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ELECTRICAL PRIORITY SWITCH

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PTO REGISTRATION 36,579

PATENT

ELECTRICAL PRIORITY SWITCH

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FIELD OF THE INVENTION

[0002] The present invention relates to electrical devices and in particular to sources of electrical power and related methods and apparatus.

BACKGROUND

[0003] The discussion of any work, publications, sales, or activity anywhere in this submission, including in any documents submitted with this application, shall not be taken as an admission that any such work constitutes prior art. The discussion of any activity, work, or publication herein is not an admission that such activity, work, or publication existed or was known in any particular jurisdiction.

[0004] In most parts of the world, electricity, particularly in homes and non-industrial businesses, is provided by a utility electrical provider over a shared electric grid. In some areas and situations, emergency or supplemental electricity power sources are available, such as emergency generators, using such systems generally requires special integration with the power grid and professional installation.

SUMMARY

[0005] According to specific embodiments, given a choice of more than one electrical sources, a general user can connect both electrical sources to a common device without the need for modification of the electrical grid connection and with an ease that allows use by the average electric customer. According to specific embodiments, a device, at times herein referred to as the "electrical priority switchboard" or EPS, allows a user to connect an electrical load to two or more electric power sources and optionally also to select the order of preference of which electrical source is to be consumed.

[0006] As one example, suppose that a grid-connected home also has an inexpensive, but intermittent electricity source, such as photovoltaic electricity (PVE). The user prefers to use the intermittent source when available, but needs to use grid electricity if this other electricity is unavailable or insufficient. An EPS according to specific embodiments connects the grid, local electrical source, and the load, allowing the user to define when the load will draw grid current or current from the local electrical source, or possibly use both sources.

[0007] According to specific embodiments, the EPS may be part of a network of electrical sources, electrical loads, thermal and electrical energy storage capacity, and various sensors and other inputs including present cost of grid electricity, time of day, projected availability and cost of PV electricity, and temperature inputs. According to specific embodiments, such a network can exist at a consumer home, an office building or at a commercial or institutional location. Such a network can consist of individual appliances with communication abilities using either a standardized or propriety network, such devices that can operate on the "Internet of Things." Thus, an EPS according to specific embodiments can better make use of intermittent electrical power in displacing grid electricity. For instance, PV solar and grid electricity may be used with an EPS to power an air conditioner, a hot water heater, and a refrigerator, which normally keep the temperature of the hot water at 45°C, the temperature of the freezer below –4°C and the home between 15°C and 30°C. During the day, the user may prioritize PV electricity using the EPS so as not to draw electricity from the grid. Additionally, the PV electricity can be used to more precisely control temperatures or store thermal energy for when there is not

PV electricity available. When PV electricity is abundant, the EPS can communicate with a water heater to heat the water to 75°C, and communicate with a freezer to lower the temperature to -15°C, and the temperature of the house may be maintained between 20°C and 24°C by the EPS communicating with a HVAC system. When PVE solar electricity is available, the indoor summer temperature can be artificially lowered or indoor winter temperature raised by the EPS in anticipation of not having inexpensive PV electricity available later in the day. These technology strategies may be coupled with thermal storage technologies such as a phase change material that could be kept in the freezer/refrigerator, hot water heater, and/or anywhere in the building or HVAC system. Lastly, the EPS may also prioritize one load over the other. For instance, the temperature of food in the refrigerator may be maintained more exactly at the expense of allowing the temperature of the hot water to drop.

[0008] According to specific embodiments, the EPS may be an integral part of an electrical appliance, so that the appliance chooses the correct electricity source, or changes its function depending on a number of inputs including whether it can draw from any or all of the given power sources. For instance, consistent with the previous description, when PV electricity is available a hot water heater may heat water to a higher set point; an air conditioner may have a lower set point; and a freezer may have a lower set point. Additionally, a cooking appliance may wait for the availability of PV electricity before beginning a cooking cycle, but may continue the cooking cycle with grid electricity if PV electricity is no longer available after the cooking cycle begins.

