Stand-alone PV Systems for Emergency Signal Transmission and Environmental Control in Isolated Mountain Areas

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ABSTRACT: Within the framework of this project, two main independent PV powered systems were realised in Romania: an emergency signal repeater station and a pollution control unit combined with a sub-system for meteorological data monitoring. The stand-alone systems are located in isolated mountain areas which are frequented by alpine tourists. This paper mainly focuses on the problems to be solved when powering an air pollution control unit with PV energy and on solutions on how to continuously control systems operated in isolated areas.
Keywords: Pollution control - 1: Emergency signal repeater - 2: Stand-alone PV Systems - 3

1. INTRODUCTION

The PV systems installed in the framework of this project shall demonstrate the capacity of the Romanian PV industry to design and install reliable stand-alone PV systems and their ability to implement smart control technologies to reduce the electricity demand of key components.

2. AUTOMATIC AMBIENT AIR POLLUTION CONTROL UNIT

The degree of damage to the European forests and the environment in general through aerosol pollutants causes severe economic damage. It quickly became evident that this damage can only be limited with the aid of continuous monitoring of the key pollutants in the atmosphere. For this reason many of the western European countries decided to install a narrow grid of ambient air pollution control systems. Today we find about 65 ambient air pollution control systems in the state of Bavaria / Germany, this number corresponds to an average density of about one pollution control system per 1,000km².

The situation is completely different in many of the central European countries. With the fall of communism the economic situation deteriorated. The entire infrastructure has to be modernised, hardly any ambient air pollution control system is of the automatic type and continuous measurements are impossible. Besides, many remote locations lack a reliable power supply and, obviously, a diesel generator as power supply would require a significant operation & maintenance effort and its exhaust fumes would falsify the measurement values.

The system installed in this project will demonstrate that a stand-alone pollution control unit can be reliably powered by PV energy at reasonable costs, provided all options to reduce the energy demand of an automatic pollution control unit are exploited.

Figure 1 depicts the block diagram of the pollution control unit. The automatic analyser is installed in a continuously manned hut depicted in **Figure 2**. This building belongs to the main background pollution control station of Romania.

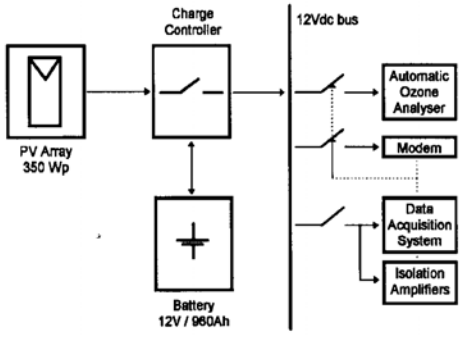

Figure 1. PV powered pollution control unit (Location: Fundata / Romania).

Figure 2. The pollution control station of Fundata / Romania with part of the PV array structure. This control station is located in the Bucegi mountain chain. It is accessible via a dirt road by donkeys, not by car.

2.1 Minimising the Power Demand of the Analyser

Operating automatic pollutant analysers with limited energy sources, i.e. not connected to a grid, can be critical for the following main reasons:

- Most of the analysers available on the market have a very high power demand of typically 70 to 200W @ 220Vac, depending on the type of pollutants to be measured and on the technology applied
- High quality measurement can be performed with a 'continuously operated' system only
- A defined minimum number of measurements per day is required to comply with international standards
- A stable operation according to international standards can only be guaranteed in a narrow temperature range (pollution analyser) between typically 15° and 35°C

A PV energy supply can therefore not be realised with the standard instruments and methods available. The non-conventional automatic ozone analyser implemented in this system is powered by 12Vdc. Its design was modified in a way that it consumes a maximum of 36W during continuous operation and an average of about 30W when the operation of different system components is controlled by an additional logic and is limited to a number of periods with a defined measurement duration per day. This operation mode does not limit the warranty given by the supplier and does also not influence the precision of the measurements. In this case the power consumption is reduced according to the curve depicted in **Figure 3.** This characteristic results in a total energy demand of minimum 300Wh for six measurements per day compared to an energy demand of around 1,700Wh for conventional, continuously operated systems.

The power supply for the pollution control unit was designed in a way to satisfy this minimum required energy demand for six periodic measurements per day during the winter time. Depending on the state-of-charge of the battery the operation time is extended to more cycles per day and continuous operation during summer time. All relevant analyser functions can be remotely controlled via modem. PV system monitoring data are continuously collected and automatically retrieved once per day for analysis purposes.

