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(54) **ENERGY APPARATUSES, ENERGY SYSTEMS, AND ENERGY MANAGEMENT METHODS INCLUDING ENERGY STORAGE**

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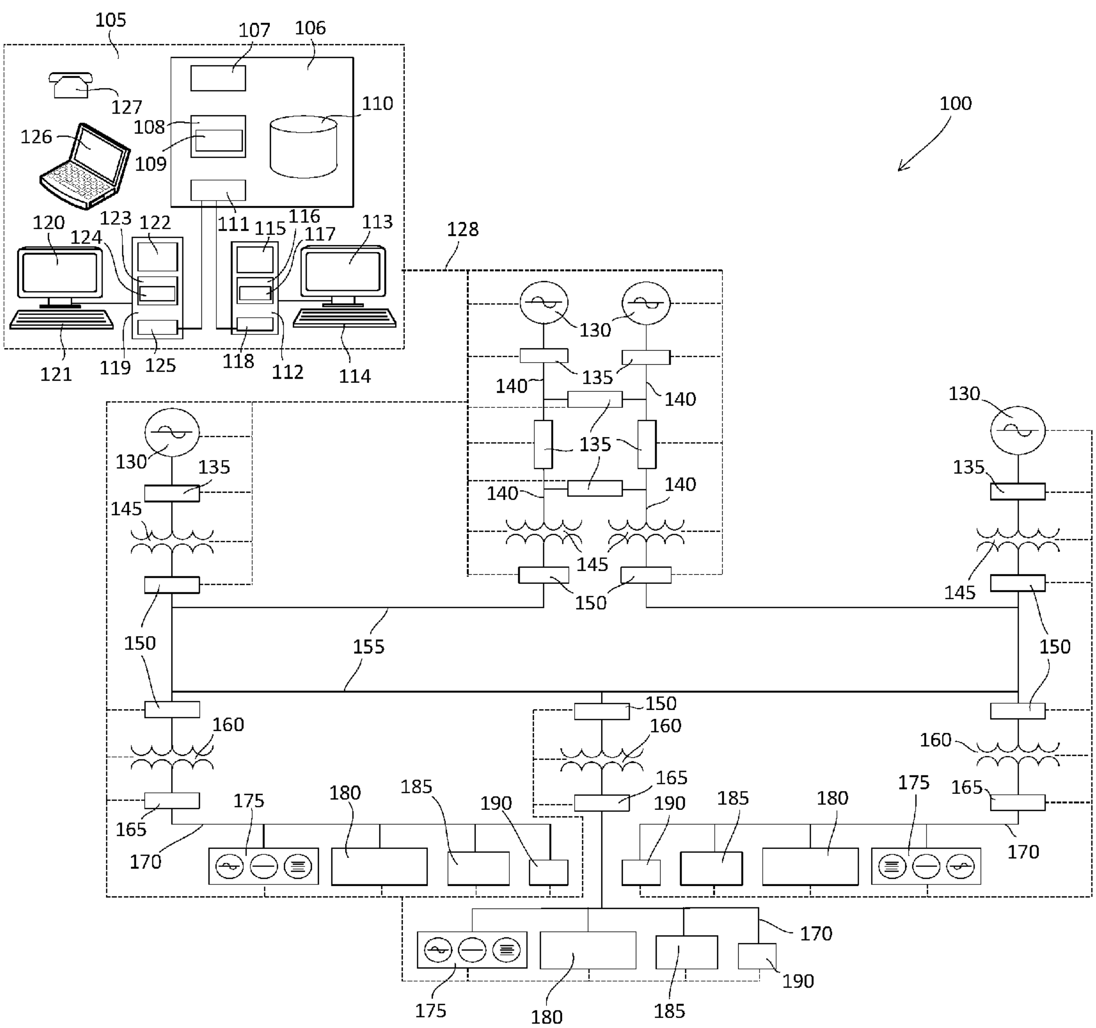
(57) **ABSTRACT**

Energy apparatuses, energy systems, and energy management methods may include energy storage. More particularly, energy apparatuses, energy systems, and energy management methods may include at least one of: energy source health data, weather data, or energy load prioritization data. The energy apparatuses, energy systems, and energy management methods may automatically control flow of energy based on at least one of: energy source health data, weather data, or energy load prioritization data.



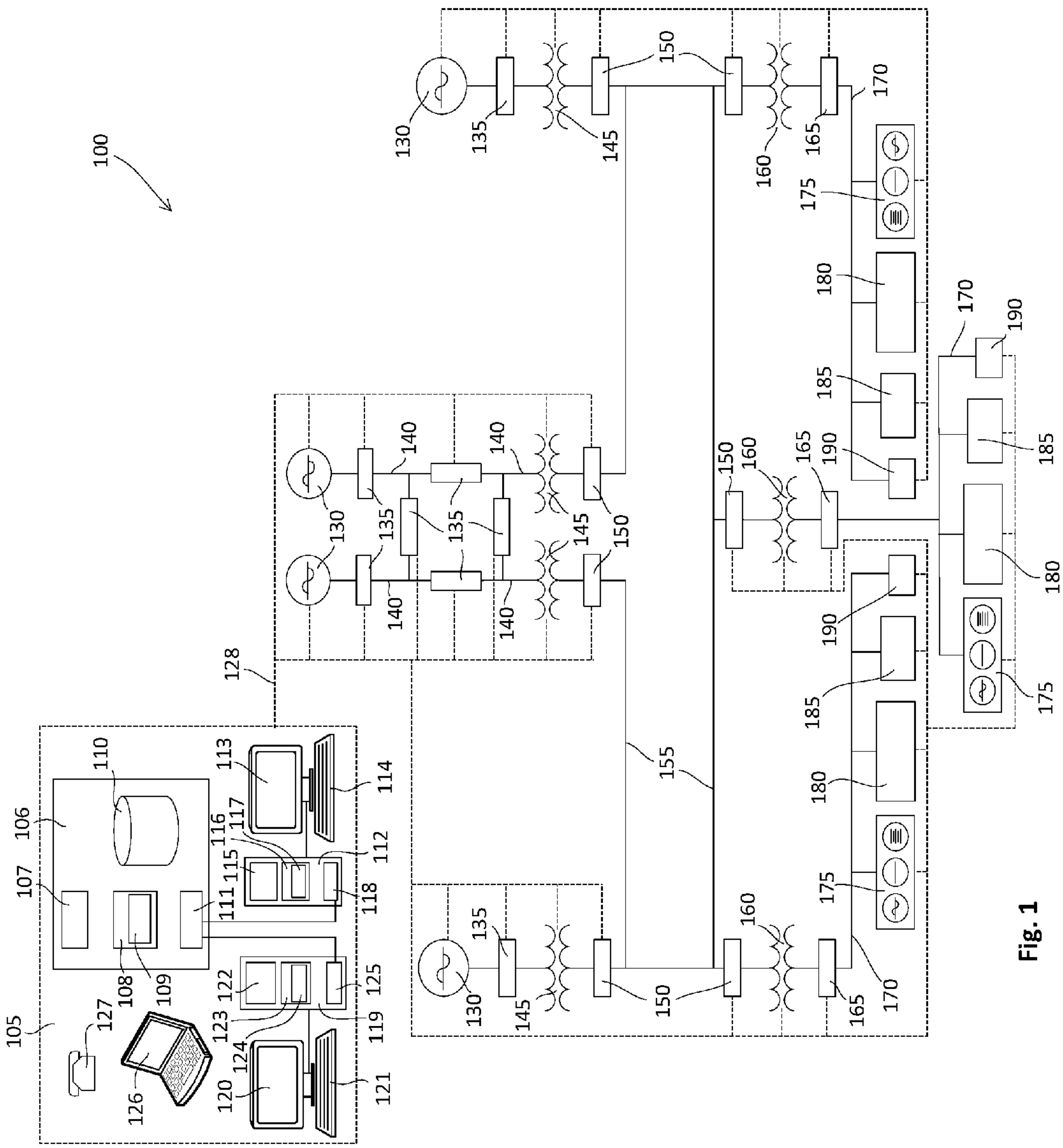

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Fig. 1

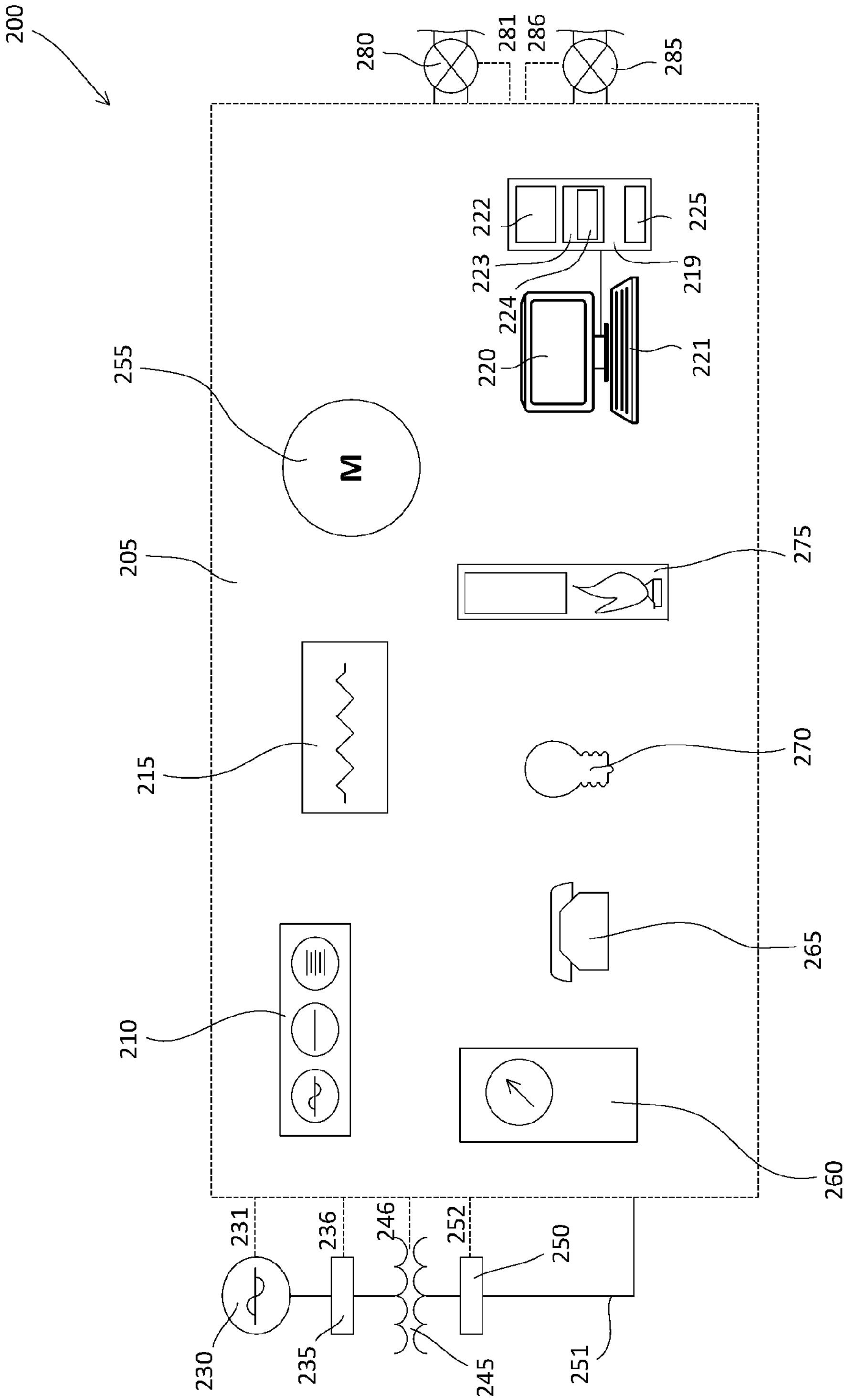
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Fig. 2

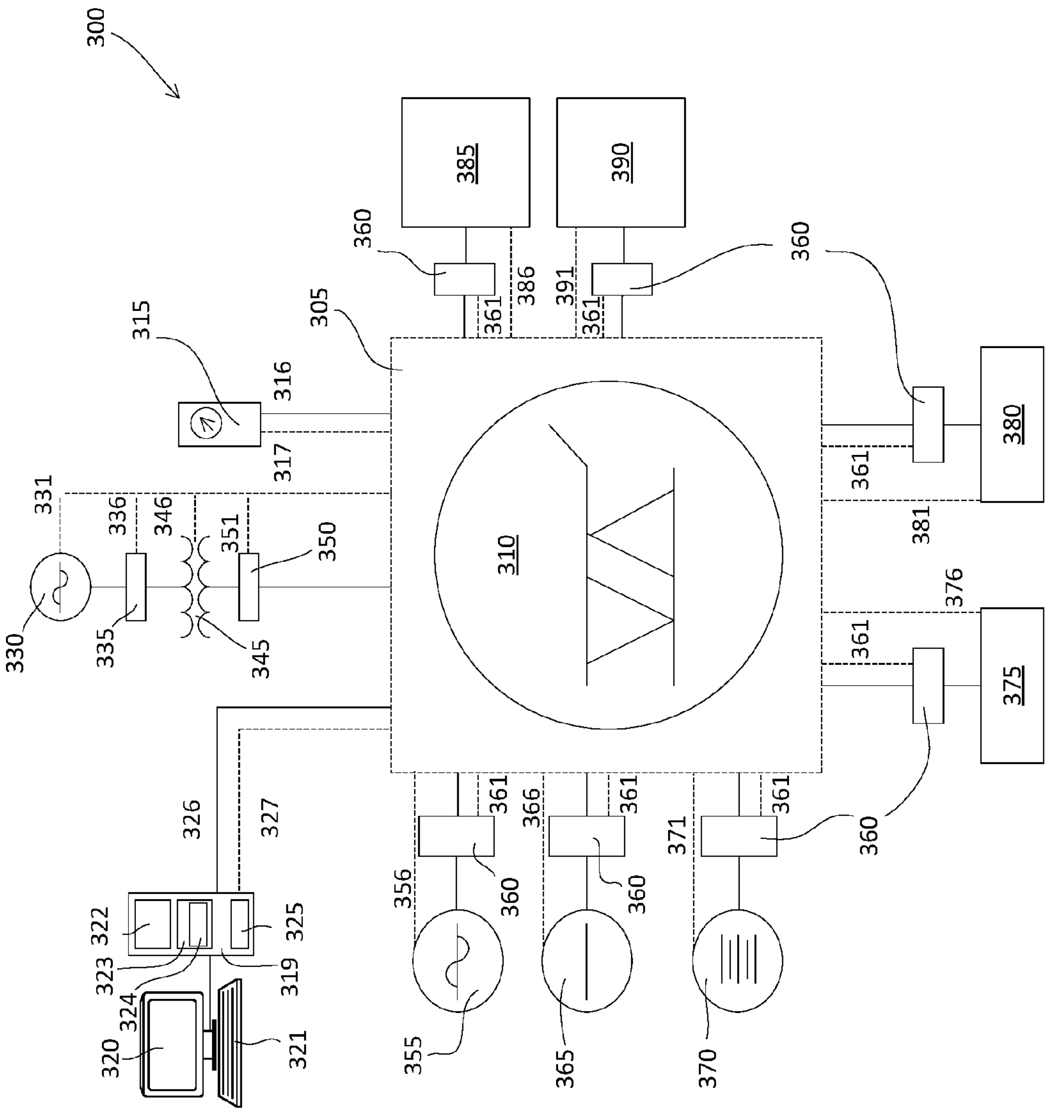
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Fig. 3