[0009] According to further specific embodiments, the EPS may be part of an integrated PV powered appliance that may also connect to one or more electrical sources and/or storage capacities including batteries and grid electricity. For instance, a stereo may be designed for camping. It has rechargeable batteries, a solar panel and connects to the grid. The EPS in the stereo would likely prioritize PVE over grid electricity and both grid and PVE over battery electricity. In specific embodiments, the rechargeable batteries could be charged by PVE and/or grid electricity when available.

[0010] The EPS may include the capability to integrate into existing smart home systems; such that the EPS will send information of the present available source and

presented load to the smart home system, as well as receive information gathered from the smart home system including: the temperature of the home, habitant's existing preferences and tendencies, etc. EPS information and specific controls will be included in the existing smart home mobile interface. These controls would allow the homeowner to prioritize the existing loads presented to the EPS based on available power sources, time of day, ambient temperature, or any preference. The information sent from the EPS will show current data and may additionally offer an organized display of accumulated data over different time scales (day, month, season year).

[0011] According to specific embodiments, an EPS can allow the locally generated electricity (such as PVE) to be provided to the building's electricity system, so that appliances plugged into the (AC or DC) local or building electrical wiring will draw electrical power from the EPS or have the grid's electrical power supplemented with the locally generated electricity. Providing power to an AC electrical system in various configurations may require that a special inverter be used to synchronize with the grid electricity. Providing power to a building's electrical system generally requires that maximum current limits in the building are not surpassed by providing current and consuming current both on the same side of the circuit breaker. However, greater power may be provided to the building if the EPS is deployed on the "upstream" side of the circuit breaker, between the circuit breaker and the electrical meter. Such an innovation may require a permit. An additional step in this direction would allow the EPS to provide power to a local microgrid between a group of buildings, or cooperating neighbors. An additional step in this direction would allow the EPS to provide power to the grid allowing the power meter to register a flow of power out of the building to the grid if and when this would be allowed. The EPS may record electrical use and cost of electricity and provide the user with the integrated electricity, cost, and cost savings made possible because of the EPS.

[0012] An EPS according to specific embodiments can also operate on one energy source that takes other inputs such as time of day, temperatures, and electricity rates. For instance in some places, the cost of electricity varies greatly during the day. An EPS could turn appliances (electricity) off when the cost is higher, or change set points. For example, an electric water tank may have a set point of 80°C when the electricity is inexpensive, and

drop the temperature down to 50°C when electricity is expensive. Such an innovation would store electrical energy in inherent thermal storage in the water tank. The EPS may also integrate into the existing smart grid whereby for instance utilities may communicate priorities set by contract with the consumer. For example, at times of peak electrical demand, the utilities may be under contract with the consumer to turn off selected appliances deemed appropriate by the consumer, such as (for example) the charging of an electric car or household heating/cooling.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagram illustrating an example embodiment of Electrical Priority Switchboard that allows the electrical consumer to draw "priority" electrical current from available intermittent source when available and consumes grid electricity when priority electricity is insufficient or not available according to specific embodiments.

FIG. 2 is a diagram illustrating an example EPS connecting the DC output from the PV panels directly to a DC load such as a DC air conditioner. The EPS uses line voltage as a back up power supply when PV power is insufficient. The AC line voltage may be first rectified with a dedicated unit, or the EPS may have a built in rectifier to be connected directly to line voltage.

DESCRIPTION OF SPECIFIC EMBODIMENTS

Example Device

[0013] According to specific embodiments, a device or method referred to as an EPS accepts more than one electricity source and connects it to a load or a series of loads in order of preference. As an example, if an EPS in a grid-connected home with 900 W of photovoltaic capacity is connected to both the grid outlet as well as the PV output, and there is a load of more than 900 W, then 900 W of solar electricity would be consumed, and the rest of the electricity would be provided by the grid.

