

Solar Energy Research & Education @TU Delft/PVMD

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Abstract

Delft University of Technology aims to become global academic leader in Solar Energy research and education. Utilization of solar energy is a crucial step in executing the energy transition towards sustainable energy. Success of the energy transition execution depends on technicians, engineers and leaders who have skills and knowledge to do it. The Electrical Sustainable Energy (ESE) department at Delft University of Technology focuses on educating their students to prepare them for taking an active role in the energy transition. Photovoltaic Materials and Devices group is a part of the ESE department and carries out research and education in the area of photovoltaic technology (PV).

Keywords: photovoltaics; research; education

INTRODUCTION

Delft University of Technology aims to become global academic leader in Solar Energy research and education. Utilization of solar energy is a crucial step in executing the energy transition towards sustainable energy. Success of the energy transition execution depends on technicians, engineers and leaders who have skills and knowledge to do it. The Electrical Sustainable Energy (ESE) department at Delft University of Technology focuses on educating their students to prepare them for taking an active role in the energy transition. Photovoltaic Materials and Devices group is a part of the ESE department and carries out research and education in the area of photovoltaic technology (PV).

ENERGY TRANSITION

The Energy Transition aims to transform the present energy system that is based on fossil fuels into one based on renewable energy sources (RES). The main challenge is to realize this transition at the lowest possible cost without compromising the system's reliability. Since the most important RES, such as solar- and wind energy, deliver electricity, the primary challenge is to accommodate RES in the existing electrical power system or to design and build new ones. Consumers are becoming electricity producers by installing their own photovoltaic (PV). In this way, micro-grids with its own electricity generation are formed where power

management and market mechanisms can be controlled locally. By interconnecting the micro-grids, the stability and resilience of the entire electrical power system can be increased, and conversion and transport losses can be minimized. When consumers mutually exchange electricity or deliver electricity to the distribution network, new market design and regulations have to be developed and put into place.

THE ELECTRICAL SUSTAINABLE ENERGY DEPARTMENT

The ESE department's research activities aim at accelerating the energy transition towards sustainable energy. The research covers conversion of RES into electricity, its transmission, distribution and storage. The department designs and fabricates high-performance, low-cost photovoltaic (PV) cells and power electronics devices for integration in future power networks. It studies systems with electricity generation using PV and wind technologies, high-voltage and direct-current transmission, and intelligent power management for increasing energy efficiency.

In anticipation of the large-scale introduction of renewable and distributed energy sources, the technical, economic and societal performances of the future electricity system are studied through multidisciplinary "system of systems" approaches. Working on this energy transition, the ESE department contributes to tackling important societal challenges such as climate change and environmental pollution.

THE PHOTOVOLTAIC MATERIALS AND DEVICES GROUP

Research

The PVMD group has a long history of research on thin-film silicon solar cells and advanced opto-electrical modelling of solar cells. The research program of the

PVMD group has been recently expanded towards crystalline Si and hybrid tandem devices, intelligent and multi-functional modules, X-IPV systems, circular photovoltaics and multi-scale modelling. The group focuses on five application areas; (1) crystalline silicon solar cells, (2) thin-film and tandem technology, (3) photonics and Si-based storage, (4) photovoltaics, (5) and urban energy (see Fig. 1).