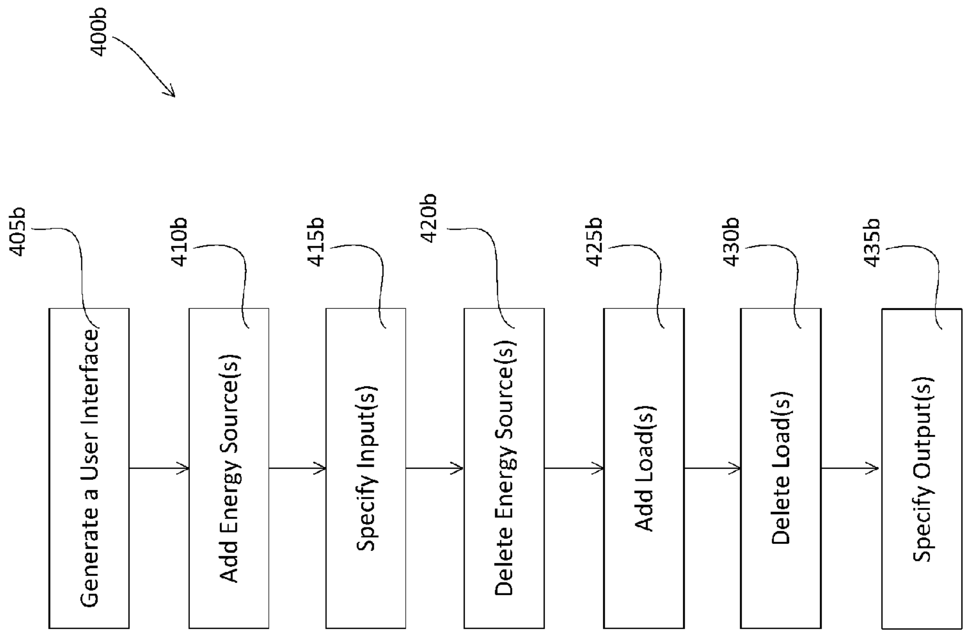
400b
405b
Generate a User Interface
410b
Add Energy Source(s)
415b
Specify Input(s)
420b
Delete Energy Source(s)
425b
Add Load(s)
430b
Delete Load(s)
435b
Specify Output(s)

Fig. 4B

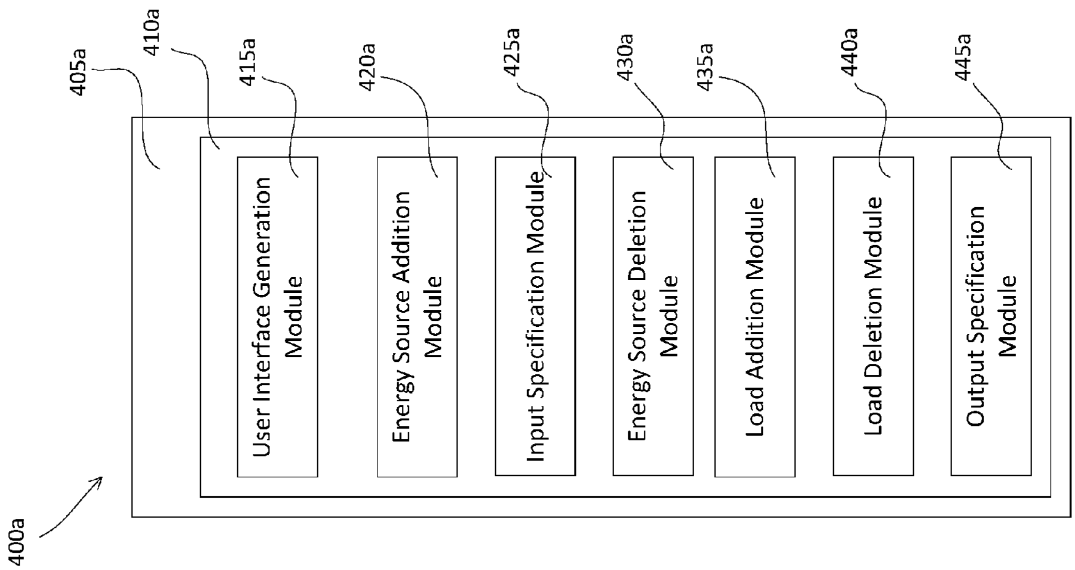
400a
405a
410a
415a
User Interface Generation Module
420a
Energy Source Addition Module
425a
Input Specification Module
430a
Energy Source Deletion Module
435a
Load Addition Module
440a
Load Deletion Module
445a
Output Specification Module

Fig. 4A

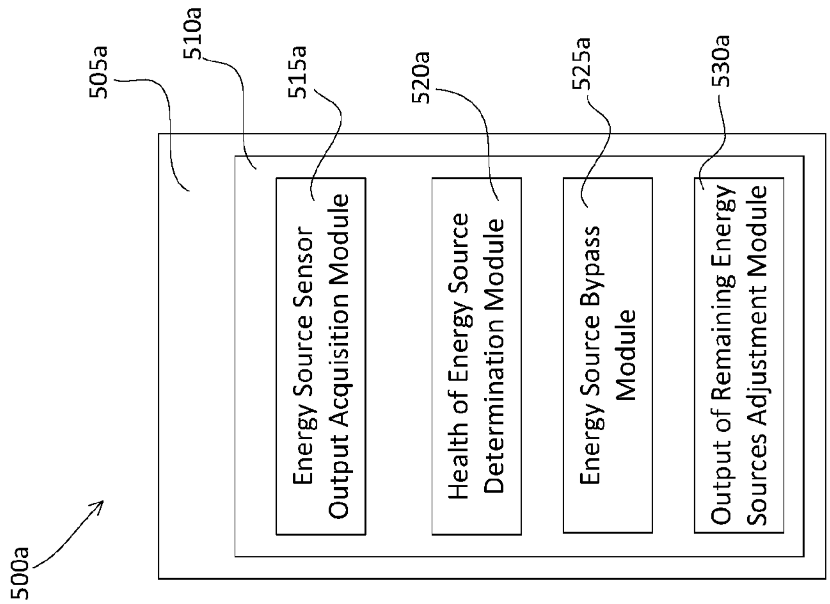
500a
505a
510a
515a
520a
525a
530a
Energy Source Sensor Output Acquisition Module
Health of Energy Source Determination Module
Energy Source Bypass Module
Output of Remaining Energy Sources Adjustment Module

Fig. 5A

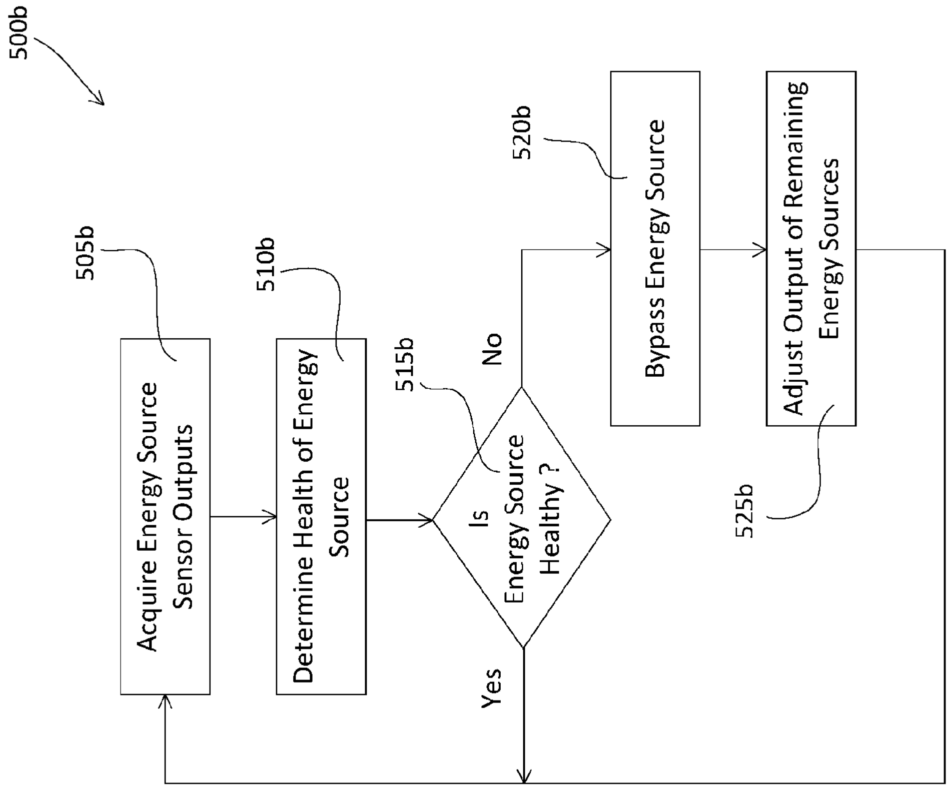
500b
505b
Acquire Energy Source Sensor Outputs
510b
Determine Health of Energy Source
515b
Is Energy Source Healthy ?
Yes
No
520b
Bypass Energy Source
Adjust Output of Remaining Energy Sources
525b

Fig. 5B

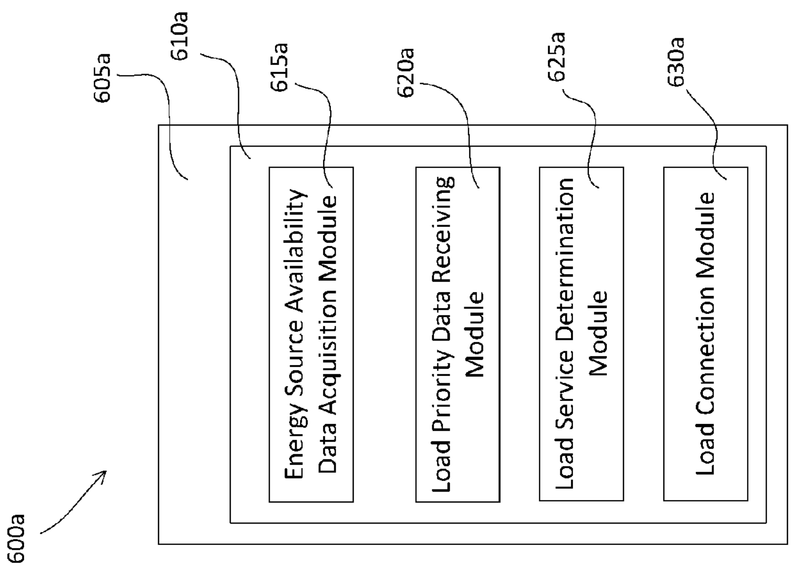
600a
605a
610a
615a
620a
625a
630a
Energy Source Availability Data Acquisition Module
Load Priority Data Receiving Module
Load Service Determination Module
Load Connection Module

Fig. 6A

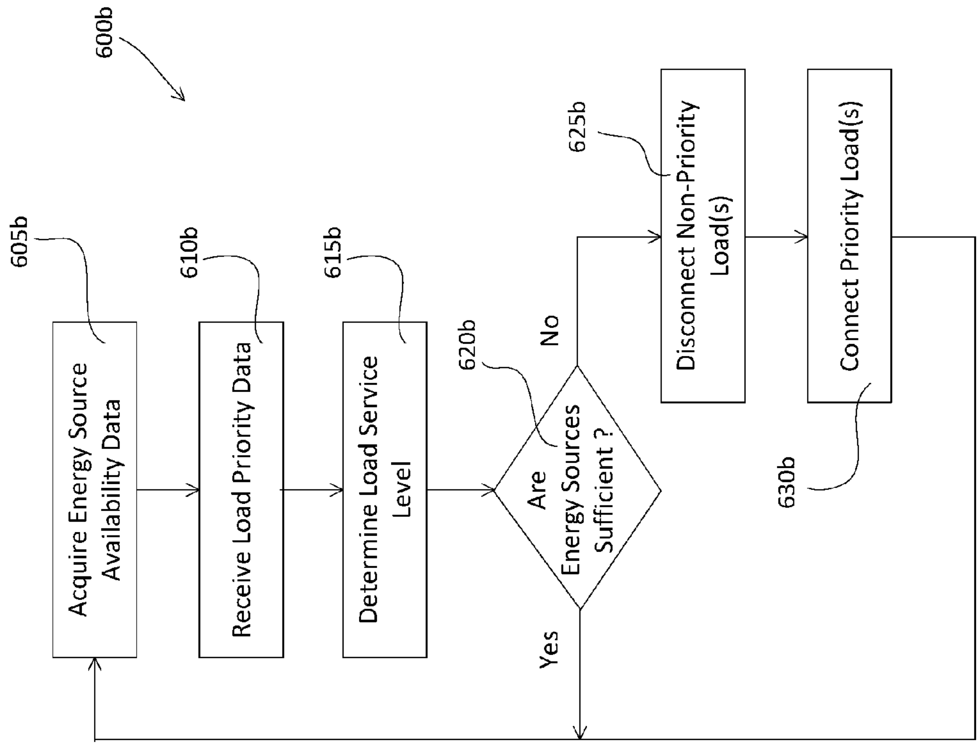
600b
605b
Acquire Energy Source Availability Data
610b
Receive Load Priority Data
615b
Determine Load Service Level
620b
Are Energy Sources Sufficient ?
Yes
No
625b
Disconnect Non-Priority Load(s)
630b
Connect Priority Load(s)

