Abstract - A solar tracking generating system is designed and developed. An expert controller, sensors, and input / output interface are integrated with a tracking mechanism to increase the energy generation efficiency of solar cells. In order to track the sun cadmium sulfide (CdS) light sensitive resistors are used to achieve optimal solar tracking. Solar tracking allows more energy retrieved from the sun and solar array is able to remain aligned to the sun. Solar modules are devices that cleanly convert sunlight into electricity and offer a practical solution to the problem of power generation in remote areas. This paper shows the potential system benefits of simple tracking solar system using stepper motor and light sensor. A solar tracker designed and constructed offers a reliable and affordable method of aligning a solar module with the sun in order to maximize its output (electricity).

Keywords: Field Programmable Gate Array, Micro-Controller, Renewable-Energy, Sensor, Solar-Energy, Stepper-Motor, Solar-Tracking.

I. INTRODUCTION
The green energy also called the regeneration energy, it can be recycled, such as solar energy etc, and it is the most power full resource. It can be used to generate power. The generating power of solar energy is relatively low. Thus how to increase the efficiency of generating power of solar energy is very important. The consumption of the energy is directly proportional to the progress of the mankind. Solar cells are hooked with fixed elevating angles, it doesn’t track the sun and the efficiency of power generation is low. It cannot obtain the optimal solar energy. In this paper the main goal is to design and implement of 10KVA solar tracking control system using field programmable gate array (FPGA). The CdS light sensitive resistors are used. The paper continues with specific design methodologies pertaining to photocells, stepper motors and drivers, micro controller selection, voltage regulation physical construction and a software system operation explanation. The paper concludes with a discussion of design results.

II. LITERATURE REVIEW
Solar Technology isn’t new. Its history spans from the 7th century B.C. [1] to today. In 1954 photo voltaic Technology is born in the United States by DARY CHAPIN in Bell laboratory produced 4% of efficiency. Solar energy (or) photo voltaic energy as an alternative power because it’s free and renewable. In solar photovoltaic’s sunlight is actually converted into electricity, sunlight is made of photons, small particles of energy. Photons are absorbed and pass through the material these photons ‘agitate’ the electrons found in the material of P-V-cells, as they begin to move (or) dislodged causes ‘routed’ into a current. Solar panels made of silicon to convert such light into electricity solar electric power generation has the highest power density (Global mean of 170w/m²) among renewable Energies [2]. Solar cells produce DC which must be convert to AC. One silicon solar cell produces 0.5 volt 36 cells connected together have energy voltage to change 12Volt batteries. Solar power is pollution free during use. Solar technologies such as photo voltaic home systems portable lamps and solar mobile phone charging systems use solar power to provide affordable electrical energy to isolated communities. Solar can charge through the day using the sun’s rays and provide hours of light after dark. In most rural places in the developing world there is no electrical supply at night to light up homes, streets, schools and hospital. Solar power can also be used to run other pieces of equipment such as computers and refrigerators, benefits of solar energy is energy independence, environmentally friendly, fuel is already delivered free everywhere, Minimal Maintenance, Max reliability, reduce vulnerability to power loss, systems are easily expanded. It can also be used for tunnels [3] and street lighting, emergency rescue, building of power complementary and be used as standby power of financial services, airports, locks and other special places, and zero carbon emissions. Automatic tracking rotation system composed of motor, gear reducer devices and even the shaft mounting brackets, etc. It carries solar panels arrays and tracks the sun path, power inverter, grid and off-grid inverter, converted photovoltaic voltage into AC. PV controller and battery, use of off-grid system, control the battery charging, discharge, and off-grid inverter power to the load. Environmental monitoring instrument and environmental testing communication instrument can provide environmental parameters for control systems.

III. DESIGN & DEVELOPMENT
Development of Fixed Panel, Tilting Panel, (Integrated With Stepped Motor)

A typical solar tracking PV system [4] must be equipped with two essential features. (a) Azimuth tracking for adjusting the tilt angle of the surface of the PV array during changing seasons, and (b) daily solar tracing for maximum solar radiation incidence to the
PV array. The Tilt Angle  $\theta$ of a PV system required at any given time in the year can be expressed as a function of the seasonal sun’s altitude $\varphi$ as follows, Tilt angle  $\theta = 90^\circ - \varphi$

![Tilt Angle Θ of A PV Array](image1.png)

**Fig 1: Tilt Angle Θ of A PV Array**

PV Array: The PV Array (Figure 2) is composed of 16 modules MM0230-IH by MICROSOL, each one with a peak power of 230W, in such a way that the total power is 4140Wp under the standard test conditions (STC). The 44 panels are arranged in 4 groups connected in parallel. Each group is formed connecting 8 panels in series, resulting in an average output voltage of 266V and an average output current of 29A, both values being related to the maximum power point (MPP). The PV generator is mounted on a structure fixed on the ground, which joins all the modules in only one array and maintains an inclination of 35° [5-6] with respect to the horizontal plane and a southwards orientations, optimizing the production over all the year.