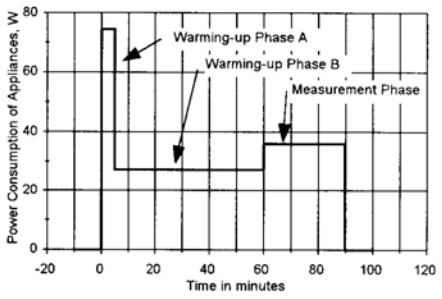

Figure 3. Power demand of the automatic ozone analyser vs time for the shortest reasonable measurement cycle at an operating voltage of 12 Vdc.

2.2 Autonomous Meteorological Sub-system

An autonomous sub-system to the pollution control unit is the PV powered meteorological system installed in Chisinău / Moldova. The block diagram of this system is depicted in **Figure 4**. Such a station is not only required in combination with a pollution control unit but can also be applied as a stand-alone system in other sectors, such as the agriculture. The main goal was to provide a complete and autonomous system which can easily be maintained and which can be offered at competitive costs in the central European marketplace.

3. EMERGENCY SIGNAL REPEATER FOR ALPINE RESCUE SERVICE

Tourism in the alpine regions is increasing in central European countries, while the technology for a reasonable rescue service which is absolutely essential, is based on a non-profit organisation, SALVAMONT, and basic rescue equipment is missing. Emergency calls in alpine touristic resorts of Romania can be transmitted

via portable transmitters but the range is dictated by the geographical conditions. A signal can only be detected in case that the sender is in a visible distance to the receiver station. Therefore the action radius is considerably limited. To overcome this problem it was decided to install an autonomous signal repeater station on a remote peak of the Predeal mountains.

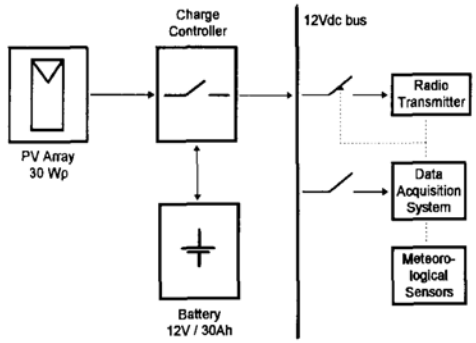

Figure 4. Sub-system to the pollution control unit. A PV powered meteorological station (Location: Chisinău / Moldova).

The emergency signal repeater station was designed in a way to allow a full operation of the system even during winter time. Its block diagram is shown in **Figure 5**.

Its control unit comprises the following features which shall help to detect critical situations and shall avoid total system failures:

1. Regular coded signals are periodically sent to the base station to signalise that the system is operational
2. 'Code I' is sent to the base station to signalise a low state-of-charge of the battery
3. 'Code II' is sent to the base station signalising a high 'loss of load probability' during the next future

This system significantly increases the action radius for mountain rescue of the SALVAMONT team and, provided a reliable operation can be demonstrated, it will create a demand for PV powered emergency signal repeater stations in Romania. **Figure 6** shows the building in the Bucegi mountains high above the resort Predeal, where the complete emergency signal repeater station was installed. It was chosen particularly for its favourable position for signal transmission - it dominates the valley from that point.

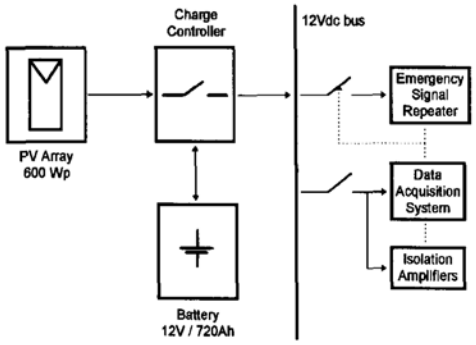

Figure 5. PV powered emergency signal repeater for the alpine rescue service (Location: Predeal / Romania).

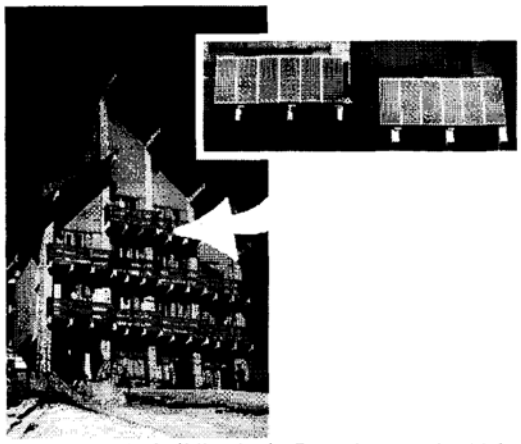

Figure 6. The building in the Bucegi mountains high above the resort Predeal, where the complete emergency signal repeater station was installed. Today it carries the PV array of the emergency signal repeater station.

4. ACKNOWLEDGEMENT

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