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SHERPEC – Hybrid System of Renewable Energies for production of Electricity and Climatization

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Abstract

The objective of this paper is to provide a description of a Hybrid system of renewable energies for electricity and climatization production..
Telecommunications is a vital sector and its remote sites must be constantly supplied with electricity. It is then necessary to implement a continuous and autonomous power supply system.
The SHERPEC project provides energy to a standalone remote telecommunications site trough solar, wind and fuel cell electric generators. In the case of lack of sun and wind, its autonomy is assured by a bank of batteries and/or hydrogen tanks (high and low pressure).
In the case of excessive electric energy production, the remaining will be used to produce hydrogen (through water electrolysis) that is stored for future use in the fuel cell.
The communication system allows long-distance communication with the monitoring room.
In order to provide a better management of energy resources, it is capable to manage the renewable energy sources in an intelligent manner, carrying out the disconnecting of less priority charges.
To reduce electric energy consumption as well as to improve its energetic efficiency, it was implemented an air-conditioning system using a solar thermal system.

Key words

Hydrogen cell, solar air conditioning, monitoring, wind, photovoltaic

1. Introduction

The scarcity of fossil fuel energy sources in the medium and long term, and the consequent increase in its price, will make renewable energy play an increasing important role.
While the cost of some equipment is still high, the market economy and the tax and economic incentives will make it more competitive, making these technologies increasingly viable, namely for standalone telecommunications systems, as in the present project.

Therefore the objective of the SHERPEC project is to test several innovative clean energy sources to feed an isolated facility, with clean energy. With this project it is possible to assure the cooling and power supply to critical loads, transmitting data remotely.

2. The System

Telecommunications sector is a vital sector, whose sites must be constantly electrically fed. It is then necessary to implement a power system that is continuous and autonomous.

The energy of the plant is provided by photovoltaic, wind (Fig. 1) and fuel cell generators, feeding the telecommunications equipment, air conditioning and charging the battery, allowing the site to have sufficient autonomy.

Fig 1. Photovoltaic and wind generators

The design of this system is done to assure production of enough electricity to supply priority loads during adverse weather conditions (low solar radiation and low wind velocity). There are, however, situations where the system can produce more energy than necessary. This extra energy available is used to produce hydrogen locally, being then used by a fuel cell.

Fig 2. View of the fuel cell and Hydrogen production system

Net Plan - Telecommunications and Energy, SA, has tested different solutions that enable the integration of other renewable energy sources for optimizing the hybrid system and reduce electrical consumption, including a cooler solar system.
The integration of the solar cooling system, consisting of solar collectors and an absorption chiller allowed the replacement of the mechanical compressor and is designed to maintain the telecom equipment at an optimal temperature during the day.
With the integration of a solar cooling system we reduce the power consumption with air conditioning, as this is one of the largest electricity consumers in the telecommunications sites.

Fig 3. View of the solar cooling system

The maximization of the available resources and the reduction of power consumption is vital in a standalone system of this nature. Therefore the implementation of a command and control system is required.
The monitoring system designed by Net Plan - Telecommunications and Energy, SA, can monitor and perform energy management of all system components.
All data relevant to the proper operation of this system is collected remotely and made available to their customers.
This type of solution enables remote off grid telecommunications sites, who still rely on diesel generators, with all the maintenance and supply problems, to be completely autonomous.

3. Equipments

The SHERPEC system can be divided by two major groups, electrical energy production [1] and thermal energy production [2].

The electric energy is generated by two energy production systems, the photovoltaic and wind generators, and by two auxiliary systems bank of batteries and a fuel cell, as can be seen on Fig. 4

