A Complete Automation of Grid Tied Roof Top Solar 11kV Substation at GNDEC, Bidar

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Abstract— With increase in population, the demand for electricity is increasing tremendously and leading to complexity in the power system. In which, substation has the critical role in the power system because it is subsidiary station of an electricity generation, transmission and distribution system. As the power consumption increases, unprecedented challenges are being faced which require modern, sophisticated methods to control and maintain them. This calls for the use of automation in the power system. The Supervisory Control and Data Acquisition (SCADA) and Programmable Logic Controller (PLC) are answer to this. SCADA refers to the system that enables on electricity utility to remotely monitor, co-ordinate, control and operate transmission, distribution and maintenance. PLC is like brain of the system i.e., PLC is a medium between electrical system and personal computer for software to take database. With the co-operative operation of the SCADA and PLC, it is possible to control and operate the power system remotely. To reduce the gap between generation and demand, Rooftop Solar Power Plant is used as alternate source of energy. The model is proposed for college 11KV Substation at GNDEC, Bidar with grid tied 100 kW solar roof top power plants. Various tasks like determining oil level, thermal stability, moisture content, loading, overvoltage, under voltage, overcurrent and maintenance schedule in Transformers, Generators and Solar Power Plant using sensors. This type of automatic network can manage load, maintain quality, and detect theft of electricity and tempering of meters. It gives the operator an overall view of the entire network.

Key words: Supervisory Control and Data Acquisition (SCADA), Programmable Logic Controller (PLC), Rooftop Solar Power Plant

I. INTRODUCTION

Electrical Power Systems are a technical wonder. Electricity and its accessibility are the greatest achievements of the 20th century. A modern society cannot exist without electricity. A substation is a place where high voltage electricity from power plants is converted to lower voltage electricity for homes or factories. Substations form a very important part in the transmission and distribution of electrical power system. The main function of the substation is to receive energy transmitted at high voltage from the generating station to a value appropriate for local distribution and provide facilities for switching.

As the demand for electricity is increasing day by day, unprecedented challenges are being faced. This calls for the use of automation in the power system. The SCADA and PLC are an answer to this. SCADA stands for Supervisory Control and Data Acquisition. As the name indicates, it is not a full control system, but rather focuses on the supervisory level. It is used to monitor or control the power plant. The control may be automatic or initiated by operator commands.

PLC (Programmable Logic Controller) is a digital computer used for the automation of various electromechanical processes in industries. PLC consists of a microprocessor which is programmed using the computer language. The program is written on a computer and is then loaded into the PLC via communication cable. These loaded programs are stored in the non-volatile memory of the PLC. With the joint operation of PLC and SCADA, it is possible to control and operate any power system remotely.

II. COMPONENTS REQUIRED

This chapter includes the hardware and the software tools used for the implementation of the project.

1) Control Kit
- Toggle Switch.
- SMPS (Switch Mode Power Supply)
- Panel Led Lighting

2) Buzzer

A. Control Kit

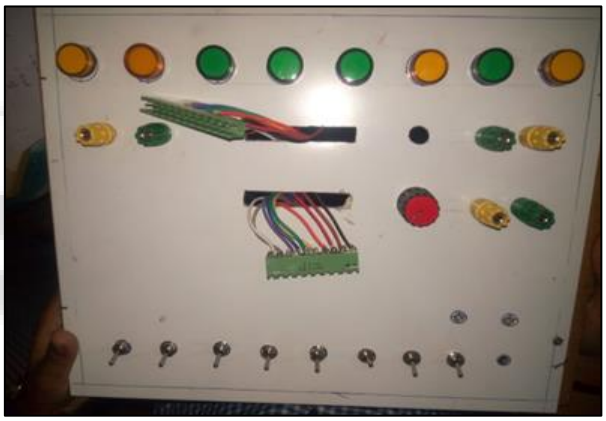

Fig. 2.1: Control Kit

The SCADA system uses different switches to operate each device and displace the status at the control area. Any part of the process can be turned ON or OFF from the control station using these switches. SCADA system is implemented to work automatically without human intervention but at critical situations it is handled by man power. A typical control kit used here consists of toggle switches, LED lights, SMPS and connecting wires.

1) Toggle Switch

Fig. 2.2: Toggle Switch

A toggle switch is a class of electrical switches that are manually actuated by a mechanical leveller, handle or rocking mechanism. Toggle switches are available in many different styles and sizes and are used in numerous applications. Many

are designed to provide the simultaneous actuation of multiple sets of electrical contacts or the control of large amounts of electrical current or mains voltages.

The word "toggle" is a reference to a kind of mechanism or joint consisting of two arms, which are almost in a line with each other, connected with an elbow-like pivot. However, the phrase "toggle switch" is applied to a switch with a short handle and a positive snap action, whether it actually contains a toggle mechanism or not. Similarly, a switch where a definitive click is heard is called a "positive ON-OFF switch". Multiple toggle switches may be mechanically interlocked to prevent forbidden combinations.

