:

1. A multi-quadrant multi-level cascaded converter connectable to a load, comprising:

a plurality of cells connected in series,

wherein each cell of the plurality of cells represents an H-bridge converter and comprises a plurality of bidirectional switches and a storage element; and

a hysteresis current control system coupled to the plurality of cells, wherein the control system is configured to control one or more of a shape and a level of current in the load, and:

determine a current error signal I_{ERROR} based on a comparison of a real feedback current signal I_{REAL} and a reference current signal I_{REF};

generate a total state value based on the current error signal I_{ERROR};

select a required output voltage of the converter based on the total state value, wherein the required output voltage compensates for the current error signal I_{ERROR}; and

select switching states for the plurality of bidirectional switches of the plurality of cells based in part on the selected required output voltage and for zero switching rotation of at least one of the plurality of bidirectional switches.

2. The converter of claim 1, comprising four (4) quadrants and nine (9) output levels.

3. The converter of claim 2, comprising four (4) cells connected in series, and wherein each cell represents a four-quadrant H-bridge converter.

4. The converter of claim 3, wherein each cell of the plurality of cells comprises four (4) bidirectional switches and a storage element.

5. The converter of claim 1, comprising two (2) quadrants and nine (9) output levels.

6. The converter of claim 5, comprising four (4) cells connected in series, and wherein each cell represents a two-quadrant H-bridge converter.

7. The converter of claim 6, wherein each cell of the plurality of cells comprises two (2) bidirectional switches, two (2) diodes, and a storage element.

8. The converter of claim 1, wherein each bidirectional switch comprises IGBT or MOSFET with freewheeling diode.

9. The converter of claim 1, wherein electrical power is transferrable from each cell of the plurality of cells to the load, and wherein electrical power is transferrable from the load to each cell of the plurality of cells in the case of a reactive or regenerative load.

10. The converter of claims 1-9, wherein the load is one of a single phase or multiple-phased resistive and inductive load, or pure reactive load, or any type of regenerative load.

11. The converter of claim 10, wherein the control system is further configured to cause the transfer of electrical power from the storage elements of the plurality of cells to the load.

12. The converter of claim 11, wherein the control system is further configured to recover energy back to the storage elements when the load is a reactive or regenerative load.

13. The converter of claim 11, wherein the control system is further configured to balance voltages on the storage elements.

14. The converter of claim 13, wherein to balance voltages, the control system is further configured to select storage elements with the minimum and maximum voltages, and determine whether to extract energy from a selected storage element.

15. The converter of claim 14, wherein to balance voltages, the control system is further configured to determine whether to extract energy from a selected storage element into the load or inject energy from the load into the selected storage element when the load is a reactive or regenerative load.

16. The converter of claim 1, wherein the storage element is a capacitor.

17. The converter of claims 1-16, wherein the control system including one or more processors coupled to a non-transitory memory comprising a plurality of instructions that when executed causes the one or more processors to control one or more of a shape and a level of current in the load.

18. The converter of claim 17, wherein the plurality of instructions when executed causes the one or more processors to control an output voltage level of the converter as a function of the level of current in the load, a reference current and a current error equal to the difference between the level of current in the load and the reference current.

19. The converter of claim 17, wherein the plurality of instructions when executed causes the one or more processors to:

determine a voltage on the storage element for each cell of the plurality of cells;

select a cell of the plurality of cells based on the voltages on the storage elements of the plurality of cells; and

repetitively switch the selected cell to provide a required output voltage level and regulation of output current.

20. The converter of claim 19, wherein the plurality of instructions when executed further causes the one or more processors to extract energy from the selected cell into a reactive or regenerative load.

21. The converter of claim 19, wherein the plurality of instructions when executed further causes the one or more processors to extract energy from a reactive or regenerative load into the selected cell.

22. The converter of claim 17, wherein the plurality of instructions when executed causes the one or more processors to:

provide a zero-voltage for a first positive/negative operational level of the cell using a first subset of the plurality of bidirectional switches; and

provide a zero voltage for a second positive/negative operational level of the cell using a second subset of the plurality of bidirectional switches;

wherein the first subset is different from the second subset, and wherein the second positive/negative operational level of the cell is directly subsequent the first positive/negative operational level of the cell.