Fig. 6B

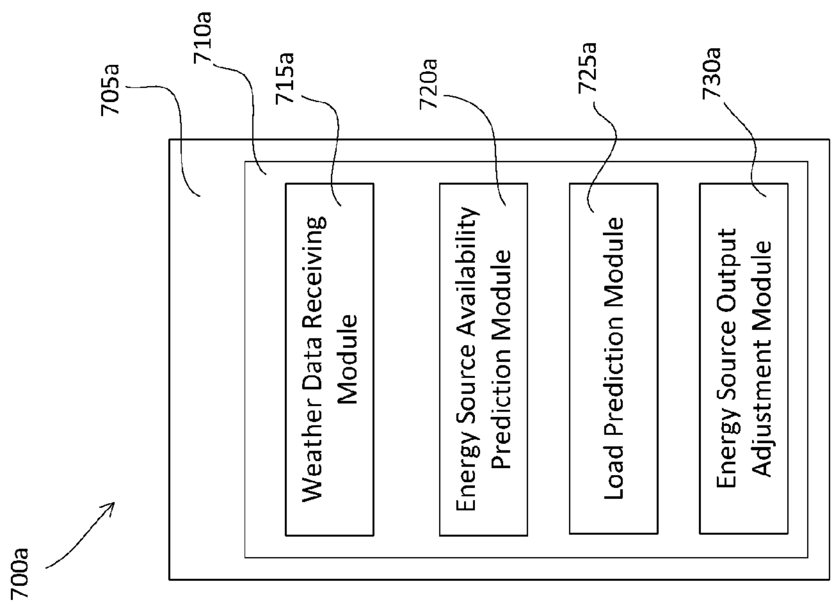
700a
705a
710a
715a
720a
725a
730a
Weather Data Receiving Module
Energy Source Availability Prediction Module
Load Prediction Module
Energy Source Output Adjustment Module

Fig. 7A

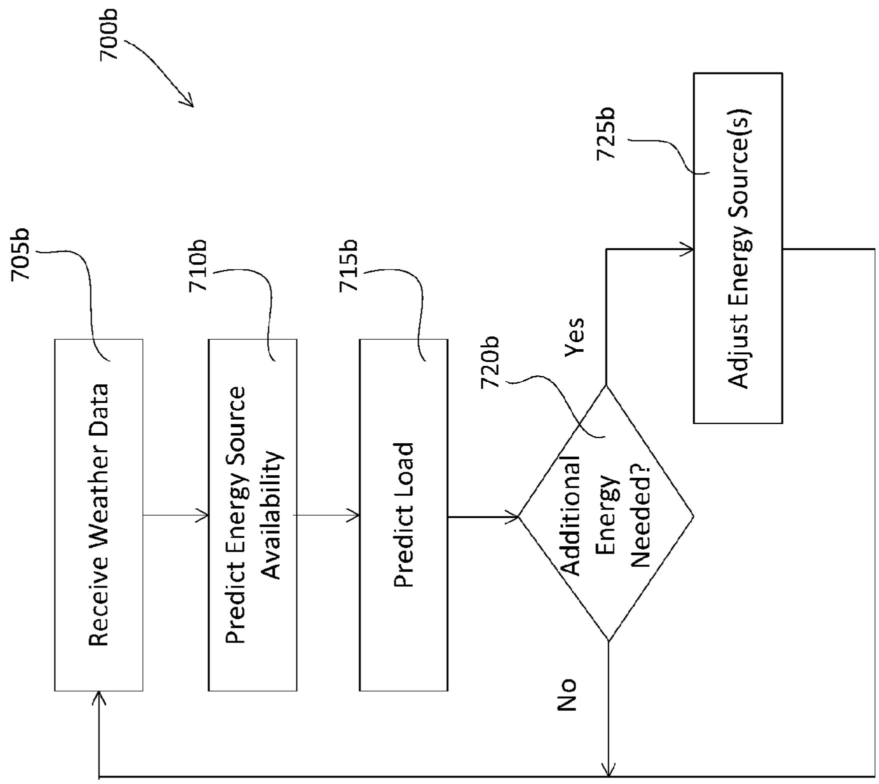
700b
705b
710b
715b
720b
725b
Receive Weather Data
Predict Energy Source Availability
Predict Load
Additional Energy Needed?
Yes
No
Adjust Energy Source(s)

Fig. 7B

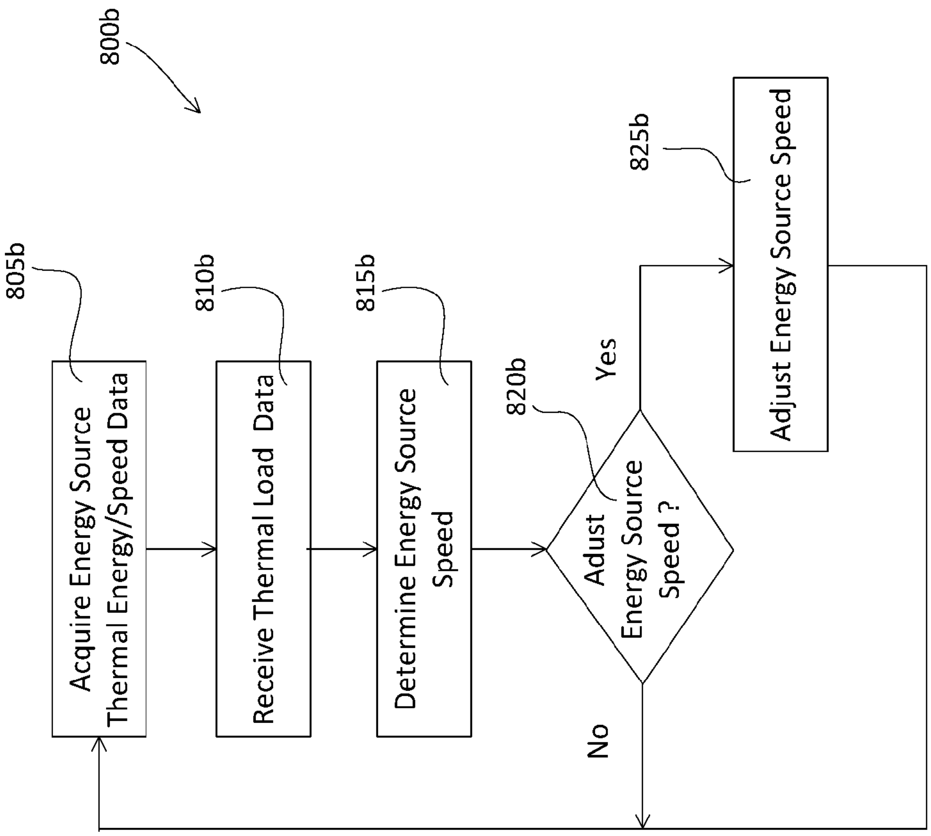
800b
805b
Acquire Energy Source Thermal Energy/Speed Data
810b
Receive Thermal Load Data
815b
Determine Energy Source Speed
820b
Adust Energy Source Speed ?
Yes
No
825b
Adjust Energy Source Speed

Fig. 8B

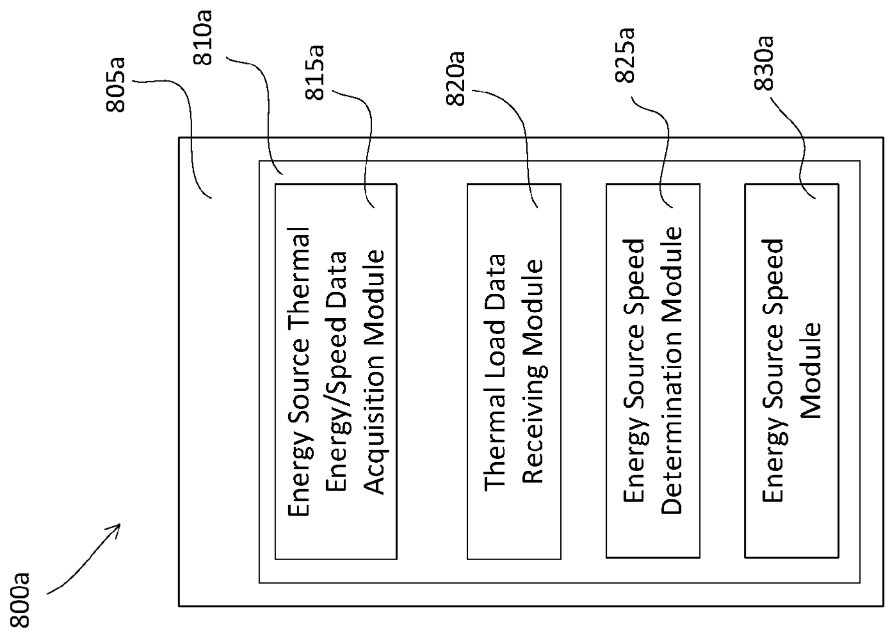
800a
805a
810a
815a
820a
825a
830a
Energy Source Thermal Energy/Speed Data Acquisition Module
Thermal Load Data Receiving Module
Energy Source Speed Determination Module
Energy Source Speed Module