Switches are the devices that create a short circuit or an open circuit depending on the position of the switch. For a light switch, ON means short circuit (current flows through the switch, lights light up and people dance). When the switch is OFF, that means there is an open circuit (no current flows, lights go out and people settle down. This effect on people is used by some teachers to gain control of loud classes). When the switch is ON, it looks and acts like a wire. When the switch is OFF, there is no connection.

2) SMPS (Switch Mode Power Supply)

Fig. 2.3: Switch Mode Power Supply

A Switched Mode Power Supply is an electronic power supply that incorporates a switching regulator to convert electrical power efficiently. Like other power supplies, an SMPS transfer's power from source like mains power, to the load, such as PC, while converting voltage and current characteristics. Unlike a linear power supply, the pass transistor of a SMPS continually switches between load dissipation full- on and full-off states and spends very little time in the high dissipation transitions, which minimizes wasted energy. Ideally, SMPS dissipates no power. Voltage regulation is achieved by varying the ratio of on-to-off time.

Switching regulators are used as replacements for linear regulators when higher efficiency, smaller size or lighter weights are required. They are, however, more complicated: their switching currents can cause electrical noise problems if carefully not suppressed and simple designs may have a poor power factor.

3) Panel Led Lighting

Fig. 2.4: Panel LED Lights

Light emitting diodes are great for projects because they provide visual entertainment. LEDs use a special material which emits light when current flows through it. Unlike light bulbs, LEDs never burn out unless their current limit is passed. A current of 0.02 A (20mA) to 0.04A (40mA) is good range for LEDs. They have a positive leg and a negative leg just like regular diodes. To find the positive side of an LED, look for a line in the metal inside the LED. It may be difficult to see the line. This line is closest to the positive side of the LED. Another way of finding the positive side is to find a flat spot on the edge of the LED. These flat spot is on the negative side.

When current is flowing through an LED, the voltage on the positive leg is about 1.4V higher than the voltage on the negative side. It has high brightness panel LED indicators light in various colors like red, green, and yellow, blue.

B. Buzzer

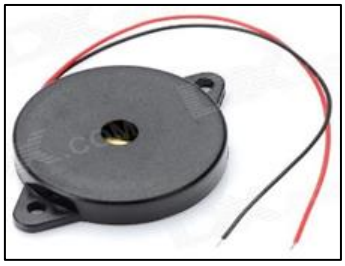

Fig. 2.5: Piezo Electric Buzzer

A Buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical or piezoelectric. Typical uses of buzzers include alarm devices, timers and confirmation of user input such as a mouse click or keystroke.

The above figure 2.5 shows a very commonly used piezo buzzer also called as piezo transducer operating at DC voltage. Encapsulated in a cylindrical plastic coating, it has a hole on the top face for sound to propagate. Piezo buzzer is based on the inverse principle of piezo electricity. It is the phenomena of generating electricity when mechanical pressure is applied to certain materials, known as piezo electric materials. These materials stretch or compress when subjected to alternating electric field, in accordance with the frequency of the signal thereby producing sound.

III. WORKING

Guru Nanak Dev Engineering College 11kV substation consists of a 500kVA transformer, two 125kVA Diesel Generators and a 100kW rooftop solar power plant installed on electrical science block. The power supply from the State Electricity Board is fed to net meter and then to 500kVA transformer. The transformer used here is a step-down transformer which steps down the voltage from 11000V to 433V. This voltage is given to the Main Distribution Board and is then used to satisfy the various loads of the college. The generators are connected to the Main Distribution Board panel. Solar panels are installed on the rooftop for satisfying the load demand of Electrical Science Block. These solar panels produce DC voltage which is converted to AC using an Inverter. On an average, 400 units of power are generated per day if extra power is generated through this, then that is given to the Main Distribution Board to feed the other loads

of college or else is directly given to the State Electricity Board. To monitor and maintain various components manually becomes difficult, hence by using PLC and SCADA monitoring and maintenance of 11kV substation becomes easy and effective. The PLC is programmed according to the college substation working. PLC includes a number of inputs and outputs to sense, activate and control various equipments. In PLC programming, we have four sub programs i.e., Main, Transformer, Generator and Solar. This PLC program is interfaced with SCADA software through which all control operations are performed and the status of the equipment is visualized on the SCADA screen through the Personal Computer. The PLC operates on ladder logic programming designed by the operator. As the PLC is interfaced with SCADA software, all the equipment's are operated from the SCADA screen. When we select auto-mode, the transformer and solar are in operating condition, and generator will operate automatically after the transformer failure. We are controlling three parameters of transformer i.e., oil level, moisture and over loading. The oil level should be greater than 80% as the limit is set. If the meter's value decreases, to take corrective action the buzzer will ON. The over loading due to overload in the secondary side of distribution transformer, as the load increases above 85%, the buzzer will be ON. For generator, we set the limit in PLC ladder diagram for fuel 100 and for temperature 0. As the fuel decreases, temperature increases or vice versa as they are inversely proportional. The buzzer will ON if the fuel decreases or temperature increases for cooling. The CV format table is used to display the runtime of the generator from local disk C. All the parameters which are being controlled can be monitored in real time trends.

