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HYBRID INSTALLATIONS REPORT

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1. INTRODUCTION & GENERAL CONCEPTS

Once a high-level technological development of renewable energy has been reached, the hybrid installations can be considered as a supplement or replacement for traditional energy.

Renewable Energies are usually used as a business model in itself through the sale of “free” energy production to a private customer, power companies or the states themselves through a PPA (Power Purchase Agreement) or as an energy-saving measure promoted by customers concerned by both their energy bills and the environment.

Also, Renewable Energies are a more than justified substitute in isolated facilities whose connection to the power grid or a fuel supply involves great difficulty or cost.

Renewable energy installations of a medium or small size, that is, from a few KW up to less than 1 MW, have traditionally been associated with solar photovoltaic technologies, solar thermal, wind, geothermal or biomass in any of their many variations. Even in some special cases involving small mini hydro turbines.

As it is well known, each of the renewable energy applications mentioned in the previous paragraph have a functioning technology and a different generation profile:

- Both *solar photovoltaic* and *solar thermal* production are associated with the sun's radiation in the sunshine hours, similar to a Gauss' bell curve that is repeated with minor changes throughout the year, and is influenced by daily weather conditions.

- *Wind power generation* presents a profile of independent and distinct production in any location, although some positive aspects include adverse weather conditions, which hinder solar output during the day.

- *Geothermal energy* has the most stable and consistent profile of all, given the great inertia of temperature changes of the surface layer of the earth's crust.

- *Hydroelectric* production could be considered of general constant operation, although it depends on river flows and rainfall data of the areas in which it is installed, which involves production changes over medium- and long-term periods involving months or years, rather than hours or days, as in the other cases.

- Finally there is *biomass* as a power source, which is fully adjustable and controllable at will, according to the requirements of the facility.

From the above, renewable energies can be considered as complementary to each other or with other traditional energy sources. This has led in many cases to the development of exclusively renewable hybrid facilities, or those associated with conventional energy sources.

The power conditioning, electronic regulation, and monitoring technologies possess a very high degree of development and allow a detailed control of all relevant parameters in a hybrid installation, from factors influencing the sources of energy present in the system, such as in consumer-modified characteristics, even if the system is isolated from or connected to the grid and evacuating all of the energy produced in a more-efficient way.

2. HYBRID INSTALLATION ELEMENTS

A hybrid power generation plant is commonly comprised of, but not limited to, the following elements:

- One or several sources of renewable-energy generation utilizing any of the types mentioned, previously studied so as to be as complementary to each other as possible, according to climatic characteristics of the area, terms of use of the system, and consumer requirements.

- A system of electrical energy storage, usually in batteries, to avoid losses of unconsumed energy at certain periods in the case of isolated facilities, and to stabilize the network by way of the production / consumption relationship. In less-common applications of hybrid facilities connected to the grid, this accumulation of energy disappears as the grid performs its own management of energy accumulation, depending on its size.

- An additional generator that is 100%-controllable by the consumer to provide all the energy needed for the consumer when there is no availability of renewable resources. This usually involves the use of diesel, with the effect of emissions of contaminants. This generator, however, could be replaced by common biomass fuel in thermal installations.

- A power conditioning system that is primarily responsible for transforming the initial energy sources into the product that the end-user needs, to produce either hot water, AC or DC electricity, steam, etc. That same system includes the control and regulation devices needed to maximize the efficiency of the entire system, avoiding, when possible, the use of auxiliary energy, or the network, which are ultimately costly and have a greater influence on the environment.

- A user, or independent electric utility, in the application of the present installation, has it own independent characteristics of use and consumption which are different from any other variables, all of which should be carefully studied in order to produce a proper, efficient, and economical system design.

It can be understood from the foregoing that the hybrid system concept is highly variable and requires an adequate and specific engineering design and adapted to each user, according to their needs. The hybrid installation can be as simple or complex as the needs and requirements of each user.

3. TYPICAL HYBRID INSTALLATIONS

Hybrid installations may be configured into many combinations of the elements shown in the previous section. Nevertheless listed below are some of the most used:

a. Isolated hybrid installation involving Wind & PV:

This facility is widely used in homes isolated from mains. It combines a photovoltaic generator with a wind generator as the primary sources of energy, with a diesel generator, which is considered as a backup, although it is really the only element that can guarantee a continued operation.

In general, often a battery storage system allows for a stable supply of electricity production, given the high peaks that can be obtained from two main sources. They also have the function of providing power during the night, if there were sufficient wind resources or not.

The photovoltaic resource is present in almost every area and is larger or smaller, depending on the exact location of the installation and weather conditions, but has reasonably predictable production profiles, on a statistical basis, throughout the year.

However, the wind resource is much more variable from one area to another within the same region or country. This depends largely on the climate zones in which they are located, but also upon individual characteristics of its position, such as topography, proximity to the sea, etc.

b. Geothermal-biomass installation:

Commonly used in Northern European countries for low-temperature heating. It consists of a geothermal system adapted to ground conditions using the thermal inertia of the land underneath the homes of users, or even under large areas inhabited, by injecting water at low temperature and getting heat by thermal exchange with the subsoil at tens or hundreds of meters of depth.

The objective of this energy-production system is to get hot water for human consumption or as a heat source for radiant floor heating, for instance. It is a cheap energy source, and very predictable in practice. It usually has some kind of support, such as a diesel or biomass boiler that would complete the installation, ensuring its operation.

Biomass replaces the diesel, as it is considered fully controllable by the user, who has to take care of this fuel supply exclusively, and whose emissions are considered "zero balance" for the environment as the carbon oxides emitted to the atmosphere have been obtained itself from the photosynthetic process.

c. Solar Thermal-Biomass installation:

Available in any region, but more present in low- latitude areas and Mediterranean climates, due to both the easy availability of solar resources, and of biomass fuel. It is used for hot water and heating in winter, or summer pool heating (including all year-round).

As in the previous case, the system is designed to extract the maximum amount of energy from solar thermal collectors by direct heat exchange through an absorber, which allows the transfer of heat to the fluid of exchange from the solar radiation.

The extra thermal break necessary to achieve the setpoint temperatures is obtained from biomass fuel. Thermal systems like this, or based on geothermal energy, do not have electrical storage, but are usually equipped with thermal storage in tanks for the purpose of buffers of exchange.

d. Mini-hydroelectric installation with wind or photovoltaic: In certain places whose geography and fluvial characteristics produce waterfalls of sufficient capacity, it is possible to install small hydroelectric generators combined with photovoltaic or wind, depending on the natural resources of the area. The operation is very similar to the rest of the facilities, and must also have an energy network support or power diesel generator in order to produce the rest of the energy required by the user.

4. CONCLUSION

Hybrid systems are very useful, especially for isolated consumers reducing their dependence on energy supplies from either the grid or from fuel. Its use greatly reduces the footprint of the user in the environment and, in most cases, the economic savings is more or less substantial.

It can be said that some technologies and combinations are more developed than others, and its profitability is higher or lower in the short term, but be aware that it is expected that energy prices and fuel prices will have an upward trend in the coming years, which improves the economic perspective of the use of renewable energy, be they hybrid or simple installations, all of which is coupled with the positive influence on the environment.