PHOTOVOLTAIC SOLAR ENERGY IN EUROPA

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ABSTRACT

Solar energy refers primarily to the use of solar radiation for practical ends. However, all renewable energies, other than geothermal and tidal, derive their energy from the sun. Solar technologies are broadly characterized as either passive or active depending on the way they capture, convert and distribute sunlight. Active solar techniques use photovoltaic panels, pumps, and fans to convert sunlight into useful outputs. Passive solar techniques include selecting materials with favorable thermal properties, designing spaces that naturally circulate air, and referencing the position of a building to the Sun. Active solar technologies increase the supply of energy and are considered supply side technologies, while passive solar technologies reduce the need for alternate resources and are generally considered demand side technologies.

1. INTRODUCTION

Over the last decade, European photovoltaic companies have achieved an average annual production growth rate of over 40 %. Currently the turnover of the photovoltaic industry amounts to some EUR 10 billion. The European market is characterised by a dominant German market while other European countries – like Spain, Italy, France and Greece – have recently boosted their share. For the whole European Union (EU), approximately 70 000 people are employed by the photovoltaic sector. Although productivity in the photovoltaic industry progresses with automated production and reduced unit and system costs, the rapid market growth will create new jobs in Europe.

2. PHOTOVOLTAIC SOLAR ENERGY

2.1. Photovoltaic technology

Photovoltaic is the field of technology and research related to the devices which directly convert sunlight into electricity. The solar cell is the elementary building block of the photovoltaic technology. Solar cells are made of semiconductor materials, such as silicon. One of the properties of semiconductors that makes them most useful is that their conductivity may easily be modified by introducing impurities into their crystal lattice.

For instance, in the fabrication of a photovoltaic solar cell, silicon, which has four valence electrons, is treated to increase its conductivity. On one side of the cell, the impurities, which are phosphorus atoms with five valence electrons (n-donor), donate weakly bound valence electrons to the silicon material, creating excess negative charge carriers. On the other side, atoms of boron with three valence electrons (p-donor) create a greater affinity than silicon to attract electrons. Because the p-type silicon is in intimate contact with the n-type silicon a p-n junction is established and a diffusion of electrons occurs from the region of high electron concentration (the n-type side) into the region of low electron concentration (p-type side). When the electrons diffuse across the p-n junction, they recombine with holes on the p-type side. However, the diffusion of carriers does not occur indefinitely, because the imbalance of charge immediately on either sides of the junction originates an electric field. This electric field forms a diode that promotes current to flow in only one direction. Ohmic metal-semiconductor contacts are made to both the n-type and p-type sides of the solar cell, and the electrodes are ready to be connected to an external load.

When photons of light fall on the cell, they transfer their energy to the charge carriers. The electric field across the junction separates photo-generated positive charge carriers (holes) from their negative counterpart (electrons). In this way an electrical current is extracted once the circuit is closed on an external load.

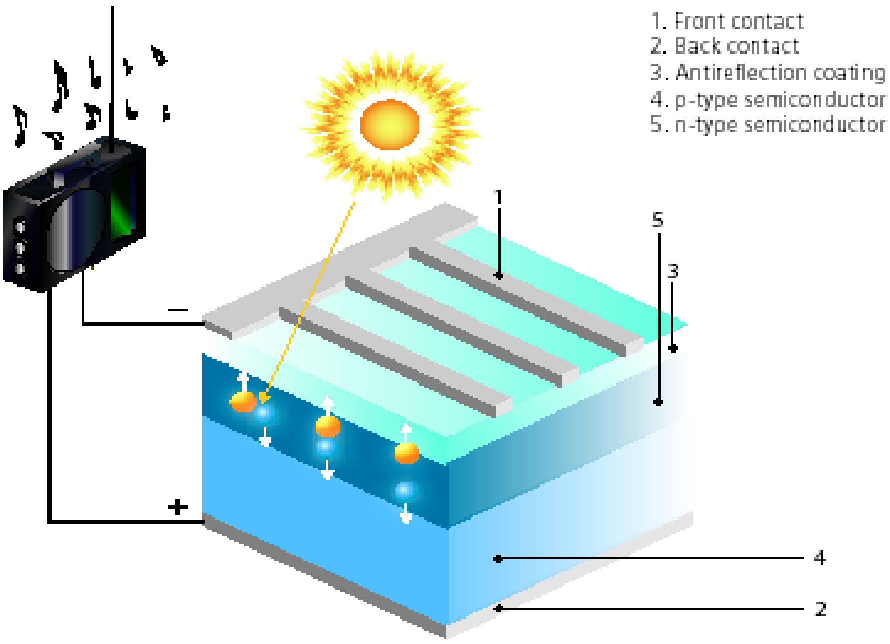

Figure 1 - Solar cell [4].

There are several types of solar cells. However, more than 90 % of the solar cells currently made worldwide consist of wafer-based silicon cells. They are either cut from a single crystal rod or from a block composed of many crystals and are correspondingly called mono-crystalline or multi-crystalline silicon solar cells. Wafer-based silicon solar cells are approximately 200 m thick. Another important family of solar cells is based on thin-films, which are approximately 1-2 m thick and therefore require significantly less active, semiconducting material. Thin-film solar cells can be manufactured at lower cost in large production quantities; hence their market share will likely increase in the future. However, they indicate lower efficiencies than wafer-based silicon solar cells, which mean that more exposure surface and material for the installation is required for a similar performance.

A number of solar cells electrically connected to each other and mounted in a single support structure or frame is called a ‘photovoltaic module’. Modules are designed to supply electricity at a certain voltage, such as a common 12 volt system. The current produced is directly dependent on the intensity of light reaching the module.

