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Parameter Logging & Remote Monitoring for Microgrid Demonstration Project

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***Abstract*—As an element of research initiative to aid the prospective smart grid issues and to integrate green energy facilities lucratively a demonstration project "Design & Development of Smart Micro- Grid" is being executed in Energy Center, Maulana Azad National Institute of Technology (MANIT), Bhopal. In view of the fact that most renewable sources are intermittent in nature, their integration into the power grid infrastructure is a challenging task which is envisaged to be effectively carried through micro grids. Real time Data Acquisition from renewable energy generators and their monitoring play an extremely important role in overall supervision and the desired coordinated operation control of such diverse energy resources. The main idea of this paper is to present a continuous remote monitoring system for renewable energy sources which is one amongst the significant footsteps taken for accomplishment of the microgrid Research & Development project. It is a PC-based monitoring system able to measure remotely the real-time data of various renewable energy sources and generate reports as tables and graphs. The user may well monitor and display the data remotely by using the local area network through specific software.**

Keywords—Data logging, Micro Grid, Remote Monitoring, Renewable Energy Sources.

I. INTRODUCTION

As well known today, Micro-Grids with renewable energy sources compose a new form of a power system, which belongs to the wider concept of Smart grids, and are becoming a remarkable part of the power system organizations. It is envisioned, in the not too distant future, that existing grid evolution towards the smart grid will emerge as a system of organically integrated intelligent micro-grids having all-encompassing visibility with command-and-control functions distributed across the levels. On the other hand Micro-grids are proving to be an ideal solution to rural electrification, electrical power service to communities with lean populations ranging up to five hundred households besides its very well use in industrial parks, commercial, institutional campus etc. A micro grid with local profuse renewable energy sources facilitate small communities to take control of their energy use and diminish their carbon footprint through a new and innovative way of generating and managing electricity [1].

In the past decade the majority of micro grids had been only as pilot projects or research-related experiments, but such is not going to be the case in near future since whole power system is growing smarter very fast specially in the developed countries. Extensive RD&D efforts are in progress in the developing countries also to provide efficient solutions and to demonstrate microgrid operating concepts in laboratories and in pilot installations. The same is the motivation behind this microgrid demonstration project [2].

In renewable energy sources applications Data-acquisition and monitoring systems are essentially used for collecting data regarding the installed system performance and for many evaluation purposes. In this paper, the development of a computer based system for renewable energy systems monitoring has been described. It is a PC-based monitoring system able to measure, monitor and display remotely the real-time data including wind turbine voltage, current and power, PV array voltage, current and power, grid voltage, current, power and energy, solar irradiance, wind speed and wind direction, ambient temperature, cell temperature and relative humidity. It can generate reports as tables and graphs. The user could monitor remotely by using the local area network through specific software. The monitoring frequency may be of every day, and the system is able to report the result daily, monthly, or yearly as desired. [3]

II. PROJECT DESCRIPTION

A distributed renewable energy generation based prototype micro grid system has been developed. the demonstration microgrid system consists of 1 kW grid-connected solar PV arrays and a 1 kW wind energy system charging four battery storage sets of 12 V, 65 Ampere hour each by means of appropriate battery chargers. The battery bank is used for short-term energy storage due to its high charging-discharging efficiency, and also to take care of the effects caused by instantaneous load and wind energy peaks.

This hybrid energy cluster is interconnected to the electric grid through individual grid-connected-type inverters through which the load is supplied.

A. RENEWABLE ENERGY INTEGRATION MICROGRID MODEL

This project has been placed in the Power Conversion Laboratory of Energy Centre, MANIT, Bhopal. The electricity generated by this renewable energy system is used as an input for essential lights in each faculty room, laboratories and corridor lighting of the energy centre. A Renewable Energy demonstration micro grid has been thus designed by connecting these sources synchronized in parallel to the power grid. Actual configuration of the RES DC microgrid system setup under consideration is shown in Fig. 1. The setup

diagram also expresses the computer based communication and data logging of various parameters of the system through software and its remote monitoring.