23. The converter of claim 17, wherein the plurality of instructions when executed causes the one or more processors to:

subtract the real feedback current signal I_{REAL} from the reference current signal I_{REF} to produce the current error signal I_{ERROR};

input the current error signal I_{ERROR} into each hysteresis block of a plurality of hysteresis blocks, wherein each hysteresis block of the plurality of hysteresis blocks has a different setting of high boundary (HB) threshold and low boundary (LB) threshold than the other hysteresis blocks of the plurality of hysteresis blocks;

for each hysteresis block of the plurality of hysteresis blocks,

set an output value of the hysteresis block to "1" when I_{ERROR} reaches the high boundary (HB) threshold of the hysteresis block;

maintain the output value of the hysteresis block at "1" until I_{ERROR} reaches the low boundary (LB) threshold of the hysteresis block; and

set the output value of the hysteresis block to "0" when I_{ERROR} reaches the low boundary (LB) threshold of the hysteresis block;

sum the output values of all of the hysteresis blocks of the plurality of hysteresis blocks to produce the total state value;

select the required output voltage level from a lookup table as a function of the total state value.

24. The converter of claim 23, wherein the selection of the required output voltage is a function of the total state value and a sign of current derivative di/dt.

25. The converter of claim 24, wherein the current derivative is one of real or reference.

26. The converter of claim 24, wherein the sign of the current derivative di/dt is determined as positive at a moment of time when the total state value reaches a value of six (6).

27. The converter of claim 24, wherein the sign of the current derivative di/dt is determined as negative at a moment of time when the total state value reaches a value of one (1).

28. A method of balancing voltages on a plurality of cells of a multi-quadrant multi-level cascaded converter, comprising:

determining a current error signal I_{ERROR} based on a comparison of a real feedback current signal I_{REAL} and a reference current signal I_{REF};

generating a total state value based on the current error signal I_{ERROR};

selecting a required output voltage of the converter based on the total state value, wherein the required output voltage compensates for the current error signal I_{ERROR};

selecting switching states for ~~the~~ a plurality of bidirectional switches of the plurality of cells based in part on the selected required output voltage and for zero switching rotation of at least one of the plurality of bidirectional switches;

for each cell of the plurality of cells, determining a voltage on a storage element of the cell; and

repetitively switching the plurality of cells according to the selected switching states to provide the required output voltage level and regulation of output current.

29. The method of claim 28, wherein repetitively switching the plurality of cells to provide the required output voltage level and regulation of output current extracts energy from the plurality of cells into a reactive or regenerative load.

30. The method of claim 28, wherein repetitively switching the plurality of cells to provide the required output voltage level and regulation of output current extracts energy from a reactive or regenerative load into the plurality of cells.

31. The method of claim 28, wherein the storage elements are capacitors.

32. The converter of claim 1, wherein, to generate the total state value representative of the required output voltage of the converter that compensates for the current error signal I_{ERROR}, the control system is configured to:

assess whether current error signal I_{ERROR} passes a plurality of current thresholds; and

generate the total state value based on a quantity of the plurality of current thresholds passed.

33. The converter of claim 32, wherein the control system is further configured to select the required output voltage based on the total state value and at least a polarity of a current derivative (di/dt).

34. The converter of claim 33, wherein the converter is configured to select the required output voltage from a discrete set of output voltages corresponding to the quantity of cells connected in series.

35. The converter of claim 33, wherein the control system comprises an estimator configured to estimate the polarity of the current derivative (di/dt) based on the total state value.

36. The converter of claim 32, wherein the plurality of current thresholds comprises a plurality of high current thresholds and a plurality of low current thresholds, and wherein the control system comprises a plurality of hysteresis blocks, each hysteresis block associated with a different one of the plurality of high current thresholds and a different one of the plurality of low current thresholds.

37. The converter of claim 36, wherein each hysteresis block is configured to output a first signal if the associated high current threshold is passed and a second signal if the associated low current threshold is passed, wherein the first and second signals are different.