Title: ENERGY DISTRIBUTION MICRO GRID

Abstract: An electrical energy production and distribution network is provided which comprises, a power grid supplied by a plurality of large scale electrical energy plants, each having a production capability of preferably greater than 500 kW. A micro electricity grid, connectable to said power grid, but capable as acting as the primary electrical energy system for a plurality of electrical energy customers drawing power from said micro electricity grid, and wherein the electrical energy for said micro electricity grid is produced by a large number of local, small scale electricity production units, each having a production capability of preferably less than 10 kW. An energy production method is provided which permits optimization of the design and use of larger scale electrical generation equipment.
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
Energy Distribution Micro Grid

Field of the Invention

The present invention relates to the field of energy production and distribution, and in particular, relates to the production of electrical energy and its utilization in an electrical energy network.

Background of the Invention

Currently electrical energy is produced in a relatively few, large scale plants that utilize large amounts of energy resources. As such, traditional electrical energy plants are based on producing electrical energy from hydroelectric dams, nuclear power stations, coal or natural gas powered stations, or the like. Power from these plants are distributed to the consumer through an electrical energy grid wherein power from each source is essentially added to the grid where it can be used by the consumer.

Recently, large scale horizontal windmills have also been integrated into the electrical energy grid in an attempt to provide additional electrical energy production capacity that is renewable.
Further, small scale electrical energy production sites have utilized based on smaller wind turbine or windmill plants, or photovoltaic cells. However, these sites are traditionally too small to have a significant impact on the electrical energy requirements of, for example, a town or city. As such, most electrical energy is still produced and supplied from large scale power plants.

In planning the production capacity of these plants, however, it is necessary to provide sufficient capacity such that the peak power consumption periods are fully supplied, which may leave excess capacity at other periods. Since there is no convenient way to store large amounts of excess energy, production capacity is taken off line. However, in a large scale production plant, terminating or re-starting power production is not easily accomplished.

As such, the power producers are constantly forced to estimate power consumption rates in an attempt to provide sufficient future power generation capability. Accordingly, applying sophisticated techniques to predict future electrical energy requirements on a real time, short, medium or long term basis, is extremely important, particularly for maximizing asset utilization, reducing inventory, and minimizing risk.

Overestimating power consumption will lead to excess capacity and higher operating costs, and underestimating power consumption will result in energy shortages, or the need to supplement the power generation capability by, for example, continuing to use outdated or inefficient power production plants, or the like.

Additionally, the capital costs of manufacturing these large scale power plants is significant sometimes costing many millions or even billions of dollars, and may take several years to be installed and brought on-line. As such, quantum changes in energy production capacity are typically required on a regular basis in order to keep up with a constantly increasing demand for more electrical power. However, most of the readily available, lower cost energy sources are already being utilized.

As a result, energy producers are now forced to bring on-line, higher cost and/or less efficient power production techniques to satisfy demand.
It would therefore be beneficial to the electrical power industry to provide a relatively low cost method for adding additional electrical power production. It would be a further advantage if this additional power production could be rapidly added or removed from the energy grid. Further, it would be advantageous to be able to provide rapidly installed, low cost electrical energy production capability that would be adaptable to provide the primary electrical energy system for relatively small scale operation, wherein electrical energy supplies might not be desirable due to cost, environment concerns, or the like.

Various authors have attempted to provide solutions to these problems. In United States Patent 6,787,258, to Prerad, electrical energy from one source was converted into high pressure gas via a pressurized electrolyser and then reconverted back to electricity via another device such as a fuel cell or a hydrogen engine turning a generator. By providing storage for the gases, the supply of electrical power may be shifted from one time to another. The patent does not teach, however, how a network of users may serve the function of becoming a micro utility, and the subsequent use of the micro utility for optimizing a larger electrical grid.