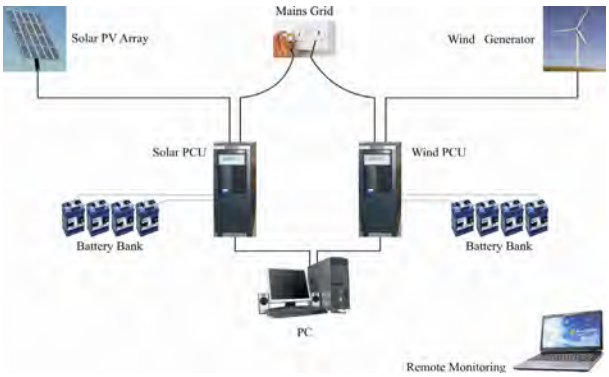

Fig. 1. Renewable Energy Micro Grid System with Remote Monitoring PC

This figure is to emphasize the DC bus configuration of the microgrid at 48 V dc.

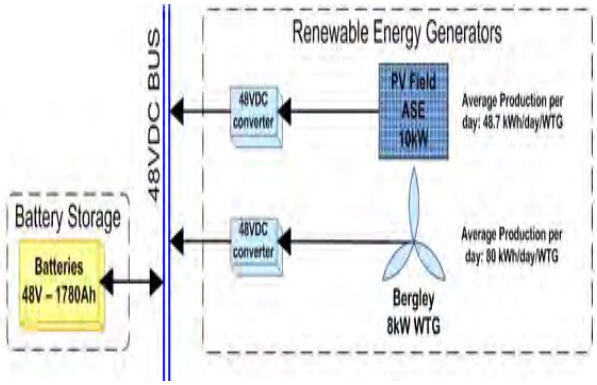

Fig. 2. DC bus configuration at 48 V for the microgrid.

B. Power Conditioning Units (PCU)

The system hardware essentially includes grid connected Power Conditioning Units separately for the two intermittent renewable sources, Solar Array and Wind Generators. The Solar PCU is connected with the output of the Solar Arrays and the Wind PCU with output of the Wind Generator. Both these PCUs work on nominal 48 VDC inputs. Each Power Conditioning Unit Inverter thus has Grid input, the renewable Generation input, Battery input/output and AC output.

The PCU specifications are as follows:

Inverter type - Unidirectional

Input DC voltage - 48 V for 1 KW (Nominal)

Input from Solar /Wind- 40 to 88 V for 1 KW

Output AC voltage - 230 V +/- 1 % (Grid synchronization operation)

Output frequency - 50 Hz +/- 3 Hz (Grid synchronization operation)

Power Conditioning Unit actually is a single phase output, unidirectional inverter system, a Grid Connected Inverter operating in parallel to the grid. Whenever grid voltage and frequency goes beyond the operating range, the same will be disconnected from the grid and inverter becomes off. The PCU unit comprises of the following sections:

Inverter controller board

DC to DC converter board

Inverter Power board

Feedback & relay board

Keypad & display board

For data communications from PCU to a personal computer (PC) the Communication Cables are connected in between RS232 port of the PCU and the PC. The LCD displays the device status shows different parameters like Input Voltages from Grid, PV/Wind generator, Battery Voltage, Current of PV/Wind, Battery Current, Load Current, Output Voltage.

C. Battery Bank & Load

In the existing setup, 4 nos. of 65 AH Sealed Maintenance Free Batteries of Rating 12 V, 65 AH are used with each PCU. The PCUs are designed for 48 VDC input, therefore these 4 SMF Batteries are connected in series to form a Battery Bank of 48 VDC. Battery Bank is connected with both the PCUs for backup power when both inputs from Solar as well as Wind do not generate suitable power to run the load. Battery charging is maintained by the PCUs and the same is powered by any of the renewable source, if available in excess to the load or through the grid power, if available.

Load is connected to the RES through output of the PCUs. The output power is maintained by PCUs depending on the availability of inputs from any of the renewable source or Grid or at last Battery Bank. The PCUs are programmed in such a manner to select the battery bank as the last option being the stored power.

