~~WHAT IS CLAIMED IS:~~CLAIMS

1. A power circuitry comprising:

a first input circuit for coupling to a photovoltaic (PV) source;

a second input circuit for coupling to an energy-storage source;

a third circuit coupled to the first and second input circuits for combining outputs of the first and second circuits and outputting electrical energy via a direct-current (DC) output thereof; and

a control circuit coupled to the first, second, and third circuits for controlling the output of the third circuit by controlling parameters of the first, second, and third circuits based on output voltages of the PV and energy-storage sources, outputs of the first and second input circuits coupling to the third circuits, and an output voltage of the third circuit.

2. The power circuitry of claim 1 further comprising a transformer directly coupling the first, second, and third circuits with the first and second input circuits on an input side of the transformer and the third circuit on an output side of the transformer.

3. The power circuitry of claim 1 or 2, wherein each of the first, second, and third circuits comprises one or more semiconductors for power conversion.

4. The power circuitry of claim 3, wherein the control circuit is configured for controlling the output of the third circuit by adjusting gate signals applied to gate terminals of the semiconductors of the first, second, and third circuits based on the output voltages of the PV and energy-storage sources, the outputs of the first and second input circuits coupling to the third circuits, and the output voltage of the third circuit.

5. The power circuitry of any one of claims 1 to 4, wherein the outputs of the first and second input circuits are output currents of the first and second input circuits; and

wherein the power circuitry further comprises one or more current sensors for sensing the output currents of the first and second input circuits.

6. The power circuitry of any one of claims 1 to 5, wherein the control circuit is configured for controlling the output of the third circuit further based on at least one of output currents of the PV and energy-storage sources, and an input current of the third circuit.

7. The power circuitry of any one of claims 1 to 6, wherein the output of the third circuit is a direct-current (DC) output;

wherein the power circuitry further comprises a DC-to-AC inverter circuit coupled to the third circuit for converting the DC output of the third circuit to an alternate-current (AC) output; and

wherein the control circuit is configured for controlling the output of the DC-to-AC inverter circuit based on the output voltages of the PV and energy-storage sources, the output currents of the first and second input circuits coupling to the third circuits, the output voltage of the third circuit, an output voltage of the DC-to-AC inverter circuit, and an output current of the DC-to-AC inverter circuit.

8. The power circuitry of claim 4, wherein the outputs of the first and second input circuits are output voltages of the first and second input circuits; and

wherein the power circuitry further comprises one or more current estimators for estimating the output currents of the first and second input circuits based on the output voltages of the PV source, the energy-storage source, and the third circuit, and the gate signals of the semiconductors of the first, second, and third circuits.

9. The power circuitry of claim 3 or any one of claims 4 to 8 dependent from claim 3, wherein the one or more semiconductors of at least one of the first, second, and third circuits are gallium nitride (GaN) gates; and

wherein the power circuitry further comprises a GaN gate-driver circuit for preventing the GaN gates from shoot-through, the GaN gate-driver circuit comprising a level-shifter circuit.

10. The power circuitry of claim 9, wherein the level-shifter circuit comprises a Zener diode and a capacitor coupled in parallel and connected to a resistor in series.

11. The power circuitry of claim 2 or any one of claims 3 to 10 dependent from claim 2, wherein the third circuit comprises a parallel inductor on the output side of the transformer for compensating for parasitic capacitances.

12. An energy apparatus comprising:

a transparent or semi-transparent substrate;

a solar-cell layer coupled to the substrate, the solar-cell layer comprising a plurality of solar cells for receiving light through the substrate and converting energy of the received light to a first electrical energy;

an energy-storage layer coupled to the solar-cell layer, the energy-storage layer comprising one or more energy-storage units for storing a second electrical energy; and

a converter layer coupled to the solar-cell layer and the energy-storage layer for combining outputs of the solar-cell layer and the energy-storage layer and outputting electrical energy;

wherein the converter layer comprises the power circuitry according to any one of claims 1 to 11 and using the solar-cell and energy-storage layers as the PV and energy-storage sources, respectively.