In United States Patent 6,882,904, Petrie teaches that a central processor can be used to optimize the operating characteristics of various electric power producers while meeting the electrical needs of various electrical users. However, this patent also does not teach how a network of users may also serve the function of becoming a micro utility for optimizing a larger electrical grid.

United States Patent 6,912,450 to Fairlie et al., provides a hydrogen system which includes a hydrogen generator such as an electrolyser, a hydrogen user and a controller. The controller matches the demand of the hydrogen user to the hydrogen available from the generator. The patent does not teach how a network of users may also serve the function of becoming a micro utility for optimizing a larger electrical grid.

United States Patent 6,925,361, to Sinnock provides a means to direct power to and from an electrical grid and to and from distributed energy generators which are
coupled through a controller. The invention permits distributed power generators to collectively sell energy to the power grid. However, the patent does not teach how a network of users may also serve the function of becoming a micro utility, and how that micro utility can be used for optimizing a larger electrical grid.

Further, in United States Patent Publication No. 2002/0036430, Welch et al. provide a system wherein a number of small scale generators and users may be connected in a micro grid and that micro grid may also be connected to a larger electrical grid. The patent does not teach how a network of users can establish a micro grid primarily for their use by utilizing the power from the micro grid, and subsequently supplying excess electrical energy to the larger grid in order to optimize the electrical energy generation by the larger grid system. As such, the Welch et al. document does not describe how providing a micro grid which acts as a primary source of electrical energy for a group of users can also serve the function of becoming a micro utility for optimizing a larger electrical grid.

As such, provision of a network of small scale electrical energy production sites as micro grid production sites, that would further act to optimize a larger electrical energy grids, would be beneficial.

Further, a system that would be able to rapidly adjust electrical energy production by adding numerous smaller micro-grid production sites on-line, would allow larger production plants to operate more closely to their peak operating efficiency and allow them to better plan for future electrical energy consumption.

Summary of the Invention

Accordingly, it is a principal advantage of the present invention to provide an electrical energy production network that includes the incorporation of a micro grid comprised of number of smaller scale, sustainable or renewable energy production and distribution systems that, when combined, are capable of acting as a primary energy system to part of the total energy grid. As such, the smaller scale production and
distribution systems act as a micro electricity grid, and the micro grids is adapted to be connected to a larger electrical grid system as needed, in order to optimize the efficiency of the total electrical energy grid.

It is a further advantage of the present invention that the smaller scale, sustainable or renewable energy production and distribution systems are preferably comprised of a large number of low output, renewable electrical energy devices, selected from lower powered windmills and turbines, photovoltaic cells, or the like.

The advantages set out hereinabove, as well as other objects and goals inherent thereto, are at least partially or fully provided by the electrical energy production and distribution network of the present invention, as set out herein below.

Accordingly, in one aspect, the present invention provides an electrical energy production and distribution network comprising a first power grid supplied by at least one large scale electrical energy plant having an electrical energy production of greater than 500 kW, and a micro grid electricity power grid which is connected to said first power grid, wherein said micro grid acts as the primary electrical energy system for a plurality of electrical energy consumers drawing electrical power from said micro grid, and wherein the electrical energy for said micro grid is produced by a plurality of local, small scale electricity production units, each having a production capability of preferably less than 100 kW, and more preferably of less than 10 kW.

The large scale electrical energy plants would include the hydroelectric, nuclear, coal, oil or gas powered electricity generation plants described hereinabove, and typically these types of plants would produce power far in excess of 500 kW, and typically more than 1 MW or more. Also included would be systems comprising relatively large scale windmills, wind turbines, and large scale photovoltaic cells arrays, whose output is also above the 500 kW output level, and who are merely connected to the preexisting energy grid to supply energy, and which are not, to any significant extent, energy consumers from the grid.

It is to be noted that several large scale electrical energy plants might be
connected to the large scale energy grid. As well, a plurality of micro-grid electrical energy production units might also be individually connected to the large scale energy grid.

