

# Preface

The energy consumption associated with the Internet has become a major concern of the scientific and technological communities, the economic and political establishment as well as the media and the public at large. The vast increase in the Internet usage, driven by a continuous introduction of new applications, integration and reliance of public services and an increase in the number of users worldwide brought upon a situation where the ability of modern society to supply the required energy for the predicted consumption associated with future computing and communication came into question. While several apocalyptic predictions published in the early years of the third millennium will definitely not materialize, the problem is real and requires a solutions to which the technological community must dedicate itself.

Achieving an energy-efficient Internet requires a multi-facet solution that addresses all aspects of the complex data network. An important part of the solution will involve photonic devices and systems. The photonics technologies have traditionally not emphasized sufficiently energy issues but once it became clear that efficiency is paramount, large efforts aiming at reducing the power required by photonic devices, mainly lasers, have started. A new field called *Green Photonics* has emerged and quickly became popular.

However, photonic devices are driven by and feed electronic circuits, which are often energy inefficient and hence have to also be improved. Above and beyond this, the energy consumption is affected by the complete computing and communication systems. It is obvious, therefore, that what is needed are not photonic devices and systems that are *Green* but rather, the technological community should seek to develop a *Green Internet* where each part is as energy efficient as possible.

The development of a *Green Internet* requires a dialog and collaborations between experts of many fields including photonics, VLSI circuit design, computer architecture, networks, switching and information sciences. An additional aspect of the *Green Internet* is the use of renewable energy sources whenever possible.

The significance of holding this multidisciplinary dialog was recognized by the directors of the Russell Berrie Nanotechnology Institute at Technion – Israel Institute of Technology and the Center for Nano Photonics at the Technical

University of Berlin who joined forces and established a series of three annual *Green Photonics* symposia held alternatively in Haifa and Berlin between 2014 and 2016. These symposia which were funded by the Reinhart Frank Foundation brought together world famous experts in all fields related to the *Green Internet*. This book summarizes the three *Green Photonics* symposia highlighting the most important topics that were covered.

Optoelectronic semiconductor devices are addressed extensively. Energy-efficient VCSELs for the common 850 nm range as well as for 1550 nm are covered in two separate Chaps. 1 and 2, respectively. The advantages of quantum dots are highlighted in two chapters one, Chap. 3 dealing with optical amplifiers and the second, Chap. 4 with mode-locked lasers. Low-energy fast switching is described in Chap. 5 which addresses nonlinear photonic crystal waveguides. The electronic aspects of a *Green Internet* is covered in a few chapters. Low-energy logic design is presented in Chap. 6, while power management in the so-called Network on Chip devices is presented in Chap. 7. The higher level system aspects cover the topics of optimization of large interconnect networks is addressed in Chap. 8. Finally, we include two chapters that deal with renewable energy sources; Chap. 9 is an extensive survey of the global impact of photovoltaics and Chap. 10 deals with futuristic solar cells based on thin film organic semiconductors.

The diverse issues covered by the 10 chapters of the book highlight the need for an extensive multidisciplinary dialog and for collaborations between experts from different fields. This joint effort is needed to ensure a future *Green Internet*, which will enable all the applications needed by the modern society at an energy cost that is affordable.

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