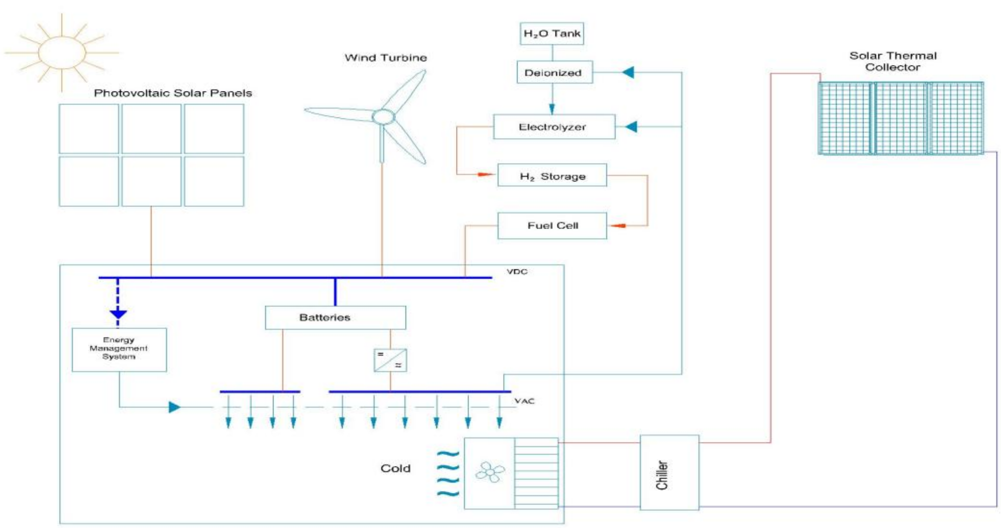

Fig 4. SCHERPEC diagram

A. Photovoltaic generator

The photovoltaic generator is constituted by a total of thirty crystalline silicon panels with a total power of 7 kWp.
The estimated production of the photovoltaic generator is 9510kWh per year. In Fig. 5 one can see the monthly estimation of photovoltaic production.

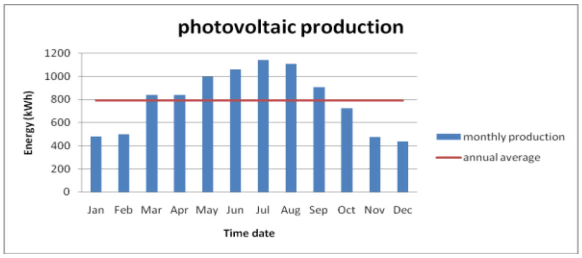

Fig 5. Estimative of Photovoltaic production

Fig 6. View of the solar panels

B. Wind generator

The wind production is assured by a 6kW wind turbine (Fig. 8), which has the capacity to produce energy from wind velocities of 3 m/s (Fig. 6). To assure a better wind capture the wind turbine is installed at the top of a 12 meter tower.

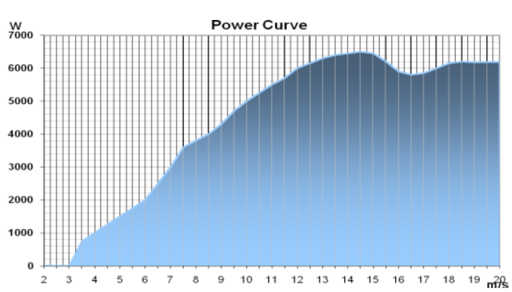

Fig 7. Wind turbine power curve

Fig 8. Wind turbine installation

The estimated production of the wind generator is 7800kWh per year. In Fig. 9 we can see the monthly estimative of wind production.

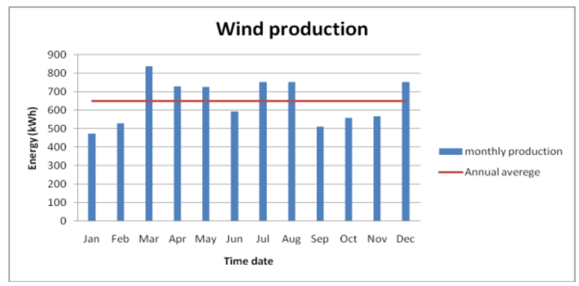

Fig 9. Estimative of wind production

C. Bank of Batteries

In order to provide energy to the site during adverse weather conditions and during the night, there is installed a bank of 48 volts batteries with a capacity of 3000Ah. With this bank it is assured 4 days autonomy to supply the critical charges.