Excluded from this system would be very small scale operations, such as photovoltaic or wind energy devices which are attached to, for example, individual houses, cottages, factories, apartments, business offices, or the like, wherein the energy devices are used to generate power for that individual user. These devices would typically have a power output of less than 2 kW, and more typically, less than 1 kW, and the energy produced would be primarily for consumption strictly by the individual house, cottage etc. As such, the energy production from these operations would not qualify as a micro grid, as defined herein.

Instead, the system of the present invention is reliant on having a large number of energy production units which are connected to a localized, micro grid. From this micro grid, a number of users would be able to draw electrical power, regardless of whether they contributed to the production of the electrical energy. The energy output capability of the micro grid will be dependent on the number of devices connected, but preferably each micro grid has a total output capability of above 10 kW, more preferably, above 50 kW, and even still more preferably, above 100 kW. Further, the total output capability of the micro grid could be as high as 200 kW or higher.

As such, the micro grid might be used to supply electrical power to, for example, a town, a city, a selected geographical region, or might be used to supply power to smaller collections of users, such as a remote subdivision, collection of factories or the like.

The small scale electricity production units in the micro grid are preferred powered by renewable energy sources such as by wind power, tidal or wave action, solar power, hydro power, or the like. Preferably greater than 50%, and more preferably, greater than 75% of the power utilized in the micro grid is sourced from such renewable energy sources.
A particularly preferred small scale electricity production unit is a wind turbine, and a preferred wind turbine is described in a co-pending US Patent Application No. 11/128251 assigned to Arrowind Corporation.

A preferred feature of this micro grid-containing electrical energy network is that it does not rely on the additional construction of large scale production facilities of any kind. Instead, it works in conjunction with these plants. When necessary, the micro grid can supply excess electrical power to the main grid, or draw electrical energy from that grid. However, the micro grid is considered to be the primary source of electricity to the consumer, and thus greater than 50%, and more preferably greater than 75%, and most preferably greater than 90% of the electricity consumed within the structure of the micro grid, in a typical consumption year, is produced by the small scale electricity production units of the micro grid. These small scale electricity production units preferably each have a production capacity of less than 10 kW, and more preferably less than 5 kW.

The draw of electrical energy from the larger scale energy grid is thereby reduced.

Accordingly, in one embodiment, the total micro grid is capable of producing in excess of 10 kW, and provides greater than 50% of the electrical energy requirements of the energy users on the micro grid. In a more preferred embodiment, however, the micro grid is capable of producing in excess of 100 kW, and provides greater than 90% of the electrical energy requirements of the energy users on the micro grid.

In a further preferred embodiment, the electricity provided to the micro grid preferably is generated from a number of small local production units. For example, a series of small scale wind turbines located on the roof of a building could provide a roof top wind farm. Provision of a number of these roof top wind farms within a micro grid could supply a significant amount of the power required within the micro grid. Solar or small-scale hydro facilities could be additional sources of energy.

The present invention also contemplates a system wherein peak energy demands within the micro grid might be met by smaller scale, more traditional and non-renewal sources, such as small hydroelectric facilities, but more likely, smaller gas, oil or coal
powered generators, or by other devices, such as fuel cells and the like. These units would likely produce electrical power of less than 500 kW, and more typically, less than 250 kW. The number of these types of devices, however, would preferably be less than 50%, more preferably less than 25%, and still more preferably less than 10% of the total number of energy production units within the micro grid.

It is to be noted that the micro grid network allows the local users and/or producers to have more control over the ultimate production rate, the production method, and, to some extent, control over the subsequent use of the electrical energy produced. As a result, the micro grid can provide improved environmental features first through the use of renewable, non-polluting energy sources, but also by providing greater control over the electrical energy used, and thereby possibly avoiding the necessity of using alternative power sources. Further, by providing a large number of local production units, energy loss due to the transmission of power is reduced.

Still further, the smaller production units in the micro grid can be brought on-line in a much more rapid fashion than a larger scale production plant. As such, the total energy grid can be better optimized for the requirements of the particular area selected.