[0014] In further embodiments, more than two energy sources could be connected to the EPS and according to specific embodiments, any permutation of alternating current (AC) and direct current (DC) sources and loads of different voltages. Therefore, an EPS according to specific embodiments may contain rectifiers, invertors, AC transformers, and

DC/DC voltage convertors as well as fuses or circuit breakers in order to make the loads compatible with the sources. It may connect to the Internet in order to allow for remote monitoring, configuration, or programming. Additionally, there may be circuitry that would allow locally generated AC electricity to be synchronized with the grid in order to draw from the multiple sources at any given ratio.

[0015] One advantage according to specific embodiments is that an EPS device can integrate locally generated electricity into a building without direct connection to the grid, so the grid electricity provider need not be consulted, and no permits are required. While this may not utilize the electricity from the PV panel when not being consumed on site, it may still save the consumer more money than using only grid electricity, especially when the cost of PV (for instance) is low, e.g., much cheaper than generally available today.

[0016] One basic EPS embodiment is illustrated in Fig. 1 for discussion purposes. In this simple example embodiment, an EPS plugs into the grid socket as well as an invertor supplying 120V 60Hz power generated by (for instance) a 900 W PV panel. The EPS has an AC socket that a power strip can be plugged into. The user prioritizes the PV by dialing it on the EPS so during the day all the appliances are powered by the PV panels and no current is drawn from the grid utilities. At night, or in the case that the load on the power strip exceeds the supply, the EPS will draw current from the grid instead of from the invertor, or in addition to the current drawn from the invertor.

[0017] A further embodiment may have several plugs and in the case that the load exceeds supply, some of the load would be connected to the grid until the load matched the supply. A further EPS embodiment directly accepts the DC power source from which an internal invertor in the EPS creates a 120V 60Hz AC synchronized with the grid electricity in order to use all the available locally generated DC power, allowing the grid to supply the rest of the power.

[0018] A further embodiment connects the DC PV output to a DC load while using AC line voltage as a back up. An example of this embodiment is illustrated in Fig. 2. This may be particularly useful for air conditioning systems, which largely run during the day when there is sufficient solar energy. The line voltage from the utilities will be rectified for

the DC load either by a dedicated external rectifier, or through a built in rectifier in the EPS.

[0019] In specific embodiments, an EPS allows for the DC source(s) to be used to maintain voltage to the load(s). Rectified line voltage would provide added power in the case the DC power source(s) were not adequate to maintain the required output voltage.

Placement

[0020] In specific embodiments, in a grid-connected house, an EPS can be placed behind the wall socket as well; and as far upstream as the circuit breaker board that connects to the grid utility, or as far up as the electrical power meter. While not the jurisdiction of the grid utility, this installation may require a permit in some situations.

[0021] In further embodiments, in projecting the creation of a DC grid or DC micro grid, the EPS would accept multiple DC sources or different DC and AC sources and provide DC output in the same manner as described above with priorities set by the user.

Conclusions

[0022] Thus, according to specific embodiments, the present invention is involved with methods and/or systems and/or devices that can be used together or independently to provide efficient use of multiple power sources as described herein. This description introduces a selection of concepts that are further described or can be further understood from other papers submitted with this application. Key features or essential features of the claimed subject matter are discussed throughout this submission, thus no individual part of this submission is intended to determine the scope of the claimed subject matter.

[0023] It is well known in the art that systems and methods such as described herein can include a variety of different components and different functions in a modular fashion. Different example specific embodiments and implementations can include different mixtures of elements and functions and may group various functions as parts of various elements. For purposes of clarity, embodiments of the invention are described in terms of systems that include different innovative components and innovative combinations of innovative components and known components. No inference should be taken to limit the claimed invention to combinations containing all of the innovative components listed in

any illustrative embodiment in this specification. The general structure and techniques, and more specific embodiments that can be used to effect different ways of carrying out the more general goals are described herein. Although only a few embodiments have been disclosed in detail herein, other embodiments are possible and the inventor(s) intend these to be encompassed within this specification. The specification describes specific examples to accomplish a more general goal that may be accomplished in another way. This disclosure is intended to be exemplary, and the claims are intended to cover any modification or alternative that might be predictable to a person having ordinary skill in the art.

