Preface

In order to contribute to the training of young scientists working in the energy sector or intending to do so, the European (EPS) and the Italian (SIF) Physical Societies started the Joint EPS-SIF International School on Energy as a collaborative initiative. The Courses are foreseen to take place on a biennial basis in the beautiful venue of Villa Monastero in Varenna, Lake Como, Italy.

The 1st Course was held in summer of 2012 on "*New strategies for energy generation, conversion and storage*". The 2nd Course in 2014 was devoted to an overview of "*Basic concepts and forefront ideas on energy*", covering the major scientific areas. The 3rd Course was exceptionally held in 2016 at the Ettore Majorana Foundation and Centre for Scientific Culture (EMFCSC), in Erice, Italy, in collaboration with the Materials Research Societies (MRS and EMRS), on "*Materials for energy and sustainability*". The 4th Course was organized in 2017 back to Varenna, with focus on "*Advances in basic energy issues*". In 2019 the 5th Course, titled "*Energy: Where we stand and where we go*", was successfully held again in Varenna.

In 2021, due to the COVID-19 pandemic, the 6th Course of the Joint EPS-SIF International School on Energy, titled "*Energy Innovation and Integration for a Clean Environment*", took place as a virtual course on 19-23 July 2021.

This was a challenge for a School which is typically meant to favour and foster interactions among students and lecturers. Nevertheless, a special online platform was devised with a "get together hallway" and parallel meeting rooms in addition to the main lecture room to allow virtual discussions and encounters among the participants. Overall, this system worked well despite the obvious limitations due to the impossibility of meeting in person and managed to keep all parties connected for the whole week.

The 2021 School's programme matched the primary goal of the School to present all research and development fields with relevance for the technologies of energy production, conversion, transmission and savings. The unique feature of the School actually lies in its multidisciplinarity and interdisciplinarity including basic and applied topics but also climate and economic aspects. This wide scope is essential in order to provide the students with a global insight into the complex nature of energy supply and consumption.

For this purpose, this School effectively brings together a large number of scientists working in different disciplines, but all related to energy technologies with young scientists from all over the world.

The 6th Course of the School gathered nearly 80 participants —lecturers, observers and students— of 10 different nations. The lectures were delivered by about 20 experts in various fields. The concepts and ideas involved in modern energy systems and technologies were clearly addressed by the lecturers who invested every effort to be as didactic as possible. In this way knowledge gaps were filled, and answers were provided to long-standing questions in the mind of the students during the lively discussion-times that followed each lecture. In this way, an online community formed and the basic idea of such a summer School was preserved.

The proceedings of the School, published as Lecture Notes, conserve the teaching material presented and make it available to those who did not attend the School. They serve as a reference book for both specialists working in one of the energy fields but with interests in the status of other energy-related areas, and non-technical readers who want to get a general overview on the involved concepts and techniques and their prospects. Papers are ordered according to topics: global overview of world energy resources, renewable energies, energy storage, nuclear energy (fission and fusion), energy and grids. These proceedings are published both on paper, in a volume of the "*Lecture Notes of the Joint EPS-SIF International School on Energy*" series, and on-line open-access in *The European Physical Journal Web of Conferences* (*EPJ WoC*).

We are especially grateful to our distinguished colleagues and to our "best students" who have all accepted to write and have timely provided their contributions for these Lecture Notes. Our heartfelt thanks go as well to our many sponsors. Finally, we are grateful to the members of the Scientific Committee of the School and to our Scientific Secretary for their dedicated work concerning the programme of this Course and these proceedings, and to the staff of the Italian Physical Society for having made this School possible despite the difficult times of the pandemic.

By the time these Lecture Notes were published, Professor Hermann-Josef Wagner (Ruhr Universität Bochum, Germany), our distinguished colleague and dear friend, unexpectedly passed away. Since the establishment of the School in 2012, his lectures on wind energy have been an extremely valuable tradition and a very strong point of the School. His last lectures in 2021 were recorded and are visible on the web site of the School. He will be sorely missed in the years to come. These Lecture Notes are published in his memory.

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