Fig. 8A

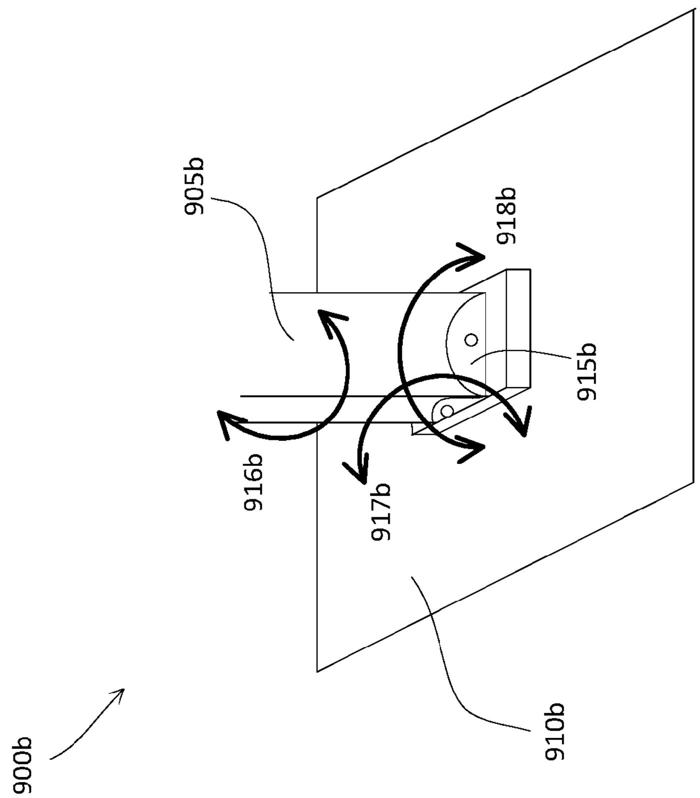

Fig. 9B

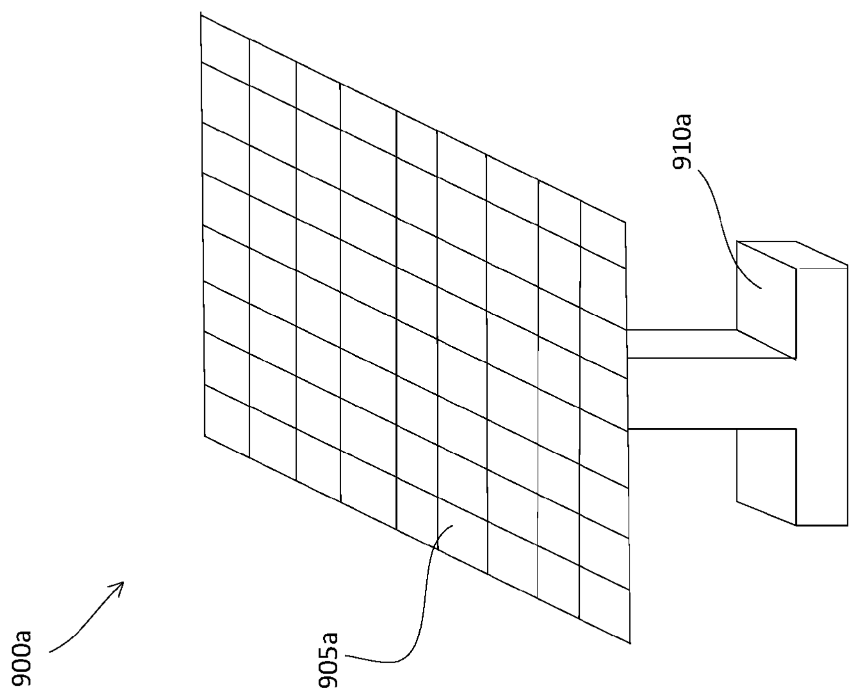

Fig. 9A

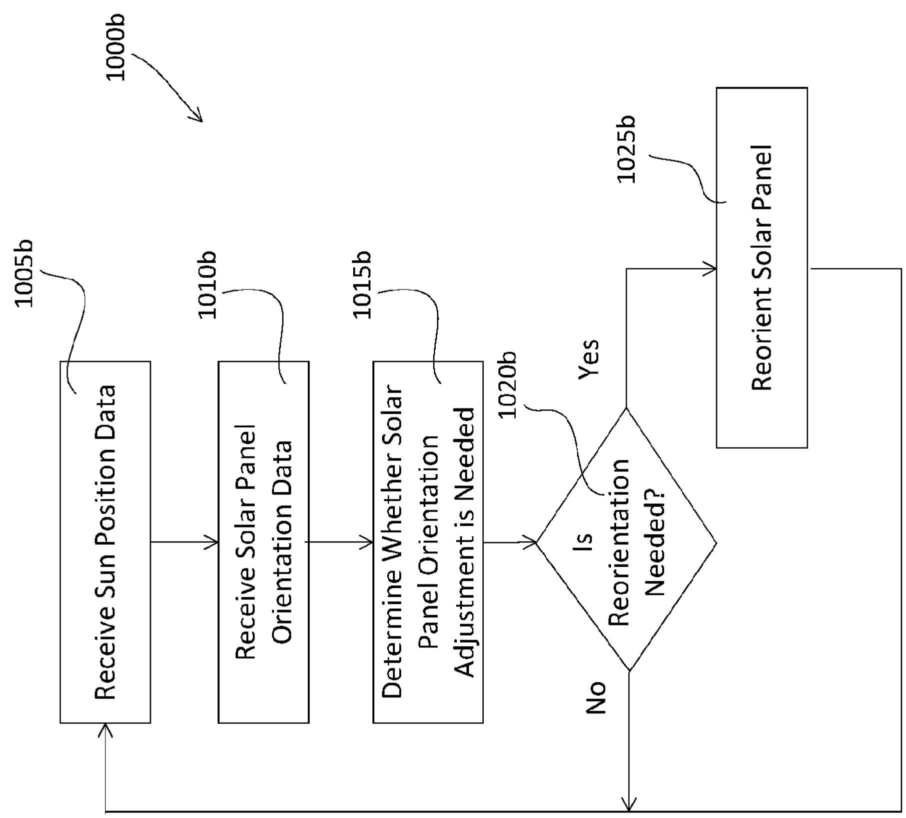

Fig. 10B

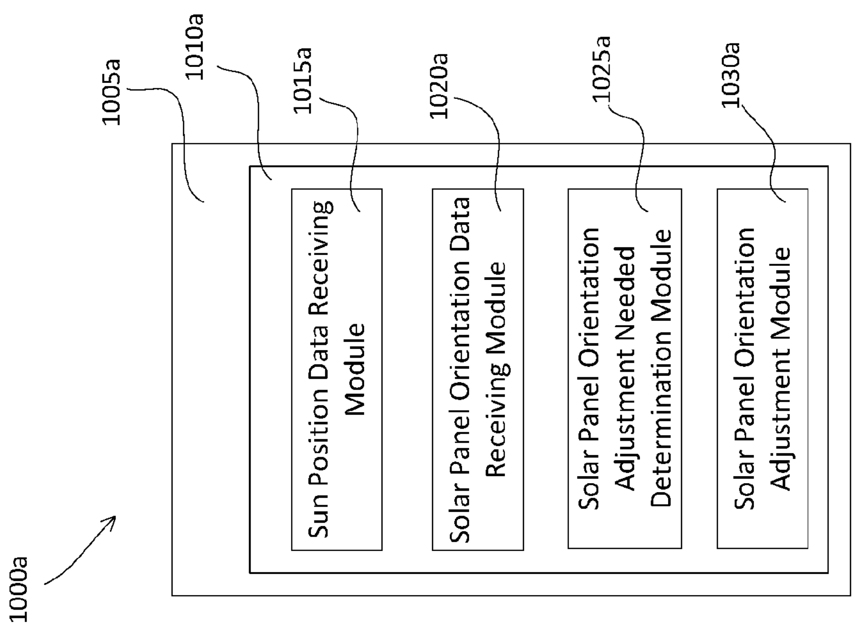

Fig. 10A

ENERGY APPARATUSES, ENERGY SYSTEMS, AND ENERGY MANAGEMENT METHODS INCLUDING ENERGY STORAGE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of U.S. patent application Ser. No. 13/628,941, entitled POWER GENERATION SYSTEM WITH INTEGRATED RENEWABLE ENERGY GENERATION, ENERGY STORAGE, AND POWER CONTROL, filed Sep. 27, 2012; U.S. patent application Ser. No. 14/852,426, entitled DISTRIBUTED ENERGY STORAGE AND POWER QUALITY CONTROL IN PHOTOVOLTAIC ARRAYS, filed Sep. 11, 2015; and U.S. patent application Ser. No. 14/880,578, entitled SOLAR PANEL SYSTEM WITH MONOCOQUE SUPPORTING STRUCTURE, filed Oct. 12, 2015, the disclosures of which are incorporated in their entireties herein by reference thereto.

TECHNICAL FIELD

[0002] The present disclosure relates generally to energy apparatuses, energy systems, and energy management methods. More particularly, the present disclosure relates to energy apparatuses, energy systems, and energy management methods that include energy storage.

BACKGROUND

[0003] In the twentieth century, grid electrical power was largely generated by burning fossil fuel. When less power was required, less fuel was burned. Concerns with air pollution and global warming have spurned growth of intermittent renewable energy (e.g., solar power, wind power, etc.). Solar and wind power are generally uncontrolled, due to availability of sun or wind, respectively, and may only be available at a time when no additional power is needed by associated loads. Thus, interest in storing solar and wind generated power grows as the industry grows.

[0004] Furthermore, off-grid electrical use was a niche market in the twentieth century, however, in the twenty-first century, off-grid electrical use has expanded. For example, portable electrical generation devices are in use all over the world. Solar panels and wind turbines are now common sights in rural settings worldwide. Access to electricity is now a question of economics, not location.

[0005] Moreover, powering transportation (e.g., electric battery powered vehicles, hydrogen powered vehicles, etc.) without burning fuel in an internal combustion engine remains in development. Hybrid vehicles, having an internal combustion engine, electrical generation, electrical energy storage, and an electrical drive motor, are common place.

[0006] Modern-day energy supply systems may include centralized energy sources, distributed energy sources, or a combination of centralized energy sources and distributed energy sources. For example, energy may be provided to industrial, commercial, and/or residential facilities as a primary energy source (e.g., coal, raw oil, fuel oil, natural gas, wind, sun, streaming water, nuclear power, gasoline, geothermal, biomass, ethanol, biodiesel, ammonium, propane, wood, corn, legumes, synthetic fuels, etc.) or as a secondary energy source (e.g., electrical, hydrogen, liquefied natural gas, etc.). Secondary energy may be obtained through conversion of primary energy and may, for example, function as an energy carrier.

[0007] Furthermore, modern-day energy supply systems may also include energy storage, for example, electrochemical energy storage (e.g., flow battery, rechargeable battery, super-capacitor, Li capacitors, ultra-battery, etc.); electrical energy storage (e.g., capacitor, superconducting magnetic energy storage (SMES), etc.); mechanical energy storage (e.g., compressed air energy storage (CAES), fireless locomotive, flywheel energy storage, gravitational potential energy (device), hydraulic accumulator, liquid nitrogen, pumped-storage hydroelectricity, etc.); biological (e.g., glycogen, starch, etc.); thermal energy storage (e.g., brick storage heater, cryogenic liquid air or nitrogen, eutectic system, ice storage, molten salt, phase change material, seasonal thermal energy storage, solar pond, steam accumulator, geothermal, etc.); and chemical energy storage (e.g., biofuels, hydrated salts, hydrogen, hydrogen peroxide, power to gas, vanadium pentoxide, etc.).

[0008] As energy supply systems become more comprehensive, management of the associated energy apparatuses becomes more complex. Accordingly, improved energy apparatuses, energy systems, and energy management methods are needed.

[0009] Energy apparatuses, energy systems, and energy management methods may include primary energy sources, secondary energy sources, and/or energy storage. Energy supply systems may include centralized energy sources, distributed energy sources, a combination of centralized energy sources and distributed energy sources, and/or energy storage. For example, energy may be provided to industrial, commercial, and/or residential facilities as a primary energy source (e.g., coal, uranium-235 (^{235}U), plutonium-239 (^{239}Pu), plutonium-238 (^{238}Pu), tritium (^{3}H), raw oil, fuel oil, natural gas, wind, sun, streaming water, nuclear power, gasoline, geothermal, biomass, ethanol, biodiesel, ammonium, propane, wood, corn, legumes, etc.) or as a secondary energy source (e.g., electrical, hydrogen, liquefied natural gas, etc.). Secondary energy may be obtained through conversion of primary energy and may, for example, function as an energy carrier. Energy storage, may include electrochemical energy storage (e.g., flow battery, rechargeable battery, super-capacitor, ultra-battery, etc.); electrical energy storage (e.g., capacitor, superconducting magnetic energy storage (SMES), etc.); mechanical energy storage (e.g., compressed air energy storage (CAES), fireless locomotive, flywheel energy storage, gravitational potential energy (device), hydraulic accumulator, liquid nitrogen, pumped-storage hydroelectricity, etc.); biological (e.g., glycogen, starch, etc.); thermal energy storage (e.g., brick storage heater, cryogenic liquid air or nitrogen, eutectic system, ice storage, molten salt, phase change material, seasonal thermal energy storage, solar pond, steam accumulator, geothermal, etc.); and chemical energy storage (e.g., biofuels, synthetic fuels, hydrated salts, uranium-235 (^{235}U), plutonium-239 (^{239}Pu), plutonium-238 (^{238}Pu), tritium (^{3}H), hydrogen, hydrogen peroxide, power to gas, vanadium pentoxide, etc.).

[0010] Lead-acid batteries hold the largest market share of electric storage products. A single cell may produce two volts when fully charged. In the charged state, a metallic lead negative electrode and a lead sulfate positive electrode are immersed in a dilute sulfuric acid (H_2SO_4) electrolyte. In a discharge process electrons are pushed out of the cell as lead sulfate is formed at a negative electrode while the electrolyte is reduced to water.

[0011] A nickel-cadmium battery (NiCd) uses nickel oxide hydroxide and metallic cadmium as electrodes. Cadmium is a toxic element, and was banned for most uses by the European Union in 2004. Therefore, nickel-cadmium batteries have been almost completely replaced by nickel-metal hydride (NiMH) batteries.

[0012] The first commercial types of nickel-metal hydride (NiMH) batteries were available in 1989. NiMH batteries are now available in common consumer and industrial types. The NiMH battery typically includes an aqueous electrolyte along with a hydrogen-absorbing alloy for a negative electrode, instead of cadmium.

[0013] Lithium-ion batteries (e.g., lithium cobalt oxide ($LiCoO_2$), lithium iron phosphate ($LiFePO_4$), lithium ion manganese oxide battery (LMnO or LMO), lithium nickel cobalt aluminum oxide ($LiNiCoAlO_2$ or NCA), lithium titanate ($Li_4Ti_5O_{12}$ or LTO), and lithium nickel manganese cobalt oxide ($LiNiMnCoO_2$ or NMC)) offer low energy density, relatively long lives, and inherent safety. Such batteries are widely used for electric tools, medical equipment and other roles. NMC, in particular, is a leading contender for automotive applications. Lithium nickel cobalt aluminum oxide ($LiNiCoAlO_2$ or NCA) and lithium titanate ($Li_4Ti_5O_{12}$ or LTO) are used in many consumer electronics and have one of the best energy-to-mass ratios and a very slow self-discharge when not in use. Lithium-ion polymer batteries are similar.

SUMMARY

[0014] An energy conversion apparatus may include at least one first reconfigurable energy source input. The at least one first reconfigurable energy source input may be reconfigurable based upon first energy source characteristic data received by the energy conversion apparatus. The energy conversion apparatus may also include at least one second reconfigurable energy source input. The at least one second reconfigurable energy source input may be reconfigurable based upon second energy source characteristic data received by the energy conversion apparatus. The energy conversion apparatus may further include at least one energy storage device connection and at least one energy load output. The energy conversion apparatus may be configured to provide energy to the at least one energy load output based upon the first and second energy source characteristic data, and further based on a quantity of energy stored in at least one energy storage device.

[0015] In another embodiment, an energy management system may include at least one energy conversion apparatus having at least two energy source inputs, at least one energy storage device connection, and at least one energy load output. The energy management system may also include a controller having at least one energy source health data input and at least one energy conversion apparatus output. The controller may generate the at least one energy conversion apparatus output based upon energy source health data received via the at least one energy source health data input.

[0016] In a further embodiment, an energy management system may include at least one energy conversion apparatus having at least one energy source input, at least one energy storage device connection, and at least two energy load outputs. The energy management system may also include a controller having at least one energy load priority data input and at least one energy conversion apparatus output. The controller may generate the at least one energy conversion apparatus output based upon energy load priority data received via the at least one energy load priority data input.

