ABSTRACT

Sustainable development can be broadly defined as living, producing and consuming in a manner that meets the needs of the present without compromising the ability of future generations to meet their own needs. It has become a key guiding principle for policy in the 21st century. Worldwide, politicians, industrialists, environmentalists, economists and theologians affirm that the principle must be applied at international, national and local level. In the international context, the word ‘development’ refers to improvement in quality of life, and, especially, standard of living in the less developed countries of the world. The aim of sustainable development is for the improvement to be achieved whilst maintaining the ecological processes on which life depends. Energy resources exemplify these issues. Reliable energy supply is essential in all economies for lighting, heating, communications, computers, industrial equipment, transport, etc. Purchases of energy account for 5–10% of gross national product in developed economies. However, in some developing countries, energy imports may have cost over half the value of total exports; such economies are unsustainable and an economic challenge for sustainable development. World energy use increased more than tenfold over the 20th century, predominantly from fossil fuels (i.e. coal, oil and gas) and with the addition of electricity from nuclear power. In the 21st century, further increases in world energy consumption can be expected, much for rising industrialization and demand in previously less developed countries, aggravated by gross inefficiencies in all countries. Whatever the energy source, there is an overriding need for efficient generation and use of energy.

Energy in different forms is the gift of the nature to the mankind. Dwindling fossil fuel resources and the adverse environmental effects arising from converting conventional resources into energy have placed increasing focus on the use of non-fossil fuel energy sources such as solar energy, wind energy, bio mass, bio-fuels etc. In recent days solar energy is becoming an important source of energy and has been accepted as a universal source of renewable energy because it is abundant, inexhaustible and absolutely clean. With ever growing population, improvement in the living standard of humanity, industrialization of developing countries like India, the demand for energy has increased. India is facing power deficiency for decades and the situation is likely to continue for quite some time. The supply and the demand of energy determine the course of global development in every sphere of human activity.
The progress of a country is evaluated on the basis of its power utilization in order to meet the prospective development in the industrial and agricultural sector. With the ever growing population, improvement in the living standard of humanity, industrialization of developing countries like India, the demand for energy has increased. The supply and the demand of energy determine the course of global development in every sphere of human activity. The growing demand is fulfilled to the level by increasing the supply rate and consumption of energy that leads to the progress of a country in different aspects. The atmospheric and environmental pollution as a result of extensive use of fossil fuel exploitation in almost all human activities, has led to some undesirable phenomena such as the global warming, the green house effect, climate change, ozone layer depletion and acid rain. The release of green house gases like carbon dioxide and methane etc. to the atmosphere from fossil fuels do have an impact on the above phenomena. As the present resources of energy by conventional sources are depleting, the use of alternative sources of renewable energy sources like wind, biomass and bio-fuels are inevitable.

The detrimental environmental effects of burning the fossil fuels likewise imply that current patterns of use are unsustainable in the longer term. In particular, CO2 emissions from the combustion of fossil fuels have significantly raised the concentration of CO2 in the Atmosphere. The balance of scientific opinion is that if this continues, it will enhance the greenhouse effect and lead to significant climate change within a century or less, which could have major adverse impact on food production, water supply and human, e.g. through floods and cyclones (IPCC).

Consequently almost all national energy plans include four vital factors for improving or maintaining social benefit from energy:

1. Increased harnessing of renewable supplies
2. Increased efficiency of supply and end-use
3. Reductions in pollution
4. Consideration of lifestyle.

- Coal production in the country during the year 2011-12 was 539.94 million tones (MTs) as compared to 532.69 MTs during 2010-11, registering a growth of 1.36%
- The Lignite production during the same period increased by 12.19%.
Considering the trend of production from 1970-71 to 2011-12, it is observed that coal production in India was about 72.95 MTs during 1970-71, which increased to 539.94 MTs during 2011-12, with a CAGR of 4.88%.

During the same period the CAGR of Lignite was about 6.20%, with production increasing from 3.39 MTs in 1970-71 to 42.33 MTs in 2011-12.

Production of crude petroleum increased from 6.82 MTs during 1970-71 to 38.09 MTs during 2011-12, a CAGR of about 4.18%.

The CAGRs for natural gas and electricity were 8.67% and 4.33%, respectively.

Natural gas has experienced the highest CAGR among all the conventional sources of energy.

For more meaningful comparison in the trends and patterns of growth of different energy resources, it is desirable to convert all the resources to their energy equivalents by applying appropriate conversion factors and express them in energy units (Joules/peta Joules/ Terra joules).

The total production of energy from conventional sources increased from 17,857 peta joules during 2010-11 to 18,734 peta joules during 2011-12, showing an increase of 4.91%.

The production of energy in peta Joules by primary sources shows in fig.2 that Coal and Lignite were the major sources of energy, accounting for about 50.23% of the total production during 2011-12. Electricity was second (31.48%), while Natural Gas (9.78%) was third.

The growing demand is fulfilled to the level by increasing the supply rate and consumption of energy that leads to the progress of the country in different aspects. With India’s GDP growth keeping 6-8 percent, the power requirement is also slated to go up at the same rate that leads to direct correlation between the growth power requirement and the GDP growth rate. As per the data published by CEA(April2012) India’s current installed power generation Capacity is 2,0137MW, of which 11,3782MW is thermal coal,18,381MW is thermal gas,11MW is diesel, 4,780MW is nuclear, 380MW is hydro and 24,503MW is through renewable sources. With the ever increasing worlds total power requirement of around 20terawatts while the solar influx coming on the planet earth figured around 1, 78,000 terawatts and present India’s total power need is 0.25terawatts which can be fulfilled to some level of extent
with the most promising methods of converting solar influx into electricity by solar photovoltaic cell.