[0024] It is intended that only those claims which use the words "means for" are intended to be interpreted under 35 U.S.C. § 112, sixth paragraph. Moreover, no limitations from the specification are intended to be read into any claims, unless those limitations are expressly included in the claims.

[0025] Where a specific numerical value is mentioned herein, it should be considered that the value may be increased or decreased by 20%, while still staying within the teachings of the present application, unless some different range is specifically mentioned. Where a specified logical sense is used, the opposite logical sense is also intended to be encompassed.

WHAT IS CLAIMED:

1. An electrical priority switchboard for connecting a power using device to multiple power sources comprising:

a power out connector for connecting a load;

at least two power in connectors for connecting to at least two different power sources; and

a switch allowing a consumer to draw electrical current from available intermittent source (called "priority electricity") when available and consume grid electricity when priority electricity is insufficient or not available.

2. The apparatus of claim 1 further comprising:

an automatic switch that connects to a priority power source when that source is available and sufficient to meet the load.

3. The apparatus of claim 1 further comprising:

a user input allowing a user to configure the switch.

4. The apparatus of claim 1 further comprising:

a communication interface allowing a user to monitor and/or configure the switch.

5. The apparatus of claim 1 further comprising:

a communication interface for communicating with power sources and/or power loads and control or affect the operation of one or more sources or loads.

6. The apparatus according to any combination of the above claims further wherein the apparatus is configured such that any of the sources and/or the loads can be AC or DC electricity.

7. The apparatus according to any combination of the above claims further wherein a DC load is directly connected to a DC source such as a photovoltaic panel as well as to grid electricity; allowing the grid electricity to be used only in the case that the DC source is unavailable or insufficient.

8. The apparatus according to any combination of the above claims further wherein electrical power is delivered consistent with inputs provided by sensors, cell phone apps, or preprogramed.

9. The apparatus described in claim 8 where the inputs include present availability of all/any electrical sources, and storage technologies (including batteries, capacitors, and super capacitors) present cost of available electrical sources, projected availability and cost of electrical sources, time of day; and various temperature readings, or light intensity readings.

10. The apparatus according to any combination of the above claims further wherein the apparatus records the electrical activity delivering to the user among other information, present and integrated electrical use from each source, cost from each electrical source, total cost, total cost savings made possible by the EPS.

11. The apparatus according to any combination of the above claims further wherein the apparatus is incorporated as an integral part of an appliance.

12. The apparatus according to any combination of the above claims further wherein the apparatus is part of a network of one or more electrical power sources, one or more electrical loads, and possible sensors as indicated.

13. The apparatus according to any combination of the above claims further wherein the apparatus incorporates energy storage for example thermal storage, mechanical storage, electrical storage and/or the associated sensors to the EPS processor.

14. The apparatus according to any combination of the above claims further wherein the apparatus is incorporated to an integrated or separate smart energy system for a home, business, or industry.

15. The apparatus according to any combination of the above claims further wherein the apparatus allows electrical power to flow into the building's electrical wiring to provide electricity to appliances plugged in elsewhere or to supplement (partially offset) grid electricity.

16. The apparatus according to any combination of the above claims further wherein the apparatus is attached at a plug (electrical outlet), or incorporated into the building's wiring on the building side, or the grid side of the circuit breaker.

17. The apparatus according to any combination of the above claims further wherein the apparatus is able to provide electrical power to a "microgrid" of adjacent buildings, whether these buildings be cooperating neighbors in a DC or AC microgrid, or be a power network inside of a business, company, or corporation.

18. The apparatus according to any combination of the above claims further wherein the apparatus records electrical energy flow and may be used to assess costs and payment.