BRIEF DESCRIPTION OF THE FIGURES

[0017] FIG. **1** depicts an example energy system including energy storage;

[0018] FIG. **2** depicts an example energy system including energy storage;

[0019] FIG. **3** depicts an example energy apparatus including energy storage;

[0020] FIG. **4**A depicts an example apparatus for managing an energy apparatus including energy storage;

[0021] FIG. **4**B depicts a flow diagram for an example method for managing an energy apparatus including energy storage;

[0022] FIG. **5**A depicts an example apparatus for managing an energy apparatus including energy storage;

[0023] FIG. **5**B depicts a flow diagram for an example method for managing an energy apparatus including energy storage;

[0024] FIG. **6**A depicts an example apparatus for managing an energy system including energy storage;

[0025] FIG. **6**B depicts a flow diagram for an example method for managing an energy system including energy storage;

[0026] FIG. **7**A depicts an example apparatus for managing an energy system including energy storage;

[0027] FIG. **7**B depicts a flow diagram for an example method for managing an energy system including energy storage;

[0028] FIG. **8**A depicts an example apparatus for managing an energy apparatus including energy storage;

[0029] FIG. **8**B depicts a flow diagram for an example method for managing an energy apparatus including energy storage;

[0030] FIGS. **9**A and **9**B depict an example energy apparatus;

[0031] FIG. **10**A depicts an example apparatus for managing an energy apparatus as depicted in FIGS. **9**A and **9**B;

[0032] FIG. **10**B depicts a flow diagram for an example method for managing an energy apparatus as depicted in FIGS. **9**A and **9**B.

DETAILED DESCRIPTION

[0033] Energy apparatuses, systems, and methods of the present disclosure may include centralized energy sources, distributed energy sources, a combination of centralized energy sources and distributed energy sources, centralized energy storage, distributed energy storage, and/or a combination of centralized energy storage and distributed energy storage. For example, energy may be provided to industrial, commercial, and/or residential facilities as a primary energy source (e.g., coal, uranium-235 (^{235}U), plutonium-239 (^{239}Pu), plutonium-238 (^{238}Pu), tritium (^{3}H), raw oil, fuel oil, natural gas, wind, sun, streaming water, nuclear power, gasoline, geothermal, biomass, ethanol, biodiesel, ammonium, propane, wood, corn, legumes, synthetic fuels, etc.) or as a secondary energy source (e.g., electrical, hydrogen, liquefied natural gas, etc.). Secondary energy may be obtained through conversion of primary energy and may, for example, function as an energy carrier.

[0034] Energy storage may, for example, include electrochemical energy storage (e.g., flow battery, rechargeable battery, Li capacitors, super-capacitor, ultra-battery, etc.); electrical energy storage (e.g., capacitor, superconducting magnetic energy storage (SMES), etc.); mechanical energy storage (e.g., compressed air energy storage (CAES), fireless locomotive, flywheel energy storage, gravitational potential energy (device), hydraulic accumulator, liquid nitrogen, pumped-storage hydroelectricity, etc.); biological (e.g., glycogen, starch, etc.); thermal energy storage (e.g., brick storage heater, cryogenic liquid air or nitrogen, eutectic system, ice storage, molten salt, phase change material, seasonal thermal energy storage, solar pond, steam accumulator, geothermal, etc.); and chemical energy storage (e.g., biofuels, synthetic fuels, hydrated salts, hydrogen, hydrogen peroxide, power to gas, uranium-235 (^{235}U), plutonium-239 (^{239}Pu), plutonium-238 (^{238}Pu), tritium (^{3}H), vanadium pentoxide, etc.).

[0035] An energy storage device may include at least one lead-acid battery. A single cell of a lead-acid battery may produce, for example, two volts when fully charged. Alternatively, or additionally, an energy storage device may include at least one nickel-cadmium battery (NiCd) and/or at least one nickel-metal hydride (NiMH) battery. As another alternative, or addition, an energy storage device may include at least one lithium-ion battery (e.g., lithium cobalt oxide ($LiCoO_2$), lithium iron phosphate ($LiFePO_4$), lithium ion manganese oxide battery (LMnO or LMO), lithium nickel cobalt aluminum oxide ($LiNiCoAlO_2$ or NCA), lithium titanate ($Li_4Ti_5O_{12}$ or LTO), solid state lithium (Li) battery, and lithium nickel manganese cobalt oxide ($LiNiMnCoO_2$ or NMC)).

[0036] Energy apparatuses, systems, and methods of the present disclosure may determine commitment requirements for various energy sources. Similarly, the energy apparatuses, systems, and methods of the present disclosure may determine dispatch requirements of previously committed energy sources. The commitment and dispatch requirements may account for routine maintenance and/or health factors of various energy sources and/or system components.

[0037] Turning to FIG. **1**, an energy system **100** may include secondary energy sources **130** and distributed energy generation/energy storage devices **175**. The energy system **100** may also include an energy management system **105** having a server **106**, a first workstation **112**, a second workstation **119**, at least one portable computing device **126** (e.g., a laptop computer, a tablet, a PDA, a smartphone, etc.), and at least one voice communication device **127** (e.g., a telephone, a voice recognition device, etc.). The server **126** may include a first module **109** stored on a computer-readable memory **108** (e.g., a non-transitory computer-readable medium, a transitory computer-readable medium, etc.) that, when executed by a processor **107**, causes the processor **107** to, for example, automatically control (e.g., commit and/or dispatch) various components (e.g., secondary energy sources **130**, distributed energy generation/energy storage device **175**, disconnect devices **135**, **150**, **165**, etc.) of the energy system **100**. While the first module **109** may include a set of computer-readable instructions, the first module **109** may alternatively be a hardware implementation of an equivalent electrical circuit. The server **106** may also include a communication network interface **111** to, for example, communicatively connect the server **106** to the first workstation **112**, the second workstation **119**, the portable computing device **126**, the voice communication device **127**, and/or the various components (e.g., secondary energy sources **130**, distributed energy generation/energy storage device **175**, disconnect devices **135**, **150**, **165** (e.g., fuse disconnects, switchgear, starters, manual disconnects, contactors, re-connection devices, circuit interrupters, valves, etc.), transformers **145**, **160**, industrial energy loads **180**, commercial energy loads **185**, residential energy loads **190**, etc.) of the energy system **100** via a communication network **128**.

[0038] The communication network **128** may include a hardwired link (e.g., a telephone line, an Ethernet connection, a coaxial line, etc.), a wireless link (e.g., a WiFi, a cellular telephone link, a local area network, a Bluetooth® link, et.), or a combination of various hardwired links and wireless links. Alternatively, or additionally, the communication network **128** may include at least one dedicated, proprietary, links (e.g., a secure network, etc.).

[0039] The energy system **100** and, in particular, the energy generation/energy storage device **175**, may be as described in U.S. patent application Ser. No. 13/628,941, entitled POWER GENERATION SYSTEM WITH INTEGRATED RENEWABLE ENERGY GENERATION, ENERGY STORAGE, AND POWER CONTROL, filed Sep. 27, 2012; and U.S. patent application Ser. No. 14/852,426, entitled DISTRIBUTED ENERGY STORAGE AND POWER QUALITY CONTROL IN PHOTOVOLTAIC ARRAYS, filed Sep. 11, 2015, the disclosures of which are incorporated herein in their entireties by reference thereto.

[0040] Similarly, the first workstation **112** may include a second module **116** stored on a computer-readable memory **117** (e.g., a non-transitory computer-readable medium, a transitory computer-readable medium, etc.) that, when executed by a processor **115**, causes the processor **115** to, for example, enable a user (e.g., an energy system operator, an engineer, an energy business manager, etc.) to monitor and/or control various components (e.g., secondary energy sources **130**, distributed energy generation/energy storage device **175**, disconnect devices **135**, **150**, **165**, transformers **145**, **160**, industrial energy loads **180**, commercial energy loads **185**, residential energy loads **190**, etc.) of the energy system **100**. While the second module **116** may include a set of computer-readable instructions, the second module **116** may alternatively be a hardware implementation of an equivalent electrical circuit. The first workstation **112** may also include a display **113**, a user input device **114**, and a communication network interface **118** to, for example, communicatively connect the first workstation **112**, the server **106**, the second workstation **119**, the portable computing device **126**, the voice communication device **127**, and/or the various components (e.g., secondary energy sources **130**, distributed energy generation/energy storage device **175**, disconnect devices **135**, **150**, **165**, transformers **145**, **160**, industrial energy loads **180**, commercial energy loads **185**, residential energy loads **190**, etc.) of the energy system **100** via a communication network **128**.

[0041] Likewise, the second workstation **119** may include a third module **124** stored on a computer-readable memory **123** (e.g., a non-transitory computer-readable medium, a transitory computer-readable medium, etc.) that, when executed by a processor **122**, causes the processor **122** to, for example, enable a user (e.g., an energy system operator, an engineer, an energy business manager, etc.) to monitor and/or control various components (e.g., secondary energy sources **130**, distributed energy generation/energy storage device **175**, disconnect devices **135**, **150**, **165**, transformers **145**, **160**, industrial energy loads **180**, commercial energy loads **185**, residential energy loads **190**, etc.) of the energy system **100**. While the third module **124** may include a set of computer-readable instructions, the third module **124** may alternatively be a hardware implementation of an equivalent electrical circuit. The second workstation **119** may also include a display **120**, a user input device **121**, and a communication network interface **125** to, for example, communicatively connect the second workstation **119**, the server **106**, the first workstation **112**, the portable computing device **126**, the voice communication device **127**, and/or the various components (e.g., secondary energy sources **130**, distributed energy generation/energy storage device **175**, disconnect devices **135**, **150**, **165**, transformers **145**, **160**, industrial energy loads **180**, commercial energy loads **185**, residential energy loads **190**, etc.) of the energy system **100** via a communication network **128**.

[0042] A secondary energy source **130** may be, for example, an electrical generation device that may convert a primary energy source (e.g., coal, raw oil, fuel oil, natural gas, wind, sun, streaming water, nuclear power, gasoline, geothermal, biomass, ethanol, biodiesel, ammonium, propane, wood, corn, legumes, etc.) to electrical energy. Alternatively, or additionally, a secondary energy source **130** may include, for example, a hydrogen generator (e.g., a fuel cell), or a liquefied natural gas compressor. In any event, a primary energy source may be delivered to a secondary energy source **130** as needed and/or the primary energy source may be stored local to a respective secondary energy source **130**. Notably, neither primary energy source delivery mechanisms nor primary energy source storage mechanisms are depicted in FIG. **1**.

[0043] A secondary energy source **130** may generate, for example, direct current (DC) electrical energy or alternating current (AC) electrical energy having a first voltage (e.g., 120 volts, 240 volts, 480 volts, 600 volts, 1,000 volts, 4,160 volts, 13,200 volts, 33,000 volts, 66,000 volts, 132,000 volts, etc.). A secondary energy source **130** may be connected to at least one step-up transformer **145** via at least one generator disconnect device **135**. A plurality of generator disconnect devices **135** may be arranged in a ring-bus configuration **140** to, for example, increase reliability and/or to facilitate maintenance activities. In any event, a step-up transformer **145** may transform the first voltage to a second voltage (e.g., 69,000 volts, 138,000 volts, 245,000 volts, 365,000 volts, 765,000 volts, 1,000,000 volts, etc.). An output side (e.g., the second voltage side) of a step-up transformer **145** may be connected to an energy transmission line **155** via, for example, at least one transmission disconnect device **150**. Notably, an energy transmission line may extend hundreds, or thousands, of miles. As shown in FIG. **1**, a transmission line may be connected in a "loop" configuration such that, for example, at least two paths may be provided for energy flow from any given secondary energy source **130** to any given energy load (e.g., industrial energy load **180**, commercial energy load **185**, residential energy load **190**, distributed energy generation/energy storage device **175**, etc.) to, for example, increase reliability and/or to facilitate maintenance activities.

[0044] A step-down transformer **160** may transform the second voltage (e.g., transmission voltage) to a third voltage (e.g., 4,160 volts, 13,200 volts, 32,000 volts, etc.). A step-down transformer **160** may be connected to an energy transmission line **155** via at least one transmission disconnect device **150** and connected to an energy distribution line **170** via at least one distribution disconnected **165**. While not illustrated as such in FIG. **1**, any given energy distribution line **170** may be connected in a "loop" such that energy may flow from at least one step-down transformer **160** to any given energy load (e.g., industrial energy load **180**, commercial energy load **185**, residential energy load **190**, distributed energy generation/energy storage device **175**, etc.) via at least two paths to, for example, increase reliability and/or to facilitate maintenance activities.

[0045] While not specifically indicated in FIG. **1**, sensors (e.g., sensor **260** of FIG. **2** or sensor **315** of FIG. **3**) may be included throughout the energy system **100** to, for example, measure and/or control various energy related values (e.g., energy measurement, electricity flow/volume, gas flow/volume, water flow/volume, mass flow/volume, etc.), and may be included at, or within, any one of the elements **130**, **145**, **150**, **160**, **165**, **175**, **180**, **185**, **190**. Outputs of these metering devices may be incorporated with the energy management system **105** to provide additional monitoring and control functions, and/or to facilitate energy accounting and invoicing. The energy system **100** may include additional elements **130**, **145**, **150**, **160**, **165**, **175**, **180**, **185**, **190** at, or within, any one of the energy sources and/or energy loads to, for example, facilitate commitment and/or dispatch of any given energy source and to connect/disconnect any given load.

[0046] With reference to FIG. **2**, an energy system **200** may include at least one energy load **205** (e.g., industrial energy load **180**, commercial energy load **185**, residential energy load **190**, distributed energy generation/energy storage device **175**, etc.). The energy system **200** may be similar to, for example, the energy system **100** of FIG. **1**. The energy system **200** may include at least one energy generation/energy storage device **210**, at least one resistive energy load **215** (e.g., a heating element, an igniter, etc.), at least one workstation **219**, at least one secondary energy source **230**, at least one rotating load (e.g., an electric motor, a steam driven motor, an internal combustion engine, etc.), at least one sensor **260** (e.g., an electric current sensor, a flow meter, a voltage sensor, a pressure sensor, a temperature sensor, a frequency sensor, a power factor sensor, a phase sequence sensor, a phase rotation sensor, a voltage waveform sensor, an oscilloscope, a strain gauge sensor, a rotation sensor, a linear sensor, a flow sensor, a proximity sensor, a watt-hour meter, a volume meter, etc.), a voice communication device **265**, a light emitter **270** (e.g., an incandescent light, a light emitting diode, a fluorescent light, a high-pressure sodium light, a metal halide light, a mercury vapor light, etc.), an energy conversion device (e.g., a water heater, a boiler, a fuel cell, a furnace, an incinerator, a primary energy source burner, etc.), a first primary energy source **280**, and a second primary energy source **285**.