![The Picture of Solar Tracking System Placed By a Large-Scale Fixed Angle Type System](image2.png)

**Fig 2: The Picture of Solar Tracking System Placed By a Large-Scale Fixed Angle Type System**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Module</th>
<th>Sub-array</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated power</td>
<td>230Wp</td>
<td>1260Wp</td>
<td>10120Wp</td>
</tr>
<tr>
<td>Total number of modules</td>
<td>1</td>
<td>4</td>
<td>44</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>-40 to</td>
<td>85°C</td>
<td></td>
</tr>
<tr>
<td>Open circuit voltage</td>
<td>53v</td>
<td>318v</td>
<td></td>
</tr>
<tr>
<td>MPP voltage</td>
<td>44,4v</td>
<td>266v</td>
<td></td>
</tr>
<tr>
<td>Short Circuit Current</td>
<td>5.25A</td>
<td>21A</td>
<td></td>
</tr>
<tr>
<td>MPP current</td>
<td>4.73A</td>
<td>18,92A</td>
<td></td>
</tr>
<tr>
<td>No of Modules in Series</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface, m²</td>
<td>1,5688</td>
<td>9,4128</td>
<td>37,6512</td>
</tr>
<tr>
<td>Scope</td>
<td>35°</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 1: Main Characteristics of the PV Array**

![General View of the Fixed Panels PV Array](image3.png)

**Fig 3: General View of the Fixed Panels PV Array**

![Stepper Motor with Tilting Panels](image4.png)

**Fig 4: Stepper Motor with Tilting Panels**

![Stepper Motor & Solar Tracking System](image5.png)

**Fig 5: Stepper Motor & Solar Tracking System**
A stepper motor (or) step motor is a brushless, synchronous electric motor that can divide a full rotation into a large number of steps. The motor's position can be controlled precisely, without any feedback mechanism. Stepper motors are similar to switched reluctance motors (which are very large stepping motors with a reduced pole count, and generally are closed-loop commutated).

Fig 6: Stepper Motor Characteristics
1. Stepper motors are constant power devices.
2. As motor speed increases, torque decreases.
3. The torque curve may be extended by using current limiting drivers and increasing the driving voltage.
4. Steppers exhibit more vibration than other motor types, as the discrete step tends to snap the rotor from one position to another.
5. This vibration can become very bad at some speeds and can cause the motor to lose torque.
6. The effect can be mitigated by accelerating quickly through the problem speeds range, physically damping the system, or using a micro-stepping driver.
7. Motors with a greater number of phases also exhibit smoother operation than those with fewer phases.

The battery bank is mounted in the same container of the control units and the inverter, but in a separate and conditioned room, in order to guarantee the safe operation of the electric equipments as can seen in the figure7.

Fig 7: The Battery Storage Unit

IV. RESULTS AND DISCUSSION

By integrating the fixed panels and tilting panels with stepped motor, the result is we obtained 10KVA and it is utilizing for to run, 40 systems, 80, small tube lights and also 4 fans in CAD CAM Center. A solar tracker was designed and developed successfully. In terms of real value the overall cost of a system can be reduced significantly, considering that much more power can be supplied by the solar array coupled to a solar tracking device. A comparison of the efficiency of the fixed and tilted panels is given in table2.

Table 2: Results of Efficiency of Fixed and Tilting Panels

<table>
<thead>
<tr>
<th>S.No</th>
<th>Type of panel</th>
<th>Efficiency Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tilting panels</td>
<td>55%</td>
</tr>
<tr>
<td>2</td>
<td>Fixed panels</td>
<td>45%</td>
</tr>
</tbody>
</table>

V. CONCLUSION

A solar tracker is designed & developed, the new principle of using small solar cell to function as self-adjusting light sensors, providing a variable indication of their relative angle to the sun by detecting their voltage output. By using this method, the solar tracker was successful in maintaining a solar array at a sufficiently perpendicular angle to the sun. The power increase gained over a fixed horizontal array by tilting array was in excess 10-15%.

REFERENCES