Several modules can be wired together to form an array. Photovoltaic modules and arrays produce direct-current electricity. They can be connected in both series and parallel electrical arrangements to produce any required voltage and current combination.

There are two main types of photovoltaic system. Gridconnected systems (on-grid systems) are connected to the grid and inject the electricity into the grid. For this reason, the direct current produced by the solar modules is converted into a grid-compatible alternating current. However, solar power plants can also be operated without the grid and are then called autonomous systems (off-grid systems).

More than 90 % of photovoltaic systems worldwide are currently implemented as grid-connected systems. The power conditioning unit also monitors the functioning of the system and the grid and switches off the system in case of faults.

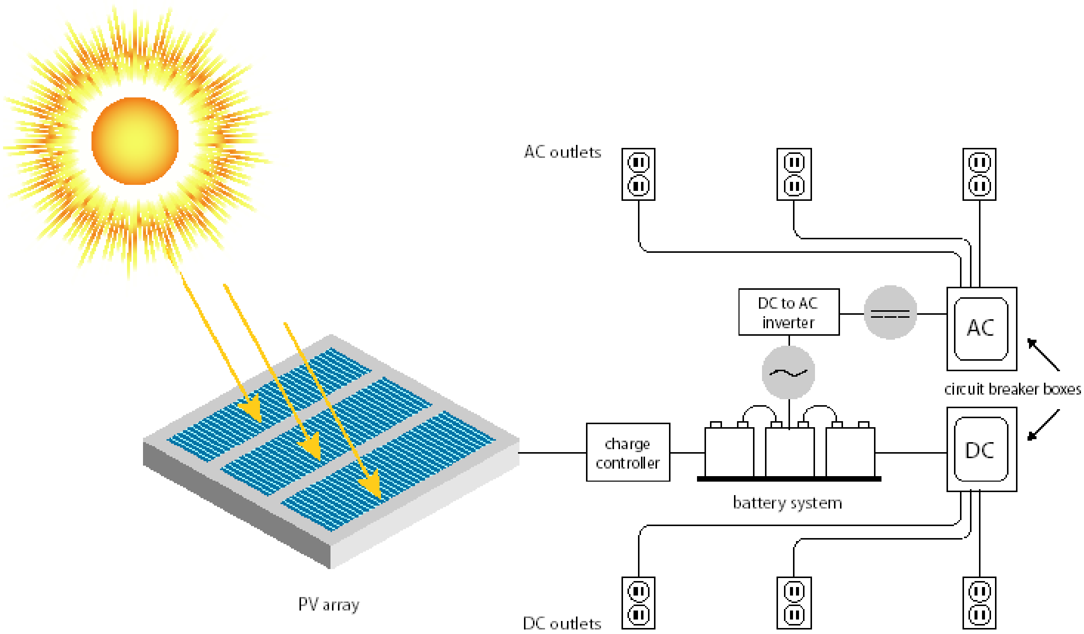

Figure 2 - Photovoltaic Installation [4].

2.2. *Photovoltaic market development*

The current levels of dependence on fossil fuels, the need of reducing the carbon emissions associated with energy use and the prospects of developing a new and extremely innovative technology sector, make photovoltaics increasingly attractive. In the last years the photovoltaic market expanded extensively, especially in Germany, followed by Spain and Italy. In addition, Greece is due to be the next fast-growing market. Several incentives have stimulated the expansion, rendering the photovoltaics industry ready to expand. However, the high production cost of electricity, due to the significant capital investment cost, is the main barrier to large-scale deployment of photovoltaics systems.

Solar photovoltaic systems today are more than 60 % cheaper than they were in the 1990s. The focus lies now on cost reduction and lowest cost per rated watt in order to reach competitiveness with all sources of electricity in the medium term. Figure 1 demonstrates the current growth. In 2010 the total cumulative capacity installed in the European Union could be as much as 16 000 MW.
The European photovoltaic industry currently has an important role in photovoltaic technology development, capturing about 30 % of the world market of photovoltaic modules.

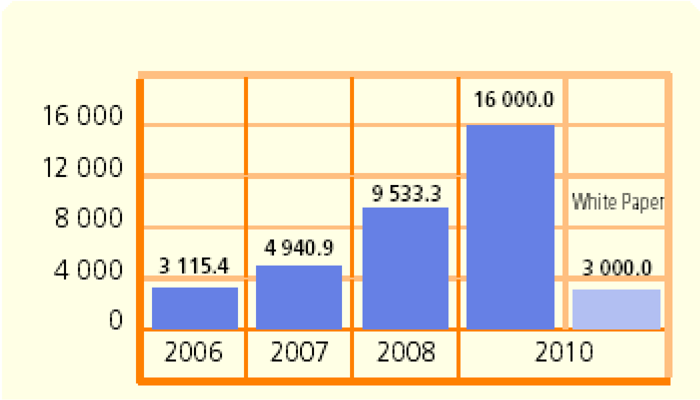

Figure 3 – Comparison of the recent photovoltaic growth (in MW) int he Europe [4].

In 2008, the photovoltaic capacity installed in the EU was about 4 600 MW, with a total cumulative capacity of more than 9 500 MW achieved. This illustrates an increase of 200 % with respect to 2006. Within the EU market, practically the whole of the newly installed capacity is focused on grid-connected power plants. More than 56 % of the EU-27 photovoltaic installations are located in Germany.

3. CONCLUSIONS

Apart from incentives, the development of photovoltaics requires the transfer of knowledge of research institutes. Innovative thin-layer cells have to be developed so that, they could be more effective than the most used mono- and polycrystalline cells. The photovoltaic sector does not imply only investment in research and technological innovation – it generates employment. Its decentralised structure leads to jobs in the less industrialised areas, with the majority encompassing high-quality jobs in aircraft enterprises and industry.
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