III. Data Logging & Display

When considering the utilization of any energy resource may be a solar electric photovoltaic (PV) system or a wind energy generation system, it is first important to assess how much energy the system can produce according to the site location, direction, climate, plant equipment quality, plant conversion efficiency etc. To make sure an energy resource generates continuous sufficient power requires monitoring of its performance around the clock. That can only be done through use of a real-time performance monitoring system. [1] Figure 3 shows the Setup of Solar & Wind PCUs with Grid, battery bank behind & personal computer (PC) for data Logging in the Power Conversion Laboratory of Energy Centre, MANIT, Bhopal.

After confirming all the connections with PCUs i.e. from

the Solar & Wind Generator, available Grid, Battery Bank and communication cable and ascertaining the firmness of the connections, the PCUs are switched ON. Load is also switched ON and the software in the PC identifies the parameters.

Fig. 3. Setup of Solar & Wind PCUs with Grid & PC for data Logging

Both Solar and Wind PCUs have the communication port available for transferring data to a personal computer (PC). RS 232 port is available with both PCUs. Separate Communication cable is connected in between RS232 port of the PCU and PC. When the software for data logging and monitoring is installed and run on the connected PC, the data is transferred from PCU to PC in PCU -MON software.

The setup of communication with PC and software for data logging is done in such a way to receive the data at the selected interval. The logged data are saved in log file, which is available for monitoring and analysis at any time. The data can be logged continuously for day / months together.

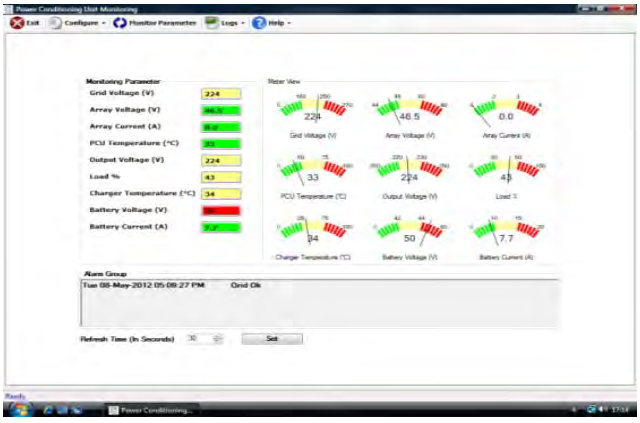

Fig. 4. Communication with PC and software for data logging

IV. System Software PCU- MON For Data Logging

PCU Monitoring (PCU MON) application Software for Windows operating system is used. This system monitors various parameters of the PCU. The monitoring can be done through Serial port or Ethernet. PC Side Data and Alarm logs are also available to track the history.

After proper installation of the PCU Monitoring Software, the PCUs are connected to the PC through RS 232 serial port. Once PCUs are connected to the PC, and setting up the com port, the Monitor Parameter action is selected by default. Date, Time, alarm, refresh rate etc can be configured manually. On this screen user can monitor current values of PCU parameters in Monitoring and Meter View. System generated alarm are available in alarm window. Time interval at which the software sends the queries to PCU for parameter monitoring is settable from 1 to 50 seconds.

The software can be configured either in Parameter or in Logger mode. From these parameters for monitoring and meter view can be selected along with the range of their measurement. In data log mode, measured parameters are recorded & file size limit in MB in the range of 1MB to 20MB. Once the data log file limit is exceeded the system will take backup of current file will generate new one. Figure 5 shows how the parameters can be selected for logging & display.