Fig 10. Bank of batteries

D. Fuel cell

The fuel cell operates when the main production sources and the bank of batteries cannot, by themselves, feed the loads.
The cell is fed by two tanks (low and high pressure) of hydrogen.
The fuel cell installed on the site is a 5kW fuel cell, and has an autonomy of 20 minutes if feed by low pressure source and an autonomy of 5 hours if feed by high pressure hydrogen tank [3].
The hydrogen used proceeds manly from local production (low pressure) but it can be used also industrial hydrogen (high pressure).

In figure 11 a diagram of the local hydrogen production is presented.

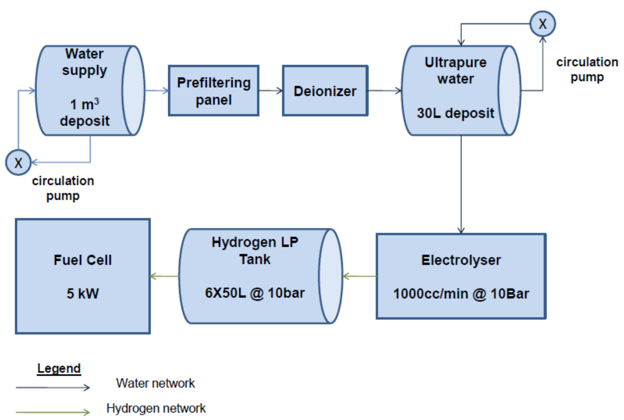

Fig 11. Hydrogen production diagram

There is hydrogen production if:

There is an excess of electric energy
The bank of batteries is full
The lung pressure is below 10 bar

Fig 12. View of the hydrogen fuel cell

Fig 13. View of the hydrogen production equipments

E. Cooling system

The cold production is made by a solar cooling system.
The production of cold is assured by the following equipments:

- 6 solar collectors with a total area of 13,2 m^2
- 500 l tank for hot water
- 4,5 kW Absorption Chiller
- Fan-convector

Operating principle

The water of the 1st circuit is heated by the solar collectors and stored in a 500 l tank, then the chiller uses the hot water to generate chilled water, through internal thermodynamic processes.
The chiller comes into operation when the water tank reaches 80 º C. The chiller can cool the water between 7 and 12 degrees.
The cold water is used by the fan-convector whose function is to extract heat from the technical telecom room.

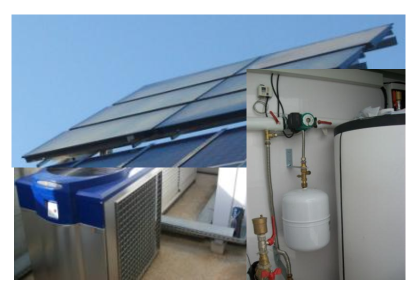

Fig 14. Some of the solar cooling systems equipments [4]

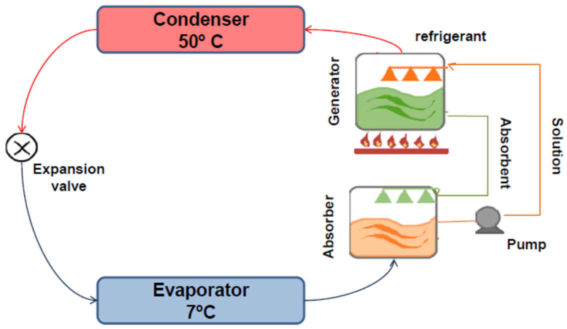

Fig 15. Internal process of absorption chiller

F. Management and control system

To keep remote "contact" with the SHERPEC there is a management and control system installed [5]. The system allows to manage and collect data remotely, sending the data to the Net Plan headquarters (Fig. 15).

The system allows

Management and control:

- Monitoring the system of equipment
- Analysis of inputs / outputs of each system
- Management of energy production and consumption
- Sending alarms
- Remote access through GSM;

Collection and Data Analysis:

- Automatic collection through GSM
- Diary Storage
- Automatic analysis of data
- Generation of reports
- View the data in the portal

Fig 16. View of software, windows/charts

4. Results

With the SCHERPEC, we can provide electric energy to the telecommunication site, using renewable energy source.

As represented on Fig. 17, the estimated production of the renewable energy system is more than sufficient to cover the energy consumption of the site, leaving enough energy to charge the battery bank or for the hydrogen production.

