

## Preface

A growing world population will consume a growing amount of energy. But unlike in the past, this need cannot be met by fossil fuels any longer because of the environmental consequences. To produce the energy for 9-10 billion people on Earth without or with much less CO<sub>2</sub> release into the atmosphere is a tremendous task for several generations of scientists and engineers. 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 first Course was held in summer of 2012. The second Course in 2014 was devoted to an overview of *Basic Concepts and Forefront Ideas* on energy, covering the major scientific areas.

The primary goal of the School is 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 is its multidisciplinary and interdisciplinarity including basic and applied topics but also climate and economic aspects. This wide scope of the school 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 second Course of the School gathered 65 participants —lecturers, observers and students— of nearly 20 different nations (including Jamaica, Japan, and China). The lectures were delivered by 25 experts in various fields<sup>(1)</sup>. 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. Students and lecturers stayed together during lunch and dinner. The attractiveness of the venue helped to keep all parties on site for the whole week. In this way knowledge gaps were filled and answers were provided to

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<sup>(1)</sup> See: [http://www.sif.it/attivita/scuola\\_energia#presentations](http://www.sif.it/attivita/scuola_energia#presentations)

long-standing questions in the mind of the students during lively discussion-times that followed each lecture. In this way, a community formed and the basic idea of such a summer School was fully met.

In the opening lecture of the Course, one of us (L.C.) had also the opportunity to present a study commissioned to Cebr by the EPS in 2012-2013 on the importance of physics to the economies of Europe<sup>(2)</sup>. The study was performed as an independent economic analysis, using statistics available in the public domain for 29 European countries. On the heels of this EPS report, an analogous study was commissioned to Deloitte by the SIF in 2013-2014, concerning this time the Italian case only<sup>(3)</sup>. Both studies assessed the contribution of physics-based sectors to the economy, namely of those industrial and business sectors where the use of physics—in terms of technology and expertise—is critical to their existence. Notably both studies emphasized the major role of physics in energy-related sectors of the economy, as it was pointed out to the students.

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.

In this volume, papers are ordered according to topics: global overview of world energy resources, environment and climate issues, renewable energies (including geothermal energy), nuclear energy (fission, including thorium fission, and fusion), energy economics, energy and transportation, energy and housing.

We are especially grateful to all our distinguished colleagues who have accepted to write and timely provide their contributions for these *Lecture Notes*. Our thanks go as well to our many sponsors. Finally we are grateful to our Scientific Secretary, Gianluca Alimonti, for his dedicated work concerning the programme of this Course and these proceedings, and to the staff of the Italian Physical Society for their warm and efficient hospitality in Varenna.

L. CIFARELLI and F. WAGNER

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<sup>(2)</sup> See: [http://www.eps.org/?page=policy\\_economy](http://www.eps.org/?page=policy_economy)

<sup>(3)</sup> See: [http://en.sif.it/activities/physics\\_economy](http://en.sif.it/activities/physics_economy)