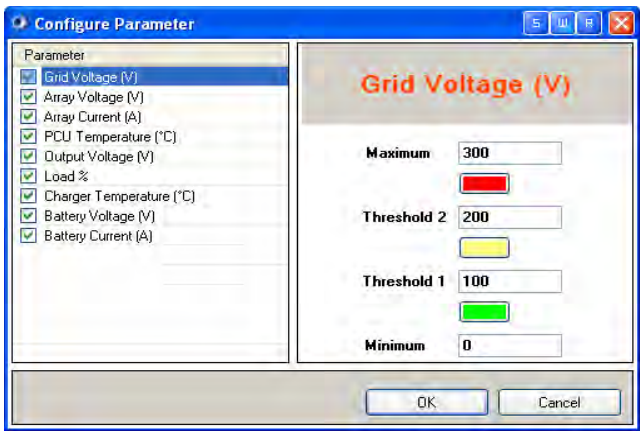

Fig. 5. Parameters Selection for Logging & Display.

As soon as the PCU MON software is run switched into Monitor Parameter mode, it will log data on PC side as per set Logging interval. As per the log interval it will fetch current status of parameter and appended in existing default file. Logged data can be viewed in the tabular form as well. Figure 6 shows the data in tabular format.

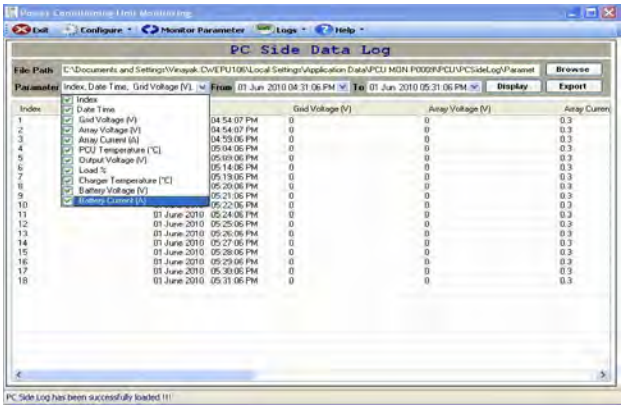

Fig. 6. Data in tabular format

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can be selected along with the range of their measurement. In data log mode, measured parameters are recorded & file size limit in MB in the range of 1MB to 20MB. Once the data log file limit is exceeded the system will take backup of current file will generate new one.

V. Remote Monitoring Software

Remote monitoring facilitate in probing the condition and status of all the linked sources of a system. Apt management of power can be done utilizing the remote monitoring of the

generated and stored parameters. If it is observed that any of these connected sources are not functioning well immediate remedy can be done at site before the situation worsen. By the real-time monitored data the operator can appraise the system current states and make decisions to take an immediate action if desired. The system can be enhanced by learning from monitored data recorded. Moreover the system itself can forecast and make a decision for future power analysis [4].

Team Viewer Software, Free License Version 7.0 for non commercial use has been used for Remote Monitoring. This Software is downloaded through the internet and installed in PC's at both ends. After its installation, the PC on which PCU's are connected acts as host PC and the other as remote PC. This software is run on the host PC thereafter the same process is repeated on the remote PC. The host PC generates a unique identification number and while connecting to the remote PC the same unique number is given to remote PC. In this way the remote PC is connected to the host PC and the screen of the host PC is displayed on the remote PC thus the host PC operation is enabled through remote PC.

The logged data and the PCU MON software can now be operated through remote PC and transferring of data can be done from host PC to the remote PC. This can be done with the remote PC from anywhere in the world using internet. [5].

VI. Experimental Results

All these logged data are recorded in the tabular form also which can be seen when log button is clicked.The data can be recorded in excel or csv format.

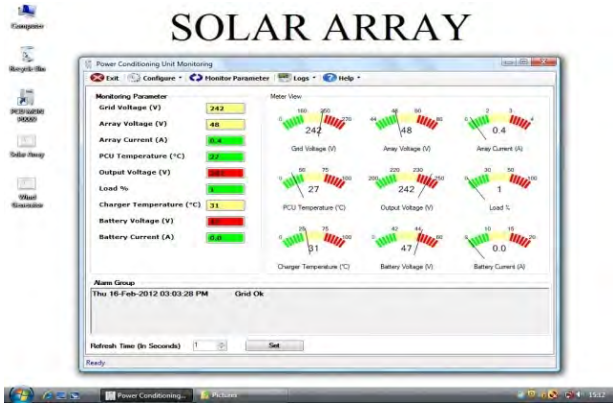

Fig. 7. Monitoring of Solar Array Parameters

Following parameters are recorded with date & time: Grid Voltage, Array Voltage, Array current, PCU Temperature, Output Voltage, Load in percentage, Charger Temperature, Battery Voltage & Battery Current. The update rate of these data depend upon the time set in sec or minutes.