[0047] The secondary energy source **230** may be connected to the energy load **205** via an energy generation disconnect device **235**, a step-up transformer **245**, an energy transmission or energy distribution disconnect device **250**, and an energy transmission or distribution line **251**. The workstation **219** may include a module **224** stored on a computer-readable memory **223** (e.g., a non-transitory computer-readable medium, a transitory computer-readable medium, etc.) that, when executed by a processor **222**, causes the processor **222** to, for example, enable a user (e.g., an energy system operator, an engineer, an energy business manager, etc.) to monitor and/or control various components (e.g., secondary energy source **230**, distributed energy generation/energy storage device **210**, disconnect devices **235**, **250**, transformer **245**, resistive heat **215**, motor **255**, sensor **260**, voice communication device **265**, light source **270**, energy conversion device **275**, first primary energy source **280**, second primary energy source **285**, etc.) of the energy system **200**. While the module **224** may include a set of computer-readable instructions, the module **224** may alternatively be a hardware implementation of an equivalent electrical circuit. The workstation **219** may also include a display **220**, a user input device **221**, and a communication network interface **225** to, for example, communicatively connect the workstation **219**, the secondary energy source **230**, the distributed energy generation/energy storage device **210**, the disconnect devices **235**, **250**, the transformer **245**, the resistive heat **215**, motor **255**, the sensor **260**, the voice communication device **265**, the light source **270**, the energy conversion device **275**, the first primary energy source **280**, and the second primary energy source **285** of the energy system **100** via a communication network **231**, **236**, **246**, **252**, **281**, **286**.

[0048] While the first and second primary energy sources **280**, **285** are illustrated as pipes/valves in FIG. **2**, any given primary energy source may be stored in any suitable container (e.g., a tank, a hopper, a pile, a silo, a bunker, bulk storage, a vessel, a cave, a mine shaft, a tunnel, etc.) and may be conveyed via any suitable conveying device (e.g., a pipe/valve, a conveyor, an auger, a chute/gravity, a blower, etc.).

[0049] Turning to FIG. **3**, an energy system **300** may include an energy conversion apparatus **305** (e.g., at least one fuel cell, at least one composter, at least one incinerator, at least one boiler, at least one burner, any combination thereof, etc.) that may convert a primary energy source to a secondary energy source. The energy system **300** may be similar to, for example, either the energy system **100** of FIG. **1** or the energy system **200** of FIG. **2**. The energy conversion apparatus **305** may be a bidirectional devise that, for example, converts a primary energy source **385**, **395** to a secondary energy source **330**, **355**, **365** and/or that converts a secondary energy source **330**, **355**, **365** to a primary energy source **385**, **390**.

[0050] The energy conversion apparatus **305** may include at least one energy conversion device **310** (e.g., AC-to-DC rectifier, at least one DC-to-AC inverter, at least on DC-to-DC converter, any combination thereof, etc.). The energy conversion device **310** may be bidirectional. For example, the energy conversion device **310** may rectify an AC electrical output of a secondary energy source (e.g., electrical generator **330**, **355**) to a DC energy storage device **370** input and may subsequently invert a DC energy output of the storage device **370** to an AC electrical supply to a load (e.g., electrical load **375**, **380**). Accordingly, a secondary energy source **330**, **355** may generate energy using a primary energy source **385**, **390**, may store the energy in an energy storage device **370** (e.g., a battery, capacitor, etc.) and, subsequently, the energy conversion device **310** may extract energy from the energy storage device **370** to serve a load **375**, **380**.

[0051] The energy system **300** may further include at least one sensor **315** (e.g., an electric current sensor, a flow meter, a voltage sensor, a pressure sensor, a temperature sensor, a frequency sensor, a power factor sensor, a phase sequence sensor, a phase rotation sensor, a voltage waveform sensor, an oscilloscope, a strain gauge sensor, a rotation sensor, a linear sensor, a flow sensor, a proximity sensor, a watt-hour meter, a volume meter, etc.), at least one generation disconnect device **335**, at least one step-up transformer **345**, at least one energy transmission disconnect device **350**, at least one energy distribution disconnect device **360**, and at least one workstation **319**. The workstation **319** may include a module **324** stored on a computer-readable memory **323** (e.g., a non-transitory computer-readable medium, a transitory computer-readable medium, etc.) that, when executed by a processor **322**, causes the processor **322** to, for example, enable a user (e.g., an energy system operator, an engineer, an energy business manager, etc.) to monitor and/or control various components (e.g., sensor **315**, secondary energy source **330**, **365**, energy storage device **370**, disconnect devices **335**, **350**, **360**, transformer **345**, first primary energy source **385**, second primary energy source **390**, first energy load **375**, second energy load **380**, etc.) of the energy system **300**. While the module **324** may include a set of computer-readable instructions, the module **324** may alternatively be a hardware implementation of an equivalent electrical circuit. The workstation **319** may also include a display **320**, a user input device **321**, and a communication network interface **325** to, for example, communicatively connect the workstation **319**, the sensor **315**, the secondary energy source **330**, **365**, the energy storage device **370**, the disconnect devices **335**, **350**, **360**, transformer **345**, the first primary energy source **385**, the second primary energy source **390**, the first energy load **375**, the second energy load **380** of the energy system **100** via a communication network **326**, **327**, **331**, **336**, **346**, **351**, **316**, **317**, **356**, **361**, **366**, **371**, **376**, **381**.

[0052] The workstation **319** may synchronize any given energy source to the energy system **300** based on frequency, power factor, inrush, transients, etc. For example, when any given energy source (e.g., primary energy source **280**, **285** of FIG. **2**, or secondary energy source **130**, **175** of FIG. **1**) is to be connected to the energy system **300**, the workstation may acquire various inputs from sensors (e.g., sensor **260** of FIG. **2** or sensor **315** of FIG. **3**), and may gradually increase energy output from the given energy source. Thereby, an energy customer may be billed for energy consumed and/or given credit for energy generated.

[0053] With reference to FIG. **4**A, an apparatus **405***a* for managing an energy device **400***a* may include a user interface generation module **415***a*, an energy source addition module **420***a*, an input specification module **425***a*, an energy source deletion module **430***a*, a load addition module **435***a*, a load deletion module **440***a*, and an output specification module **445***a* stored on a memory **410***a*. The apparatus **405***a* may be similar to, for example, the workstation **319** of FIG. **3**. The energy device **400***a* may be similar to, for example, the energy conversion device **305** of FIG. **3**.

[0054] While the user interface generation module **415***a*, the energy source addition module **420***a*, the input specification module **425***a*, the energy source deletion module **430***a*, the load addition module **435***a*, the load deletion module **440***a*, or the output specification module **445***a* may be stored on the non-transitory computer-readable medium **410***a* in the form of computer-readable instructions, any one of, all of, or any sub-combination of the user interface generation module **415***a*, the energy source addition module **420***a*, the input specification module **425***a*, the energy source deletion module **430***a*, the load addition module **435***a*, the load deletion module **440***a*, or the output specification module **445***a* may be implemented by hardware (e.g., one or more discrete component circuits, one or more application specific integrated circuits (ASICs), etc.), firmware (e.g., one or more programmable application specific integrated circuits (ASICs), one or more programmable logic devices (PLDs), one or more field programmable logic devices (FPLD), one or more field programmable gate arrays (FPGAs), etc.), and/or any combination of hardware, software and/or firmware. Furthermore, the apparatus **405***a* of FIG. **4**A may include one or more elements, processes and/or devices in addition to, or instead of, those illustrated in FIG. 4A, and/or may include more than one of, any, or all of the illustrated elements, processes and devices.

[0055] Turning to FIG. **4**B, a method for managing an energy apparatus **400***b* may be implemented by, for example, a processor (e.g., processor **322** of FIG. **3**) executing a module (e.g., module **324** of FIG. **3**, or modules **415***a*-**445***a* of FIG. **4**A). In any event, the processor **322** may execute a user interface generation module **415***a* to, for example, cause the processor **322** to generate a user interface (block **405***b*). The user interface may enable a user to configure an energy device (e.g., energy conversion device **305** of FIG. **3**). For example, a user may add an energy source (e.g., a primary energy source, a secondary energy source, an energy storage device, etc.), may specify associated inputs to the energy conversion device **305**, may delete an energy source, may add a load (e.g., any of the loads described with regard to FIGS. **1**-**3**), delete a load, or specify associated outputs of the energy conversion device **305**. Alternatively, or additionally, the processor **322** may execute the user interface generation module **415***a* to, for example, cause the processor **322** to automatically configure the energy conversion device **305** any time an energy source and/or load is added and/or deleted.

[0056] The processor **322** may execute an energy source addition module **420***a* to, for example, cause the processor **322** to automatically add an energy source when an energy source is connected to the energy conversion device **305** (block **410***b*). Thereby, an energy conversion device **305** may automatically incorporate a newly connected energy source in accordance with a "plug-and-play" architecture. For example, an energy source may include an energy source characteristic data file stored in, for example, a memory integral in the respective energy source. When the energy source is connected to the energy conversion device **305**, processor **322** may automatically receive the energy source characteristic data file, and the processor **322** may automatically configure the energy conversion device **305** to incorporate the energy source based on the energy source characteristic data.

[0057] The processor **322** may execute an input specification module **425***a* to, for example, cause the processor **322** to receive input specification data (block **415***b*). The input specification data may be representative of, for example, energy source output and/or energy conversion device **305** inputs (e.g., voltage ratings, current ratings, frequency ratings, storage capacity, etc.).

[0058] The processor **322** may execute an energy source deletion module **430***a* to, for example, cause the processor **322** to automatically delete an energy source from the energy conversion device **305** (block **420***b*). Alternatively, or additionally, a user may manually delete an energy source via the user interface described with regard to block **405***b*.

[0059] The processor **322** may execute a load addition module **435***a* to, for example, cause the processor **322** to automatically add an energy load when the energy load is connected to the energy conversion device **305** (block **425***b*). Thereby, an energy conversion device **305** may automatically incorporate a newly connected energy load in accordance with a "plug-and-play" architecture. For example, an energy load may include an energy load characteristic data file stored in, for example, a memory integral in the respective energy load. When the energy load is connected to the energy conversion device **305**, processor **322** may automatically receive the energy load characteristic data file, and the processor **322** may automatically configure the energy conversion device **305** to incorporate the energy load based on the energy load characteristic data.

[0060] The processor **322** may execute a load deletion module **440***a* to, for example, cause the processor to automatically delete an energy load from the energy conversion device **305** (block **430***b*). Alternatively, or additionally, a user may manually delete an energy load via the user interface described with regard to block **405***b*.

[0061] The processor **322** may execute an output specification module **445***a* to, for example, cause the processor **322** to receive load specification data (block **435***b*). The load specification data may be representative of, for example, energy load input and/or energy conversion device **305** outputs (e.g., voltage ratings, current ratings, frequency ratings, etc.).

[0062] As described above, the method **400***b* may comprise a program (or module) for execution by an energy apparatus processor **322**. The program (or module) may be embodied in software stored on a tangible (or non-transitory) computer readable storage medium such as a compact disc read-only memory ("CD-ROM"), a floppy disk, a hard drive, a DVD, Blu-ray disk, or a memory associated with the PED processor. Alternatively, the entire program (or module) and/or parts thereof may be executed by a device other than the energy apparatus processor **322** and/or embodied in firmware or dedicated hardware (e.g., one or more discrete component circuits, one or more application specific integrated circuits (ASICs), etc.). Further, although the example program (or module) is described with reference to the flowchart illustrated in FIG. **4**B, many other methods of implementing the method **400***b* may alternatively be used. For example, the order of execution of the blocks may be changed, and/or some of the blocks described may be changed, eliminated, or combined.

[0063] With reference to FIG. **5**A, an apparatus **500***a* for managing an energy device **505***a* may include an energy source sensor output acquisition module **515***a*, a health of energy source determination module **520***a*, an energy source bypass module **525***a*, and an output of remaining energy sources adjustment module **530***a* stored on a memory **510***a*. The apparatus **505***a* may be similar to, for example, the workstation **319** of FIG. **3**. The energy device **500***a* may be similar to, for example, the energy conversion device **305** of FIG. **3**.

[0064] While the energy source sensor output acquisition module **515***a*, the health of energy source determination module **520***a*, the energy source bypass module **525***a*, or the output of remaining energy sources adjustment module **530***a* may be stored on the non-transitory computer-readable medium **510***a* in the form of computer-readable instructions, any one of, all of, or any sub-combination of the energy source sensor output acquisition module **515***a*, the health of energy source determination module **520***a*, the energy source bypass module **525***a*, or the output of remaining energy sources adjustment module **530***a* may be implemented by hardware (e.g., one or more discrete component circuits, one or more application specific integrated circuits (ASICs), etc.), firmware (e.g., one or more programmable application specific integrated circuits (ASICs), one or more programmable logic devices (PLDs), one or more field programmable logic devices (FPLD), one or more field programmable gate arrays

(FPGAs), etc.), and/or any combination of hardware, software and/or firmware. Furthermore, the apparatus **505***a* of FIG. **5**A may include one or more elements, processes and/or devices in addition to, or instead of, those illustrated in FIG. **5**A, and/or may include more than one of, any, or all of the illustrated elements, processes and devices.