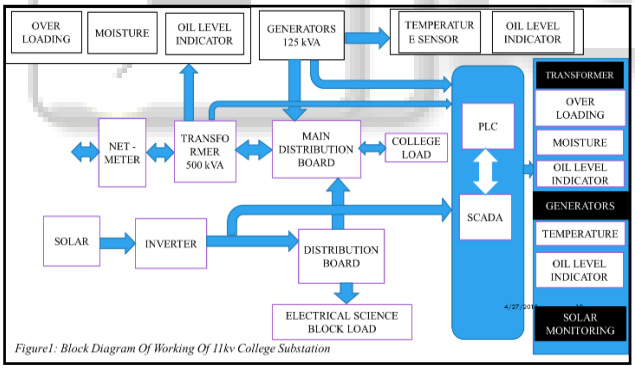

Figure1: Block Diagram Of Working Of 11kv College Substation

IV. RESULTS

Figure 4.1: Main Window

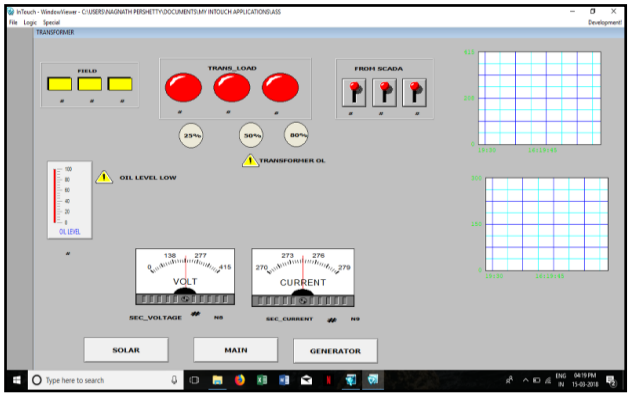

Fig. 4.2: Transformer Window

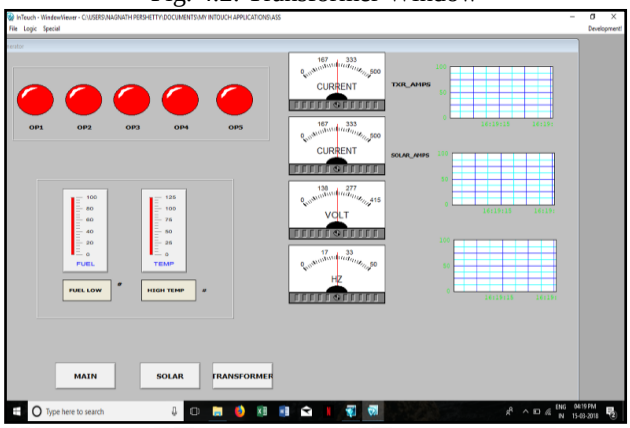

Fig. 4.3: Generator Window

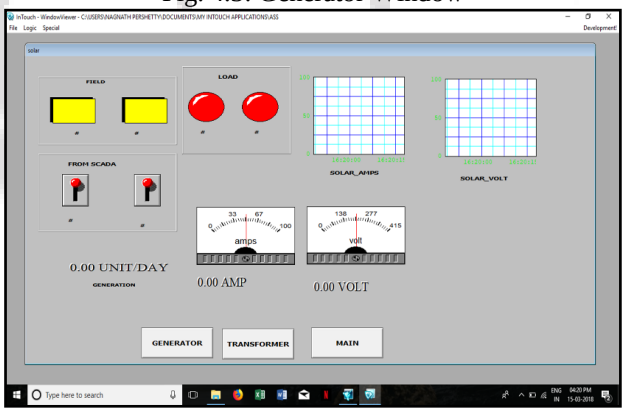

Fig. 4.4: Solar Window

V. ADVANTAGES & DISADVANTAGES

A. Advantages

1) Reduction in Production Time

Having a machine that is automated definitely speeds up the production time since no thinking is needed by the machine; there is better repeatability, and less human error.

2) Increase in Accuracy & Repeatability

When an automated machine is programmed to perform a task over and over again, accuracy and repeatability compared to an employee is far greater.

3) Less Human Error

No one is perfect, and we all are prone to making mistakes. This is why a machine that performs repeated tasks is less likely to make mistakes than an employee.

4) Less Employee Costs

By adding automated machines to an operation, means less employees are needed to get the job done. It also indicates less safety issues, which leads to financial savings. With having fewer employees, there are numerous costs that are diminished or reduced such as payroll, benefits, sick days, and etc.

5) Increased Safety

Having automated machines means having less employees who performs tasks that can be dangerous and prone to injury, which can make the work environment safer.

6) Higher Volume Production

Investing in automated equipment creates a valuable resource for large production volumes, which in turn, will increase profitability.

B. Disadvantages

1) Less Versatility

By having a machine that can perform a certain task limits to the flexibility and the variety of tasks that can employee could do.

2) More Pollution

Different types of machines operate using motor which may require or chemicals in order to operate. This can cause an increase in pollution in the workplace.

3) Large Initial Investment

Automated machines can be one of the most costly operating costs for a company. With automated machines running anywhere between thousands and millions of dollars spending on the type and degree of automation.

4) Increase in Unemployment

By increasing the amount of automation, there are fewer employees required causing high employment rates.

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