19. The apparatus according to any combination of the above claims further wherein the apparatus consists of only a single electrical energy source.

20. A method for managing electrical priority when connecting a power using device (load) to multiple power sources comprising:

configuring a power out connector for connecting a load to be operationally connectable to at least two power in connectors for connecting to at least two different power sources; and

configuring a switch able to draw electrical current from available intermittent source (called "priority electricity") when desired or available and to consume grid electricity when desired.

21. The method of claim 20 further comprising:

configuring the switch to automatically connect to a priority power source when that source is available and sufficient to meet the load.

22. The method of claim 20 further comprising:

configuring the switch to operate at a consumer location without requiring modification or integration with external grid electricity beyond what is provided to a consumer not using a switch or multiple power sources.

23. The method of claim 20 further comprising:

configuring the switch to change operating parameters (such as temperature setting, light intensity setting, powering on or off, etc.) of one or more electric loads and/or electric storage devices based on present or predicted future availability of PV or on any other operating parameters.

24. The method of claim 20 further comprising:

configuring the switch to change operating parameters (such as temperature setting) of one or more electric loads and/or electric storage devices so as to store energy based on present and/or predicted future availability of PV and/or on any other operating parameters.

25. The method of according to any combination of claim 20 to the preceeding claim further comprising:

configuring the switch to receive one or more of user input data, sensor data, communications and control data from one or more power sources and/or one or more power loads, grid pricing data, and/or other electronic or user input data related to power use and the switch using that data to determine and transmit control signals to one or more power sources and/or one or more power loads.

26. The method of according to any combination of claim 20 to the preceeding claim further comprising:

configuring the switch to use a communication interface for communicating with power sources and/or power loads and control or affect the operation of one or more sources or loads.

27. The method of according to any combination of claim 20 to the preceeding claim further comprising:

configuring one or more DC loads to be directly connected to a DC source such as a photovoltaic panel as well as to grid electricity such that the switch can allow the grid electricity to be used only in the case that the DC source is unavailable or insufficient.

28. The method of according to any combination of claim 20 to the preceeding claim further comprising:

configuring the switch to receive one or more of: (1) present availability of all/any electrical sources, and/or storage technologies (including batteries, capacitors, and super capacitors) (2) present cost of available electrical sources, projected availability and cost of electrical sources, time of day; and (3) various temperature readings, light intensity readings, or other sensor data related to electricity use.

29. The method of according to any combination of claim 20 to the preceeding claim further comprising:

configuring the switch to be incorporated as part of an appliance.

30. The method of according to any combination of claim 20 to the preceeding claim further comprising:

configuring the switch to be part of a network of one or more electrical power sources, one or more electrical loads, and possible sensors as indicated.

31. The method of according to any combination of claim 20 to the preceeding claim further comprising:

configuring the switch to be incorporated as part of an energy storage device for example thermal storage, mechanical storage, electrical storage and/or the associated sensors.

32. The method of according to any combination of claim 20 to the preceeding claim further comprising:

configuring the switch to be incorporated to an integrated or separate smart energy system for a home, business, or industry.

33. The method of according to any combination of claim 20 to the preceeding claim further comprising:

configuring the switch to be able to allow electrical power to flow into the building's electrical wiring to provide electricity to appliances plugged in elsewhere or to supplement (partially offset) grid electricity.

34. The method of according to any combination of claim 20 to the preceeding claim further comprising:

configuring the switch to be attached at a plug (electrical outlet), or incorporated into the building's wiring on the building side, or the grid side of the circuit breaker.

35. The method of according to any combination of claim 20 to the preceeding claim further comprising:

configuring the switch to be able to provide electrical power to a "microgrid" of adjacent buildings, whether these buildings be cooperating neighbors in a DC or AC microgrid, or be a power network inside of a business, company, or corporation.

36. The method of according to any combination of claim 20 to the preceeding claim further comprising:

configuring a sensor indicating availability of priority electricity to start a process (such as cooking) at a time that coincides availability of priority electricity.