~~13. A thermoelectric recycling structure comprising:~~

~~a heat-conductive first component for engaging a heat source for receiving heat generated therefrom;~~

~~a second component spaced from the first component; and~~

~~a heat-nonconductive and electrons-and-holes-transportive thermoelectric layer sandwiched between the first and second components for receiving the heat from the first component and converting the received heat to electrical power.~~

~~14. The thermoelectric recycling structure of claim 13 further comprising:~~

~~a light-harvesting layer coupled to the first component one an opposite side of the thermoelectric layer for engaging the first component with the heat source therethrough, the light-harvesting layer comprising:~~

~~a metasurface for harvesting light; and~~

~~a nano-wire layer coupled to the metasurface for converting the harvested lighted to converted heat and transferring the converted heat to the thermoelectric layer.~~

~~15. The thermoelectric recycling structure of claim 13 or 14, wherein the thermoelectric layer comprises one or more thermoelectric components made of one or more two-dimensional (2D) materials.~~

~~16. The thermoelectric recycling structure of claim 15, wherein the one or more 2D materials comprises 2D perovskite.~~

~~17. The thermoelectric recycling structure of claim 15 or 16, wherein the one or more thermoelectric components comprise a continuous thermoelectric sheet made of the one or more 2D materials.~~

~~18. The thermoelectric recycling structure of claim 15 or 16, wherein the thermoelectric layer comprises a plurality of the thermoelectric components separated from each other.~~

~~19. The thermoelectric recycling structure of claim 13 or 14, wherein the thermoelectric layer comprises a plurality of electrically conductive nano-channels having one or more subwavelength dimensions thereof.~~

~~20. The thermoelectric recycling structure of claim 19, wherein the thermoelectric layer has a thickness of about 10 nanometers (nm).~~

~~21. An energy apparatus comprising:~~

~~a transparent or semi-transparent substrate;~~

~~a solar-cell layer coupled to the substrate, the solar-cell layer comprising a plurality of solar cells for receiving light through the substrate and converting energy of the received light to a first electrical energy;~~

~~an energy-storage layer coupled to the solar-cell layer, the energy-storage layer comprising one or more energy-storage units for storing a second electrical energy;~~

a converter layer coupled to the solar-cell layer and the energy-storage layer for combining outputs of the solar-cell layer and the energy-storage layer and outputting electrical energy via a DC output thereof; and

at least one of the thermoelectric recycling structure according to claims 13 to 20, coupled to at least one of the solar-cell layer and the converter layer for receiving the heat generated therefrom.

22. A supercapacitor comprising:

one or more capacitor layers; and

a first and a second electrical terminals;

wherein each capacitor layer comprises:

a pair of electrically conductive thin-film sublayers sandwiching electrically insulating membrane sublayer,

a conductive medium between the each of the thin-film sublayers and the membrane sublayer, and

a first and a second conductor sublayers sandwiching the pair of thin-film sublayers and the membrane sublayer, the first conductor sublayer coupled to the first electrical terminal and the second conductor sublayer coupled to the second electrical terminal.

23. The supercapacitor of claim 22, wherein the thin-film sublayers comprise at least one of activated carbon, graphene, and graphite.

24. The supercapacitor of claim 22 or 23, wherein the conductive medium comprises at least one of ionic liquid, conductive ink, and current collector.

25. The supercapacitor of claim 22 or 23, wherein the conductive medium is coated onto the membrane sublayer.

26. The supercapacitor of claim 25, wherein the ionic liquid comprises 1-Ethyl-3-methylimidazolium tetrafluoroborate ($EMIMBF_4$).

~~27. The supercapacitor of any one of claims 22 to 26, wherein the conductive thin-film sublayers, the membrane sublayer, and the first and second conductor sublayers are flexible.~~

~~28. The supercapacitor of any one of claims 22 to 27, wherein the conductive thin-film sublayers and the first and second conductor sublayers are coated to the membrane sublayer using at least one of slot-die coating, spray coating printing, and doctor blade.~~

~~29. An energy apparatus comprising:~~

~~a transparent or semi-transparent substrate;~~

~~a solar-cell layer coupled to the substrate, the solar-cell layer comprising a plurality of solar cells for receiving light through the substrate and converting energy of the received light to a first electrical energy;~~

~~an energy-storage layer coupled to the solar-cell layer, the energy-storage layer comprising one or more energy-storage units for storing a second electrical energy;~~

~~a converter layer coupled to the solar-cell layer and the energy-storage layer for combining outputs of the solar-cell layer and the energy-storage layer and outputting electrical energy via a DC output thereof;~~

~~wherein the energy-storage layer comprises one or more supercapacitors according to any one of claims 22 to 28.~~