For the present invention, local production is production occurring within 100 km of the micro grid, and more preferably within 25 km of the micro grid. Most preferably, however, over 90% of the small scale production units are located within the area supplied by the micro grid.

The large capital costs for construction of a larger electrical energy production plant, are also avoided, or minimized.

The micro grid is preferably one for generating electricity from a renewable resource, and supplying that electricity to users of the electricity on the micro grid. The users might include, for example, individual residences, apartment complexes, commercial and industrial buildings or sites. Surplus power could also be fed back to a main power grid such as that currently found supplying power in a national or other large scale electricity grid.
Brief Description of the Drawings

Embodiments of this invention will now be described by way of example only in association with the accompanying drawing in which a schematic representation of a micro grid, in accordance with the present invention, is described.

Detailed Description of the Preferred Embodiments

The novel features which are believed to be characteristic of the present invention, as to its structure, organization, use and method of operation, together with further objectives and advantages thereof, will be better understood from the following drawings in which a presently preferred embodiment of the invention will now be illustrated by way of example only. In the drawings, like reference numerals depict like elements.

It is expressly understood, however, that the drawings are for the purpose of illustration and description only and are not intended as a definition of the limits of the invention.

Referring to the drawing, a main energy grid 12 is shown and is representative of the energy grid currently used on a national, state or provincial level. Large scale power plants 14 are used to produce the electricity to this grid.

Separate from grid 12 is micro grid 20 which is used to supply electrical power to a much smaller group of users, which in this case, might be a town. Connected to micro grid 20 are a number of small production sites 22, which represent a number of small scale production facilities including windmills, wind turbines, photovoltaic cells, roof top wind farms, and the like. Each of small production sites 22 is preferably a production site which produces less than 10 kW, and which preferably produces that power from renewable resources such as wind or solar power. In a preferred option, the majority (greater than 50%) of production sites within the micro grid produce less than 10 kW per unit. However, it is to be noted that any suitable power source can be included.
A connection 30 is provided which links grid 12 to micro grid 20 and allows electrical energy to pass from one system to the other. However, controller 32 is provided in order to control and/or limit any transmissions between grid 12 and micro grid 20. Further, controller 32 can act to ensure that the electrical energy supplied from the micro grid to the larger power system, or vice versa, meets the necessary requirements of the larger or smaller power grids, as appropriate, with respect to voltages, frequency, phase considerations and the like.

By utilizing the system described herein, the electrical needs of the smaller group of users is at least partially met by the production of electrical energy from the energy micro grid. The larger scale plants are thus planned, designed and built to operate at their optimal levels, and provide a optimized level of electrical energy output. This will likely be at or near their designed load capacity.

The micro grid provides the additional electrical energy required by the total system in order to meet demand. The electrical energy generation capability of the micro grid can be increased, or decreased, much more rapidly than the capability of the larger scale plants. As such, micro grid energy generation devices can be added or removed from the system in a much more rapid fashion. This allows the total system to be better optimized. As such, the efficiency of the larger scale production plants is improved, and is more controllable and plan-able.

Thus, it is apparent that there has been provided, in accordance with the present invention, an electrical energy production and distribution grid, which fully or at least partially satisfies the goals, objects, and advantages set forth hereinbefore. Therefore, having described specific embodiments of the present invention, it will be understood that alternatives, modifications and variations thereof may be suggested to those skilled in the art, and that it is intended that the present specification embrace all such alternatives, modifications and variations as fall within the scope of the appended claims.

Additionally, for clarity and unless otherwise stated, the word “comprise” and variations of the word such as “comprising” and “comprises”, when used in the
description and claims of the present specification, is not intended to exclude other additives, components, integers or steps.

Moreover, the words "substantially" or "essentially", when used with an adjective or adverb is intended to enhance the scope of the particular characteristic; e.g., substantially planar is intended to mean planar, nearly planar and/or exhibiting characteristics associated with a planar element.