37. The method of according to any combination of claim 20 to the preceeding claim further comprising:

configuring the switch to record electrical energy flow and may be used to assess costs and payment.

38. The method of according to any combination of claim 20 to the preceeding claim further comprising:

configuring the switch to operate using only a single electrical energy source.

ELECTRICAL PRIORITY SWITCH

ABSTRACT OF THE DISCLOSURE

Method and apparatus allowing use of different power supplies by a customer are described herein.

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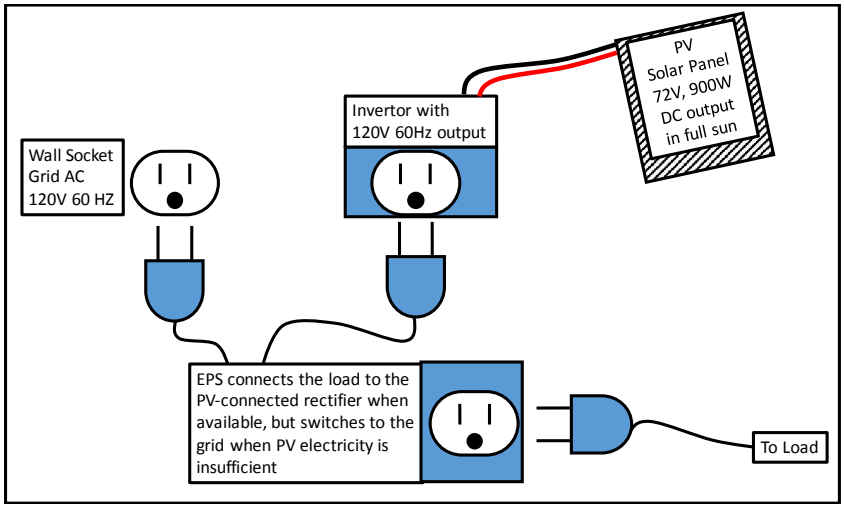
PV
Solar Panel
72V, 900W
DC output
in full sun
Invertor with
120V 60Hz output
Wall Socket
Grid AC
120V 60 HZ
EPS connects the load to the PV-connected rectifier when available, but switches to the grid when PV electricity is insufficient
To Load

FIG. 1

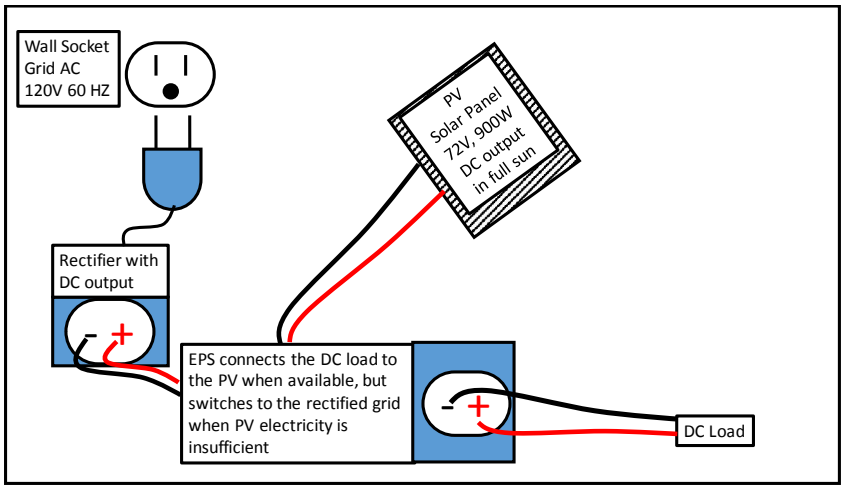
Wall Socket
Grid AC
120V 60 HZ
PV
Solar Panel
72V, 900W
DC output
in full sun
Rectifier with
DC output
EPS connects the DC load to the PV when available, but switches to the rectified grid when PV electricity is insufficient
DC Load

FIG. 2