Optimizing the use of power available from the existing public power utility system and the power generated from a solar unitary system and appropriately controlling the mix up for the best advantage of the receiving system. The control system design for the operating of the system is essential.

Photovoltaic (PV) is the field of technology and research related to the application of solar cells for energy by converting sun energy (sunlight, including sun ultra violet radiation) directly into electricity. Solar illumination can be converted into electrical energy by solar cells and the energy generated is called Photo Voltaic (PV) energy. While the sun as a source is available for free, generating PV energy involves various methods and techniques for harvesting, controlling, optimizing energy with minimum power losses and low cost. This creates an area of research to extract the maximum PV energy from the incident sunlight using the solar cells and controlling the same for optimum utilization with higher efficiency.

Researchers in the field of automatic solar charge controller unit and controlling techniques have long been concerned with the problem seasonal weather condition, conventional inefficient methodologies, harvesting and usage power losses and efficiency of the entire system. Many controllers are designed, implemented and various techniques are applied to achieve a good performance result but are proved to be required improvements. A linear charge controller is a charge controller that just senses the voltage from the solar panel and gives it to the battery. A linear charge controller does not regulate the voltage or current. It does not perform buck and boost operation. Whatever the voltage obtained from the panel is directly given to the dc load. The major drawback of this linear controller is that, it will not do any conversion operation (buck or boost the voltage) due to this there will be losses around and the efficiency drops, also battery life gets reduced and the average efficiency achieved is around 80% to 85%. Pulse Width Modulation (PWM) is the most effective means to achieve constant voltage battery charging by switching the solar system controller’s power device. Where in PWM regulation, the current from the solar array tapers according to the battery’s condition and charging needs. Extracting the maximum power and controlling the current is the difficult task and the efficiency achieved is within 80% to 90%.
While the MPPT charge controller in which MPPT (maximum power point tracker) is a technique is used to obtain maximum power from varying source. The MPPT will act as a battery charger for the solar panel. It will be designed to operate the panel at the voltage, which will extract maximum power from the panel. The major drawback of this MPPT charge controller is that uses the buck or boost converter topology which step down or step up the voltage level voltage below or above battery level and fails in case of less or greater than battery voltage under very hot and cold weather condition. The efficiency achieved around 90%.

The present research work focuses on introducing the advance technique and methodologies of harvesting, charging, protecting the batteries from the power generated by a Photovoltaic panel using a High Efficiency enabled Solar charge controller and in addition to that the complete system is evaluated and analyzed periodically by conducting tests to investigate the concept of buck-boost converter to extract the maximum power from solar panel during all weather condition and Pulse Width Modulation (PWM) technique to achieve constant voltage battery charging and protects the battery from over current, short circuit by switching the solar system controller’s power device.

The experimental study of Linear, PWM and MPPT charge controller needs many improvements required in terms self monitoring, continuous evaluation, system efficiency etc.. Depending on the topology of the power electronics, a charge controller can be either:

- **Buck only** – the PV voltage must be higher than the battery voltage
- **Boost only** – the PV voltage must be lower than battery voltage
- A linear charger that just senses the voltage from the solar panel and gives it to the battery. A linear charge controller does not regulate the voltage or current. It does not perform buck and boost operation. Whatever the voltage obtained from the panel is directly given to the dc load.

Some other problems concerned with the conventional controlling units are reverse connection, over charging and deep discharging, no extra Load protection against overloads and short-circuits irrespective of weather and load conditions. Thus a detailed investigation is essential to improve the efficiency of solar charge controller to achieve better harvesting, charging, and protecting the battery from over current and short circuit, situations.
The main Objective of the present study will be to introduce the advance technique and methodologies of harvesting, charging, protecting the batteries from a PV panel using a High Efficiency enabled Solar charge controller and in addition to that the complete system evaluation, analysis periodically and an attempt will be made to design and implement the concept of buck-boost converter based PWM with MPPT charge controller to extract the maximum power from solar panel during all weather condition and Pulse Width Modulation (PWM) technique to achieve constant voltage battery charging and protects the battery from over current, short circuit by switching the solar system controller’s power device and efficiency up to 10%-14% by implementing PWM with MPPT charge controller, if in case both the charge controllers are failed to perform the operation then the SEPIC converter come in to picture and perform the required operation of charging the battery through PWM MPPT algorithm. The Keil uvision and easy NN software’s are used to build the proposed algorithm and to evaluate the better performance result. The scope and significance of the work are as follows

- To build simple, efficient platform and is affordable compared to other charge regulators which are quite expensive.
- Experimental Study of Existing Linear and MPPT charge controller and operation and its result analysis.
- Choosing the microcontroller as per the application requirement and Study of ARM7 microcontroller and its features.
- Referenced Design and implementation of high efficiency Buck-Boost converter.
- Developing firmware for entire automatic system control unit through ARM7TDMI micro controller.
- To understand and enhance the voltage sense circuit, battery level sense and over load sense.
- The Study of Artificial Neural Network helps in applying the same technique for the Analysis of the test and experimental results.

The work has been carried out with the ideas and methodologies of various field visit to India’s first 3 MW solar power plant situated at Yalesandra village in Bangarpet taluk of kolar district, where the power generation and power flow controlling methodology has been studied. Visit to GREPI Pvt. Ltd, REI electronics Pvt .Ltd and Shimsha solar energy power plant helped in gaining knowledge about solar power
generation and harvesting. The two day training programme on ‘Functioning And Maintenance Of Solar Radiation Resource Assessment Station’ conducted by CWET was successfully completed, which helped in carrying out the research work.