[0065] Turning to FIG. **5**B, a method for managing an energy apparatus **500***b* may be implemented by, for example, a processor (e.g., processor **322** of FIG. **3**) executing a module (e.g., module **324** of FIG. **3**, or modules **515***a*-**530***a* of FIG. **5**A). In any event, the processor **322** may execute an energy source sensor output acquisition module **515***a* to, for example, cause the processor **322** to receive energy source sensor output data from a sensor (e.g., sensor **260** of FIG. **2**, or sensor **315** of FIG. **3**) (block **505***b*). The energy source sensor output data may be representative of, for example, energy source output connections and/or characteristics (e.g., energy source primary energy input, energy source output voltage, energy source output current, energy source frequency, energy source pressure, energy source storage capacity, energy source stored energy, etc.).

[0066] The processor **322** may execute a health of energy source determination module **520***a* to, for example, cause the processor **322** to determine a health of an energy source based on, for example, the energy source sensor output data (block **510***b*). For example, the processor **322** may receive sensor data associated with a solar panel (e.g., incident light data and output voltage data) and the processor **322** may determine whether the solar panel, or a connection to the solar panel, is malfunctioning based on the sensor data.

[0067] The processor **322** may execute an energy source bypass module **525***a* to, for example, cause the processor **322** to bypass an energy source (block **520***b*) when, for example, the processor **322** determines that the energy source is not healthy (block **515***b*). If the processor **322** determines that the energy source is healthy (block **515***b*), the processor may return to block **505***b*.

[0068] The processor **322** may execute an output of remaining energy sources adjustment module **530***a* to, for example, cause the processor **322** to adjust outputs of remaining energy source(s) (block **525***b*). For example, if the processor **322** bypasses an unhealthy energy source (block **520***b*), the processor **322** may adjust output of at least one remaining, healthy, energy source to account for the energy source that was bypassed.

[0069] As described above, the method **500***b* may comprise a program (or module) for execution by an energy apparatus processor **322**. The program (or module) may be embodied in software stored on a tangible (or non-transitory) computer readable storage medium such as a compact disc read-only memory ("CD-ROM"), a floppy disk, a hard drive, a DVD, Blu-ray disk, or a memory associated with the PED processor. Alternatively, the entire program (or module) and/or parts thereof may be executed by a device other than the energy apparatus processor **322** and/or embodied in firmware or dedicated hardware (e.g., one or more discrete component circuits, one or more application specific integrated circuits (ASICs), etc.). Further, although the example program (or module) is described with reference to the flowchart illustrated in FIG. **5**B, many other methods of implementing the method **500***b* may alternatively be used. For example, the order of execution of the blocks may be changed, and/or some of the blocks described may be changed, eliminated, or combined.

[0070] With reference to FIG. **6**A, an apparatus **605***a* for managing an energy system **600***a* may include an energy source availability data acquisition module **615***a*, a load priority data receiving module **620***a*, a load service determination module **625***a*, and a load connection module **630***a* stored on a memory **510***a*. The apparatus **605***a* may be similar to, for example, the first or second workstations **112**, **119** of FIG. **1**, the workstation **219** of FIG. **2**, or the workstation **319** of FIG. **3**. The energy system **600***a* may be similar to, for example, the energy system **100** of FIG. **1**, the energy system **200** of FIG. **2** or the energy system **300** of FIG. **3**.

[0071] While the energy source availability data acquisition module **615***a*, the load priority data receiving module **620***a*, the load service determination module **625***a*, or the load connection module **630***a* may be stored on the non-transitory computer-readable medium **610***a* in the form of computer-readable instructions, any one of, all of, or any sub-combination of the energy source availability data acquisition module **615***a*, the load priority data receiving module **620***a*, the load service determination module **625***a*, or the load connection module **630***a* may be implemented by hardware (e.g., one or more discrete component circuits, one or more application specific integrated circuits (ASICs), etc.), firmware (e.g., one or more programmable application specific integrated circuits (ASICs), one or more programmable logic devices (PLDs), one or more field programmable logic devices (FPLD), one or more field programmable gate arrays (FPGAs), etc.), and/or any combination of hardware, software and/or firmware. Furthermore, the apparatus **605***a* of FIG. **6**A may include one or more elements, processes and/or devices in addition to, or instead of, those illustrated in FIG. **6**A, and/or may include more than one of, any, or all of the illustrated elements, processes and devices.

[0072] Turning to FIG. **6**B, a method for managing an energy system **600***b* may be implemented by, for example, a processor (e.g., processor **115** of FIG. **1**) executing a module (e.g., module **117** of FIG. **1**, or modules **615***a*-**630***a* of FIG. **6**A). In any event, the processor **115** may execute an energy source availability data acquisition module **615***a* to, for example, cause the processor **115** to acquire energy source availability data (block **605***b*). The energy source availability data may be, for example, representative of whether, or not, a particular energy source is available. The energy source availability data may be received from, for example, an energy source disconnect (e.g., disconnect **135**, **150**, **165** of FIG. **1**) and/or an sensor (e.g., sensor **260** of FIG. **2**, or sensor **315** of FIG. **3**).

[0073] The processor **115** may execute a load priority data receiving module **620***a* to, for example, cause the processor **115** to receive load priority data (block **610***b*). The load priority data may be representative of a pre-defined priority of connected energy loads. For example, a residential energy load may include a heating ventilating and air conditioning system load, a light load, a water heater load, a television load, etc. The load priority data may indicate which load(s) will be disconnected in an event that not enough energy is available from available energy sources.

[0074] The processor **115** may execute a load service determination module **625***a* to, for example, cause the processor **115** to determine which load(s) to serve (block **615***b*). For example, the processor **115** may determine which load(s) to serve based on the energy source availability data and the load priority data.

[0075] The processor **115** may execute a load connection module **630***a* to, for example, cause the processor **115** to automatically disconnect non-priority load(s) (block **625***b*) connect priority energy load(s) (block **630***b*). For example, the processor may automatically disconnect non-priority load (s) (block **625***b*) connect priority energy load(s) (block **630***b*) based on whether the processor **115** determines whether available energy sources are sufficient (block **620***b*).

[0076] As a particular example, if the processor **115** determines that a heater load has a highest priority, and the processor **115** determines that only enough energy is available to serve the heater load, the processor **115** may automatically cause all other loads to be disconnected.

[0077] As described above, the method **600***b* may comprise a program (or module) for execution by an energy apparatus processor **115**. The program (or module) may be embodied in software stored on a tangible (or non-transitory) computer readable storage medium such as a compact disc read-only memory ("CD-ROM"), a floppy disk, a hard drive, a DVD, Blu-ray disk, or a memory associated with the PED processor. Alternatively, the entire program (or module) and/or parts thereof may be executed by a device other than the energy apparatus processor **115** and/or embodied in firmware or dedicated hardware (e.g., one or more discrete component circuits, one or more application specific integrated circuits (ASICs), etc.). Further, although the example program (or module) is described with reference to the flowchart illustrated in FIG. **6**B, many other methods of implementing the method **600***b* may alternatively be used. For example, the order of execution of the blocks may be changed, and/or some of the blocks described may be changed, eliminated, or combined.

[0078] With reference to FIG. **7**A, an apparatus **705***a* for managing an energy system **700***a* may include a weather data receiving module **715***a*, an energy source availability prediction module **720***b*, a load prediction module **725***b*, and an energy source output adjustment module **730***a* stored on a memory **510***a*. The apparatus **605***a* may be similar to, for example, the first or second workstations **112**, **119** of FIG. **1**, the workstation **219** of FIG. **2**, or the workstation **319** of FIG. **3**. The energy system **600***a* may be similar to, for example, the energy system **100** of FIG. **1**, the energy system **200** of FIG. **2** or the energy system **300** of FIG. **3**.

[0079] While the weather data receiving module **715***a*, the energy source availability prediction module **720***b*, the load prediction module **725***b*, or the energy source output adjustment module **730***a* may be stored on the non-transitory computer-readable medium **610***a* in the form of computer-readable instructions, any one of, all of, or any sub-combination of the weather data receiving module **715***a*, the energy source availability prediction module **720***b*, the load prediction module **725***b*, or the energy source output adjustment module **730***a* may be implemented by hardware (e.g., one or more discrete component circuits, one or more application specific integrated circuits (ASICs), etc.), firmware (e.g., one or more programmable application specific integrated circuits (ASICs), one or more programmable logic devices (PLDs), one or more field programmable logic devices (FPLD), one or more field programmable gate arrays (FPGAs), etc.), and/or any combination of hardware, software and/or firmware. Furthermore, the apparatus **705***a* of FIG. **7**A may include one or more elements, processes and/or devices in addition to, or instead of, those illustrated in FIG. **7**A, and/or may include more than one of, any, or all of the illustrated elements, processes and devices.

[0080] Turning to FIG. **7**B, a method for managing an energy system **700***b* may be implemented by, for example, a processor (e.g., processor **115** of FIG. **1**) executing a module (e.g., module **117** of FIG. **1**, or modules **715***a*-**730***a* of FIG. **7**A). In any event, the processor **115** may execute a weather data receiving module **715***a* to, for example, cause the processor **115** to receive weather data (block **705***b*). The weather data may be, for example, representative of an actual temperature, a predicted temperature, historical temperature for a given day of a year and time of the day, actual wind, predicted wind, historical wind for a given day of a year and time of the day, actual precipitation, predicted precipitation, historical precipitation for a given day of a year and time of the day, actual cloud/sun, predicted cloud/sun, historical cloud/sun for a given day of a year and time of the day, actual humidity, predicted humidity, historical humidity for a given day of a year and time of the day, actual parametric pressure, predicted parametric pressure, historical parametric pressure for a given day of a year and time of the time, actual UV index, a predicted UV index, historical UV index for a particular day of a year and time of the day, an impending earthquake, etc.

[0081] The processor **115** may execute an energy source availability prediction module **720***b* to, for example, cause the processor **115** to predict availability of an energy source (block **710***b*). For example, the processor **115** may predict availability of an energy source based on the weather data. As a particular example, the processor **115** may predict availability of energy from a solar panel based on actual cloud/sun data, predicted cloud/sun data, historical cloud/sun data for a particular day of a year and time of the day, or any combination thereof. As another example, the processor **115** may predict availability of energy from a wind turbine based on actual wind data, predicted wind data, historical wind data for a particular day of a year and time of the day, or any combination thereof.

[0082] The processor **115** may execute a load prediction module **725***b* to, for example, cause the processor **115** to predict an energy load (block **715***b*). For example, the processor **115** may predict an energy load based on the weather data.

[0083] The processor **115** may execute an energy source output adjustment module **730***a* to, for example, cause the processor **115** to adjust an output of at least one energy source (block **720***b*). For example, the processor **115** may automatically adjust an output of an energy source (block **720***b*) based on whether the processor **115** determines that additional energy is needed (block **720***b*). As a particular example, the processor **115** may automatically adjust an amount of energy to be stored in an energy storage device based on predicted weather. Thereby, the processor **115** may automatically adjust outputs of various energy sources prior to an actual change in weather that would require an adjustment in the future. Predicting future energy source availability and energy loads may increase energy system reliability, reduce energy system costs, avoid energy system outages, avoid energy system overloads, etc.

[0084] As described above, the method **700***b* may comprise a program (or module) for execution by an energy apparatus processor **115**. The program (or module) may be embodied in software stored on a tangible (or non-transitory) computer readable storage medium such as a compact disc read-only memory ("CD-ROM"), a floppy disk, a hard drive, a DVD, Blu-ray disk, or a memory associated with the PED processor. Alternatively, the entire program (or module) and/or parts thereof may be executed by a device other than the energy apparatus processor **115** and/or embodied in firmware or dedicated hardware (e.g., one or more discrete component circuits, one or more application specific integrated circuits (ASICs), etc.). Further, although the example program (or module) is described with reference to the flowchart illustrated in FIG. **7**B, many other methods of implementing the method **700***b* may alternatively be used. For example, the order of execution of the blocks may be changed, and/or some of the blocks described may be changed, eliminated, or combined.

[0085] With reference to FIG. **8**A, an apparatus **800***a* for managing an energy device **805***a* may include an energy source thermal energy/speed data acquisition module **815***a*, a thermal load data receiving module **820***a*, an energy source speed determination module **825***a*, and an energy source speed module **830***a* stored on a memory **510***a*. The apparatus **505***a* may be similar to, for example, the workstation **319** of FIG. **3**. The energy device **500***a* may be similar to, for example, the energy conversion device **305** of FIG. **3**.

[0086] While the energy source thermal energy/speed data acquisition module **815***a*, the thermal load data receiving module **820***a*, the energy source speed determination module **825***a*, or the energy source speed module **830***a* may be stored on the non-transitory computer-readable medium **810***a* in the form of computer-readable instructions, any one of, all of, or any sub-combination of the energy source thermal energy/speed data acquisition module **815***a*, the thermal load data receiving module **820***a*, the energy source speed determination module **825***a*, or the energy source speed module **830***a* may be implemented by hardware (e.g., one or more discrete component circuits, one or more application specific integrated circuits (ASICs), etc.), firmware (e.g., one or more programmable application specific integrated circuits (ASICs), one or more programmable logic devices (PLDs), one or more field programmable logic devices (FPLD), one or more field programmable gate arrays (FPGAs), etc.), and/or any combination of hardware, software and/or firmware. Furthermore, the apparatus **805***a* of FIG. **8**A may include one or more elements, processes and/or devices in addition to, or instead of, those illustrated in FIG. **8**A, and/or may include more than one of, any, or all of the illustrated elements, processes and devices.

[0087] Turning to FIG. **8**B, a method for managing an energy apparatus **800***b* may be implemented by, for example, a processor (e.g., processor **322** of FIG. **3**) executing a module (e.g., module **324** of FIG. **3**, or modules **815***a*-**830***a* of FIG. **8**A). In any event, the processor **322** may execute an energy source thermal energy/speed data acquisition module **815***a* to, for example, cause the processor **322** to acquire energy source thermal energy/speed data (block **805***b*). The energy source thermal energy/speed data may be, for example, representative of relationship between a speed of rotation of a secondary energy source and an amount of thermal energy produced by the secondary energy source. Alternatively, or additionally, the energy source thermal energy/speed data may be representative of a relationship between an amount of electrical energy produced by an energy source and an amount of thermal energy produced by the energy source.