Further, use of the terms "he", "him", or "his", is not intended to be specifically directed to persons of the masculine gender, and could easily be read as "she", "her", or "hers", respectively.

Also, while this discussion has addressed prior art known to the inventor, it is not an admission that all art discussed is citable against the present application.
We claim:

1. An electrical energy production and distribution network comprising a first power grid supplied by at least one large scale electrical energy plant having an electrical energy production of greater than 500 kW, and a micro grid electricity power grid which is connected to said first power grid. wherein said micro grid acts as the primary electrical energy system for a plurality of electrical energy consumers drawing electrical power from said micro grid, and wherein the electrical energy for said micro grid is produced by a plurality of local, small scale electricity production units, each having a production capability of less than 100kW.

2. A network as claimed in Claim 1 wherein a plurality of large scale electrical energy plants is connected to said first power grid.

3. A network as claimed in Claim 1 or 2 wherein said large scale energy plant is a hydroelectric, nuclear, coal, oil or gas powered electricity generation plant, or is a large scale windmill, wind turbine, or large scale photovoltaic cells array, each of which has a production output of greater than 500 kW.

4. A network as claimed in Claim 3 wherein each large scale energy plant has an energy production output of greater than 1 MW.

5. A network as claimed in Claim 1 wherein each of said small scale electricity production units has a production capability of less than 10 kW.

6. A network as claimed in Claim 1 wherein said micro grid has a total output capability of greater than 10 kW.
7. A network as claimed in Claim 1 wherein said micro grid has a total output capability of greater than 50 kW.

8. A network as claimed in Claim 1 wherein said micro grid has a total output capability of greater than 100 kW.

9. A network as claimed in Claim 1 wherein said micro grid has a total output capability of greater than 200 kW.

10. A network as claimed in Claim 1 wherein greater than 50% of the power provided to said micro grid is sourced from a renewal energy source.

11. A network as claimed in Claim 10 wherein greater than 75% of the power provided to said micro grid is sourced from a renewal energy source.

12. A network as claimed in Claim 10 or 11 wherein said renewal energy source is provided by wind power, tidal or wave action, solar power, or by hydro power.

13. A network as claimed in Claim 1 wherein greater than 50% of the electricity used from the micro grid in a typical consumption year, is produced by small scale electricity production units each having a production capacity of less than 10 kW.

14. A network as claimed in Claim 13 wherein greater than 75% of the electricity used from the micro grid in a typical consumption year, is produced by small scale electricity production units each having a production capacity of less than 10 kW.

15. A network as claimed in Claim 14 wherein greater than 90% of the electricity used from the micro grid in a typical consumption year, is produced by small scale
electricity production units each having a production capacity of less than 10 kW.

16. A network as claimed in Claim 1 wherein greater than 90% of the small scale production units are located within the area supplied by the micro grid.

17. A network as claimed in Claim 1 wherein a plurality of micro grid electricity power grids are connected to said first power grid.

18. A network as claimed in Claim 1 wherein surplus power from said micro grid is fed to said first power grid.
A. CLASSIFICATION OF SUBJECT MATTER
IPC: H02J 3/38 (2006.01) ; H02J 3/04 (2006.01)
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
IPC: H02J 3/38 (2006.01) ; H02J 3/04 (2006.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
WPI, Delphion, Canadian Patent Database, USPTO, Qweb, Espacenet
Keywords: micro grid, power grid, energy distribution, power plant, wind energy, electric power, electricity production.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>WO02071572 (Young et al.) 12 Sep., 2002. (12-09-2002) see Abst.; page 3, lines 27-53; page 4, lines 16-37, 41-52, page 5, lines 18-25; page 6, lines 6-13; Figs. 3-5; Claims 1, 9.</td>
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[X] Further documents are listed in the continuation of Box C.  
[X] See patent family annex.

Date of the actual completion of the international search  
24 July 2006 (24-07-2006)

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