



Dienstag, 15.11.2016, 16.15 Uhr in W0 0-001

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### **The Technological System of Photovoltaics: Identification and Analysis with Patent Classes**

Climate change is considered as one of the major challenges of the world (Glenn & Florescu, 2015). In fact, the global average temperature has increased by more than 0.8°C over the last century, for which, CO<sub>2</sub> emissions resulted from burning fossil fuels are considered among the main causes (NRC, 2010). Therefore, innovations in clean energy technologies have gained an increasing importance in the last decade. The use of solar photovoltaic PV technologies as a green renewable source for generating electrical energy is gaining high importance all over the world. PV Technology development is forming a special interest by many developed and developing countries (UNEP, et al., 2010; IEA, 2014). Such development is both vertical: by increasing cells efficiency, and horizontal: by enlarging the coverage area of installed solar panels and power generation projects. In parallel, technical development and innovation have long been considered as the main driving factor of economic growth (Schumpeter, 1912). As new innovations emerge, a structural change can follow, opening new horizons for economic growth.

This research paper contributes to a deeper understanding of innovation systems by providing a comprehensive definition of the PV technological system in terms of its structure and components on one hand, and by capturing its development trends using patent data on the other.

The PV technological system is defined in this paper to encompass six main groups, which are: solar cell technologies; solar panels; the relevant electronic circuits; monitoring and testing techniques; energy storage means; and portable devices powered by solar energy. Under each group in the definition, some subgroups were outlined to capture the detailed components and to distinguish between different technologies developed therein. Such subgroups are the solar cell technologies of crystalline silicon, Gallium Arsenide, Thin-film (CIGS, CdTe, and Amorphous Silicon Hydrogen), multi-junction cells, and the emerging PV cells family (Dye sensitized, and Organic).

In order to identify the patent applications related to the technological system of photovoltaics and its groups, this paper introduces an integrated approach that combines keyword and international patent classification IPC searching; data validation by technical checking; data verification by words frequency analysis; and finally IPC codes assignment to the PV technological system groups and subgroups. The proposed approach shows a high level of data completeness; high relevancy; relative simplicity and replicability for future applications.

## Bibliography

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