[0088] The processor **322** may execute a thermal load data receiving module **820***a* to, for example, cause the processor **322** to receive thermal load data (block **810***b*). The thermal load data may be representative of an amount of thermal energy required by a particular energy load. For example, the thermal energy data may be derived from a sensor (e.g., sensor **260** of FIG. **2**, or sensor **315** of FIG. **3**). In a particular example, the sensor **260**, **315** may be a thermostat.

[0089] The processor **322** may execute an energy source speed determination module **825***a* to, for example, to cause the processor **322** to determine a speed of an energy source (block **815***b*). For example, the processor **322** may determine a speed of a secondary energy source based on energy source thermal energy/speed data and/or thermal load data. The thermal energy may be generated from an exhaust of a prime mover (e.g., an exhaust of an internal combustion engine, an exhaust of a turbine, etc.) and/or from burning a primary energy source. In any event, a heat duct (e.g., a plenum, ductwork, etc.) may be configured to convey the thermal energy to an associated thermal load via, for example, either convection and/or forced air.

[0090] The processor **322** may execute an energy source speed module **830***a* to, for example, cause the processor **322** to adjust a speed of an energy source (block **825***b*). For example, the processor **322** may adjust a speed of an energy source (block **825***b*) based on whether the processor **322** determines that a speed of an energy source needs to be adjusted (block **520***b*). In a particular example, the processor **322** may adjust a speed of an electrical generator based on whether a thermostat output is indicative of a thermal load requiring more heat (e.g., a house requiring more heat). Any excess electricity may be stored in an associated energy storage device and/or may be used to generate additional heat via, for example, a resistive heater or a electrically driven heat pump.

[0091] As described above, the method **800***b* may comprise a program (or module) for execution by an energy apparatus processor **322**. The program (or module) may be embodied in software stored on a tangible (or non-transitory) computer readable storage medium such as a compact disc read-only memory ("CD-ROM"), a floppy disk, a hard drive, a DVD, Blu-ray disk, or a memory associated with the PED processor. Alternatively, the entire program (or module) and/or parts thereof may be executed by a device other than the energy apparatus processor **322** and/or embodied in firmware or dedicated hardware (e.g., one or more discrete component circuits, one or more application specific integrated circuits (ASICs), etc.). Further, although the example program (or module) is described with reference to the flowchart illustrated in FIG. **8**B, many other methods of implementing the method **800***b* may alternatively be used. For example, the order of execution of the blocks may be changed, and/or some of the blocks described may be changed, eliminated, or combined.

[0092] With reference to FIGS. **9**A and **9**B, an energy apparatus **900***a*, **900***b* may include at least one solar panel **905***a*, **905***b* reorientably attached to a mount **910***a*, **910***b* via a pivot mechanism **915***b*. As illustrated in FIG. **9**B, the solar panel **905***a*, **905***b* may rotate **916***b*, may tilt **917***b*, and/or may pan **918***b* about the pivot mechanism **915***b*. The pivot mechanism may include an actuating mechanism such that the solar panel **905***a*, **905***b* may be automatically reoriented via an associated control apparatus (e.g., first or second workstations **112**, **119** of FIG. **1**, workstation **219** of FIG. **2**, or workstation **319** of FIG. **3**). The energy apparatus **900***a*, **900***b* may be, for example, as described in U.S. patent application Ser. No.

14/880,578, entitled SOLAR PANEL SYSTEM WITH MONOCOQUE SUPPORTING STRUCTURE, filed Oct. 12, 2015, the disclosure of which is incorporated in its entirety herein by reference thereto.

[0093] Turning to FIG. **10**A, an apparatus **1005***a* for managing an energy device **1000***a* may include a sun position data receiving module **1015***a*, a solar panel orientation data receiving module **1020***a*, a solar panel orientation adjustment needed determination module **1025***a*, and a solar panel orientation adjustment module **1030***a* stored on a memory **510***a*. The apparatus **605***a* may be similar to, for example, the first or second workstations **112**, **119** of FIG. **1**, the workstation **219** of FIG. **2**, or the workstation **319** of FIG. **3**. The energy system **600***a* may be similar to, for example, the energy system **100** of FIG. **1**, the energy system **200** of FIG. **2** or the energy system **300** of FIG. **3**.

[0094] While the sun position data receiving module **1015***a*, the solar panel orientation data receiving module **1020***a*, the solar panel orientation adjustment needed determination module **1025***a*, or the solar panel orientation adjustment module **1030***a* may be stored on the non-transitory computer-readable medium **1010***a* in the form of computer-readable instructions, any one of, all of, or any sub-combination of the sun position data receiving module **1015***a*, the solar panel orientation data receiving module **1020***a*, the solar panel orientation adjustment needed determination module **1025***a*, or the solar panel orientation adjustment module **1030***a* may be implemented by hardware (e.g., one or more discrete component circuits, one or more application specific integrated circuits (ASICs), etc.), firmware (e.g., one or more programmable application specific integrated circuits (ASICs), one or more programmable logic devices (PLDs), one or more field programmable logic devices (FPLD), one or more field programmable gate arrays (FPGAs), etc.), and/or any combination of hardware, software and/or firmware. Furthermore, the apparatus **1005***a* of FIG. **10**A may include one or more elements, processes and/or devices in addition to, or instead of, those illustrated in FIG. **10**A, and/or may include more than one of, any, or all of the illustrated elements, processes and devices.

[0095] With reference to FIG. **10**B, a method for managing an energy apparatus **1000***b* may be implemented by, for example, a processor (e.g., processor **115** of FIG. **1**) executing a module (e.g., module **117** of FIG. **1**, or modules **1015***a*-**1030***a* of FIG. **10**A). In any event, the processor **115** may execute a sun position data receiving module **1015***a* to, for example, cause the processor **115** to receive sun position data (block **1005***b*). While the sun position data may be representative of a current position of the sun relative to an associated solar panel (e.g., solar panel **905***a*, **905***b* of FIGS. **9**A and **9**B), the sun position data may, alternatively, be representative of a position of a highest concentration of solar energy radiating from the sun. For example, while the sun may be located in a particular position, clouds may be blocking a portion of the solar energy radiating from the sun, thus, the sun position data may be representative of a position having less cloud cover. Similarly, the actual position of the sun may be in a location that produces both direct radiation and reflected radiation (e.g., reflected radiation from water, reflected radiation from mirrors, reflected radiation from snow, reflection from a pond, reflected radiation from other structures, etc.), accordingly, the sun position data may be representative of a location that experiences a maximum of direct radiation plus reflected radiation. The processor **115** may receive the sun position data from, for example, a sensor (e.g., sensor **260** of FIG. **2** or sensor **315** of FIG. **3**).

[0096] The processor **115** may execute a solar panel orientation data receiving module **1020***a* to, for example, cause the processor to receive solar panel orientation data (block **1010***b*). The solar orientation data may be, for example, representative of an orientation of at least one solar panel relative to the sun position data. The processor **115** may receive the solar panel orientation data from, for example, a sensor (e.g., sensor **260** of FIG. **2** or sensor **315** of FIG. **3**) incorporated into, for example, a pivot mechanism (e.g., pivot mechanism **915***b* of FIG. **9**B).

[0097] The processor **115** may execute a solar panel orientation adjustment needed determination module **1025***a* to, for example, cause the processor to determine whether solar panel orientation adjustment is needed (block **1015***b*). For example, the processor **115** may determine whether solar panel orientation adjustment is needed based on the sun position data and the solar panel orientation data (block **1020***b*).

[0098] The processor **115** may execute a solar panel orientation adjustment module **1030***a* to, for example, cause the processor to automatically adjust an orientation of at least one solar panel (block **1025***b*). For example, the processor **115** may automatically transmit a control signal to a pivot mechanism (e.g., pivot mechanism **915***b* of FIG. **9**B) in response to determining that at least one solar panel orientation adjustment is needed based on the sun position data and the solar panel orientation data (block **1020***b*).

[0099] As described above, the method **1000***b* may comprise a program (or module) for execution by an energy apparatus processor **115**. The program (or module) may be embodied in software stored on a tangible (or non-transitory) computer readable storage medium such as a compact disc read-only memory ("CD-ROM"), a floppy disk, a hard drive, a DVD, Blu-ray disk, or a memory associated with the PED processor. Alternatively, the entire program (or module) and/or parts thereof may be executed by a device other than the energy apparatus processor **115** and/or embodied in firmware or dedicated hardware (e.g., one or more discrete component circuits, one or more application specific integrated circuits (ASICs), etc.). Further, although the example program (or module) is described with reference to the flowchart illustrated in FIG. **10**B, many other methods of implementing the method **1000***b* may alternatively be used. For example, the order of execution of the blocks may be changed, and/or some of the blocks described may be changed, eliminated, or combined.

[0100] Numerous modifications to the apparatuses, systems, and methods disclosed herein will be apparent to those skilled in the art in view of the foregoing description. Accordingly, this description is to be construed as illustrative only, and is presented for the purpose of enabling those skilled in the art to make and use the invention and to teach the preferred mode of carrying out same. The exclusive rights to all modifications within the scope of the disclosure and the appended claims are reserved.

What is claimed is:

1. An energy conversion apparatus, comprising:

at least one first reconfigurable energy source input, wherein the at least one first reconfigurable energy source input is reconfigurable based upon first energy source characteristic data received by the energy conversion apparatus;

at least one second reconfigurable energy source input, wherein the at least one second reconfigurable energy source input is reconfigurable based upon second energy source characteristic data received by the energy conversion apparatus;

at least one energy storage device connection; and

at least one energy load output, wherein the energy conversion apparatus is configured to provide energy to the at least one energy load output based upon the first and second energy source characteristic data, and further based on a quantity of energy stored in at least one energy storage device.

2. The energy conversion apparatus as in claim **1**, wherein the at least one energy storage device connection is reconfigurable based upon energy storage device characteristic data received by the energy conversion apparatus.

3. The energy conversion apparatus as in claim **1**, wherein the at least one energy load output is reconfigurable based upon energy load characteristic data received by the energy conversion apparatus.

4. The energy conversion apparatus as in claim **1**, wherein at least one of: the first energy source characteristic data, or the second energy source characteristic data is automatically received by the energy conversion apparatus when a respective energy source is connected to the energy conversion apparatus.

5. The energy conversion apparatus as in claim **1**, further comprising:

a user interface device, wherein at least one of: the first energy source characteristic data, or the second energy source characteristic data is received by the energy conversion apparatus via the user interface device.

6. The energy conversion apparatus as in claim **1**, further comprising:

an energy conversion device, wherein the energy conversion device is configured to perform at least one of: rectify alternating electric current to direct electric current, invert direct electric current to alternating electric current, or convert a first direct electric current source value to a second direct current source value.

7. The energy conversion apparatus of claim **6**, wherein the energy conversion device is bidirectional.

8. The energy conversion apparatus of claim **1**, wherein the energy conversion apparatus automatically receives weather data, and wherein the energy conversion device automatically determines an amount of energy to provide to the at least one energy load connection from the first energy source input and the second energy source input based on the weather data.

9. The energy conversion apparatus of claim **1**, wherein the energy conversion apparatus automatically receives energy source health data, and wherein the energy conversion device automatically determines an amount of energy to provide to the at least one energy load connection from the first energy source input and the second energy source input based on the energy source health data.

10. The energy conversion apparatus of claim **1**, further comprising:

at least one second energy load output, wherein the energy conversion device automatically receives energy load priority data, and wherein the energy conversion device determines energy flow to a respective energy load based upon the energy load priority data.

11. An energy management system, comprising:

at least one energy conversion apparatus having at least two energy source inputs, at least one energy storage device connection, and at least one energy load output; and

a controller having at least one energy source health data input and at least one energy conversion apparatus output, wherein the controller generates the at least one energy conversion apparatus output based upon energy source health data received via the at least one energy source health data input.

12. The energy management system as in claim **11**, wherein the energy source health data is representative of at least one of: a health of at least one energy source, a health of at least one connection to at least one energy source, or availability of a primary energy source to at least one secondary energy source.

13. The energy management system of claim **11**, wherein the energy source health data includes weather data that is representative of at least one of: a solar radiation value, or a wind speed value.

14. The energy system of claim **11**, wherein the controller automatically receives energy storage device health data, and wherein the controller automatically determines an amount of energy to provide to the at least one energy load connection from the first energy source input and the second energy source input based on the energy storage device health data.

15. The energy conversion apparatus of claim **11**, further comprising:

at least one second energy load output, wherein the controller automatically receives energy load priority data, and wherein the controller determines energy flow to a respective energy load based upon the energy load priority data.

16. An energy management system, comprising:

at least one energy conversion apparatus having at least one energy source input, at least one energy storage device connection, and at least two energy load outputs; and

a controller having at least one energy load priority data input and at least one energy conversion apparatus output, wherein the controller generates the at least one energy conversion apparatus output based upon energy load priority data received via the at least one energy load priority data input.

17. The energy conversion apparatus of claim **16**, wherein the controller automatically receives energy source health data, and wherein the controller determines energy flow based upon the energy source health data.

18. The energy management system as in claim **17**, wherein the energy source health data is representative of at least one of: a health of at least one energy source, a health of at least one connection to at least one energy source, or availability of a primary energy source to at least one secondary energy source.

19. The energy management system of claim **17**, wherein the energy source health data includes weather data that is representative of at least one of: a solar radiation value, or a wind speed value.

20. The energy system of claim **17**, wherein the controller automatically receives energy storage device health data, and wherein the controller automatically determines an amount of energy to provide to at least one energy load connection from the energy source input and the energy device connection based on the energy storage device health data.

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