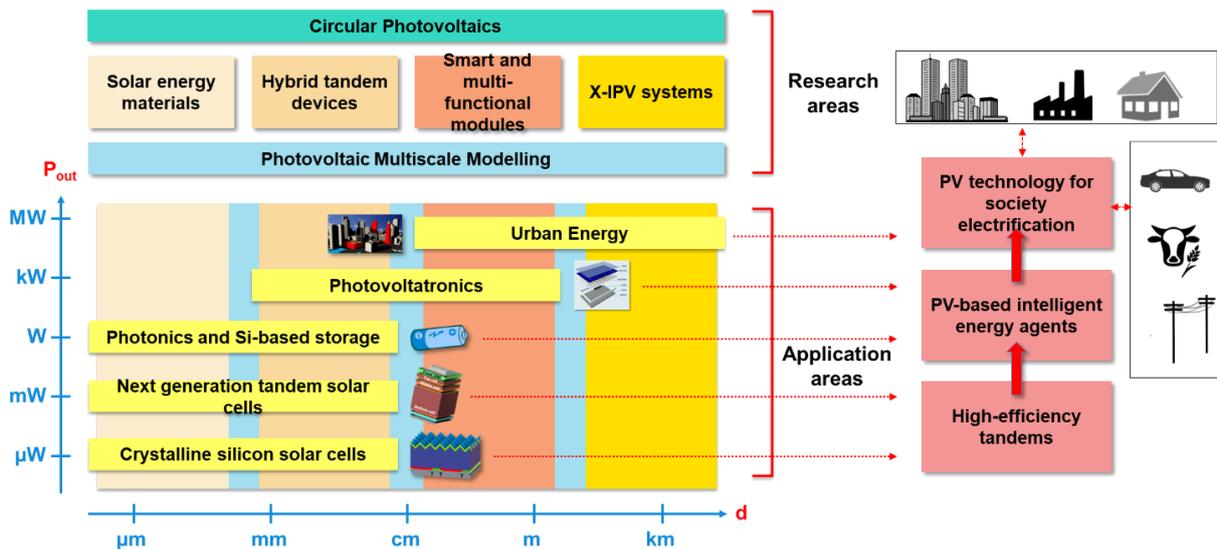


Fig. 1: Research topics and application areas of the PVMD group @TU Delft.

Education

PVMD group has developed a package of PV-related courses for MSc programs that is called PV profile (see Fig. 2). In addition to standard PV courses such as PV Basics, PV Technologies and PV Systems, new courses such as PV Modelling, PV Processing and Virtual PV

Lab were added. We have developed a digital twin of the PV profile so that both on-campus and ex-campus students can learn about the whole PV value chain from solar energy materials to devices, modules, and systems. In addition, the PVMD group organizes annual PV Systems Summer School.

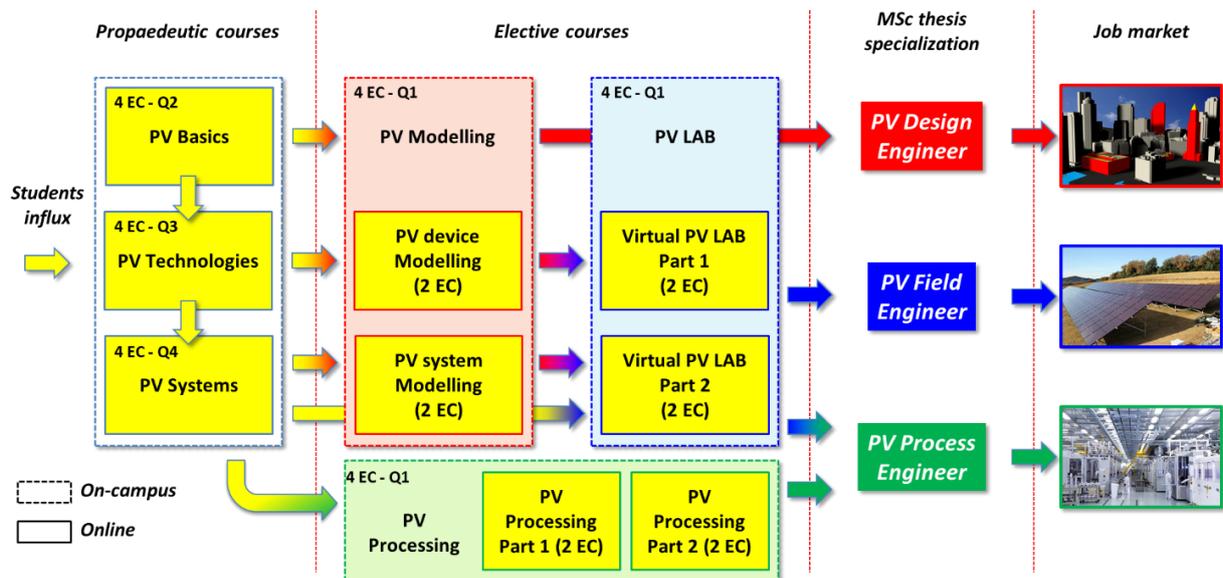


Fig. 2: PVMD group educational activities

CONCLUSION

Our academic mission is to deliver excellent young engineers and future leaders in the field of energy transition. Therefore, we believe that PhD candidates, PostDocs, R&D people and engineers who work in the area of sustainable energy should have knowledge in how real PV systems operate. In these times of fast changes in the way we use electricity, the penetration of

photovoltaic systems in the electricity grid is literally booming. Our Summer school offers theoretical knowledge and practical training in design, installation, understanding, and monitoring of PV systems.

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