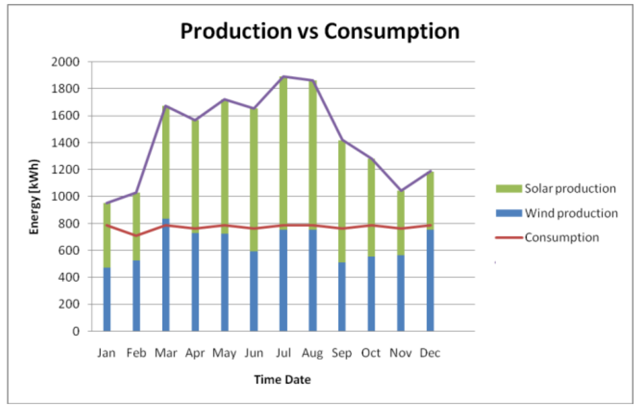

Fig 17. Estimative of production and consumption

In figure 18 it`s represented the production and consumption data between 11 of November of 2009 and 10 of December of 2009.

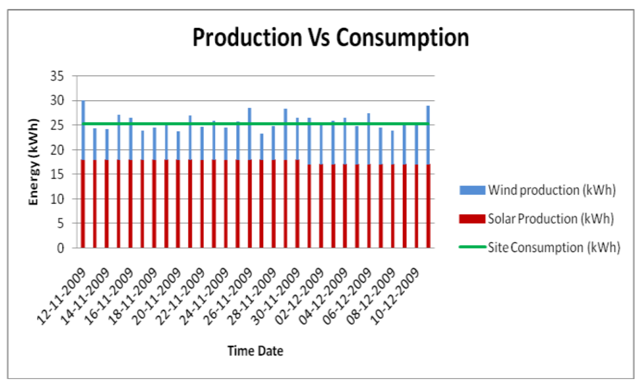

Fig 18. Production vs. consumption during the period of 12 of November to 10 of December of 2009

As represented during that period in Winter the energy produced was almost sufficient to feed all the charges, nevertheless in some days there was not enough production to feed all the energy demand. In those short periods, the batteries had to compensate the remaining of the energy request, as shown in figure 19.

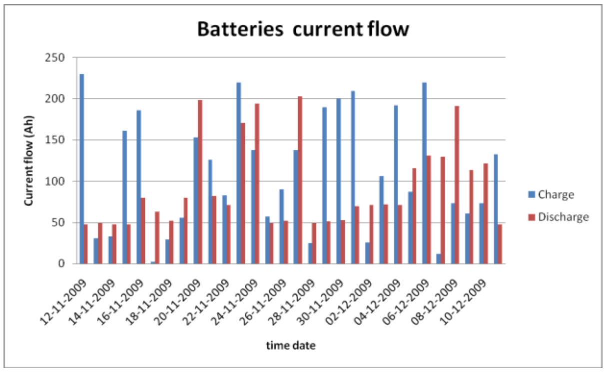

Fig 19. Batteries current flow

As represented on the previous figure, in the days with lack of production, the batteries had to give more current to comply with all the site`s power consumption.

Due to the low energy production during this period (12 Nov to 10 Dec), the production of hydrogen was nonexistent. Nevertheless the supply of energy to the equipments present on the telecommunication site was guaranteed by the wind and solar generators and by the bank of batteries.

5. Conclusion

With the SHERPEC project and concept, electricity and air conditioning can be supplied to a remote location using renewable energy sources, even when weather conditions are not the ideal for production.

With the use of the solar air conditioning, further optimization can be done, by reducing the energy consumption of the conventional cooling system.

With the management system, the entire plant can be monitored, allowing the transmission of data and alarms remotely.

As shown on section 4 the SCHERPEC project is an alternative to the convectional diesel generators normally present on remote telecommunications site, being the system able to supply all the energy necessities continuously.

With the solar cooling system cold can be produced using renewable energy sources, reducing the energy consumption comparing to a convectional cooling system used on telecommunication site.

With the management and control system the SCHERPEC is constantly in contact with Net Plan`s headquarters allowing remote monitoring and configuration of the renewable energy production and the backup systems.

6. References

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