The Fig 7 shows meter view of the parameters logged by the Solar PCU and similar is for the Wind PCU. Along with the meter view, the numerical readings of the parameters are also displayed in the Table at right hand side of the meters. This screen also shows date & time and refreshes rate set by the user. All these logged data are recorded in the tabular form also which can be seen when log button is clicked Fig 8.

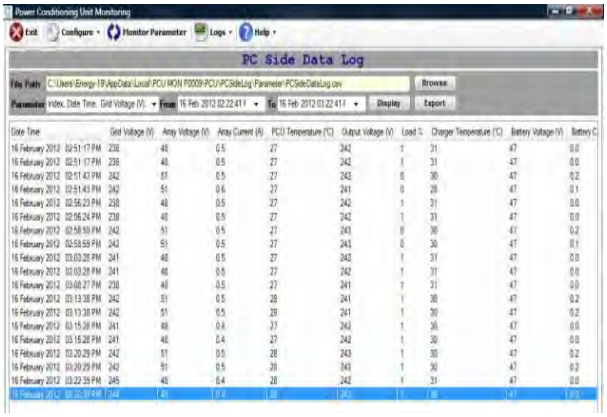

Fig. 8. The Logged Data in the Tabular Form

PC side Data Logging of Monitored Parameters in PCU MON Software in tabular form is shown in Figure 9.

The logged data can now be analyzed and represented in different forms. In the similar way, graphical representation of other logged parameters are also displayed like Battery Current with Time, Array Current data with Time, Load Variation data with Time, etc. All these data and screens can also be seen on remote PC through Team Viewer Remote Monitoring software.

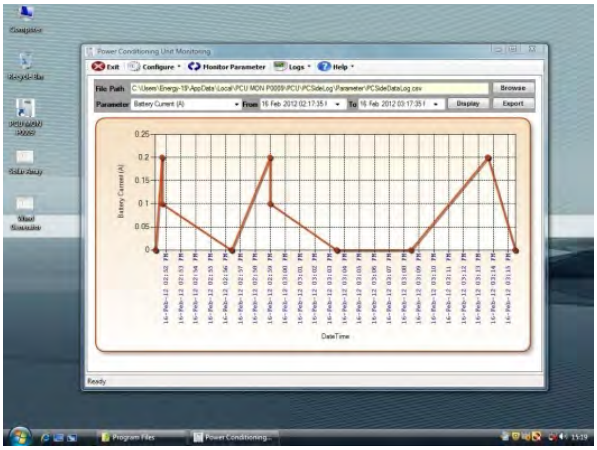

Fig. 9. Graphical Representation of Battery Voltage with Time.

VII. CONCLUSIONS

This paper has reported regarding initial phase experiments of the research project Design & Development of a Smart Micro Grid which is data acquisition and remote monitoring of various renewable energy sources. Data acquisition from PV-Wind energy sources has been done successfully by deploying PCUMON software along with the grid connected power conditioning units PCU hardware. Remote monitoring of the logged parameters is done using an internet based complete remote monitoring tool named Team Viewer software. The set up helps to analyze activities on wind-solar hybrid power systems, grid-tie interaction, and investigation of ac/dc interactions between conventional and renewable energy systems. All these logged data are recorded in the tabular form also and can be analyzed and represented in different graphical forms too as has been effectively shown in the experimental results. The remote data monitoring system provides a round the clock information on the Grid Voltage, PV/Wind generator Voltage, Battery Voltage, Current of PV/Wind, Battery Current, Load Current, Output Voltage, PCU Temperature, Charger Temperature etc. The system has been programmed to provide data logging for assessment of the system condition.

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