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NEW STRATEGIES FOR ENERGY GENERATION, CONVERSION AND STORAGE  
LECTURE NOTES. JOINT EPS-SIF INTERNATIONAL SCHOOL ON ENERGY. COURSE 1

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Where will we end up if we do not change direction in global energy trends?

If you were to ask a member of the public about the meaning of the 450 climate change mitigation scenario, they might wonder: What on earth has this to do with us? Indeed, not so long ago scientists were considered a closed society living in ivory towers, spending much of their time in exotic laboratories and academic institutions. Nowadays, there is a growing commitment of scientists to share their knowledge and opinions with society. Scientists should take the lead in informing society and policy-makers on problematic and delicate issues, such as energy supply, environmental and climate changes.

This book addresses the threats and opportunities facing the global energy systems based on a qualitative analysis of new strategies for energy generation, conversion and storage. These Lecture notes, from the first course of the Joint European and Italian Physical Societies (EPS-SIF) International School on Energy, examine the characteristics of major energy shifts including energy and climate policy options, requirements for fossil, nuclear and renewable power plans and prospects for future massive energies like nuclear fusion. While each energy shift took place within a different socio-economic context involving different technological and political issues, they all had one thing in common: they were very slow requiring long-term perspectives with sustained investment in research and development.

After reading this book, it is clear that we are facing an energy transition phase with new global-drivers like climate change and globalization. Indeed, we need a society with a critical knowledge that should understand how much energy (based on fossils) we need to substitute compared

with previous transitions, which are much greater than at any other time. The quest for energy is a global endeavour and new energy strategies require technologies for energy production, conversion, transmission and savings.

The reader will find some clues to answer key energy-related questions like: Where will we end up if we do not change direction in global energy trends? What are the energy options and their pros and cons? What can be done in terms of physics and technology development?

The book covers physics fields with relevance for all energy technologies, including:

- Basics, present and future of nuclear fission energy after Fukushima, including a review of properties of radioactive waste and options for conditioning and storage.
- Basic concepts of renewable energies, which should be made competitive by both new innovative solutions and by lowering the cost of the present technologies.
- The impact of replacing conventional fossil or nuclear energy sources using intermittent renewable energy sources, whose production capacity will have to be increased by factors well above the maximum energy peak load.
- The development of massive energy sources, like fusion, since the dominance of fossil fuels must decline.
- Energy and transport, where there is a need for smart transport and alternative energy carrier developments.
- Requirements for fossil power plans and technologies to reduce CO<sub>2</sub> emissions and feasibility of large-scale CO<sub>2</sub> storage.
- The issue of energy cost and its impact on economic capacity and

competitiveness, which must be balanced against the cost associated with the continued use of fossil fuels.

Energy is the life-blood of today's society and new strategies for the development of sustainable energy sources are needed to reduce energy-related carbon emissions. We cannot afford to delay further action to tackle climate change if the long-term target of limiting the global average temperature increase to 2 °C, as analysed in the 450 scenario [the 450 referring to a parts-per-million (ppm) concentration of carbon dioxide (CO<sub>2</sub>) in the atmosphere], is to be achieved at a reasonable cost. In this scenario, the Joint EPS-SIF International School on Energy is a timely initiative to promote a regular forum for discussion on energy issues.

The book, which is very much worth reading, shows that we need the development of all potentially viable options for low-carbon energy, promoting research, encouraging investment, favouring innovation and supporting the industrial market without jeopardising the security of energy supply.

But we should be realistic; the need for new strategies for energy generation, conversion and storage is a colossal challenge. A global challenge where the dynamics of energy markets are increasingly due to population growth, increase in economic output and energy demand. A global challenge that would require multi-decade approach, keeping a coherent and sustained energy policy that strengthens the mutually beneficial relationship between education, research and innovation.

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