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The Green Energy Ship Concept

Renewable Energy from Wind Over Water

Springer

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Preface

We are passengers in a spaceship that is getting warmer year after year. The climatologists tell us that the continued emission of greenhouse gases will risk the onset of irreversible climate change by mid-century. Many influential people have been warning about the consequences, and many people, especially the young ones, have been expressing their anger and frustration about the lack of an effective response. In his recent addresses to the United Nations General Assembly in New York in September 2019 and the United Nations COP25 conference in Madrid in December 2019, the United Nations Secretary General Antonio Guterres stressed the need for the declaration of a global climate emergency. Unfortunately, COP25 yielded no consensus on how to respond.

The aim of our book is to draw attention to the fact that the record of past engineering achievements should encourage us to meet this century's challenge of developing sustainable energy conversion systems. Only 120 years ago, it was unimaginable that engineering would make it possible to "conquer space and time." By this, we mean the development of airplanes, which enabled the transport of hundreds of people in a single plane to any point on the globe within a day, and the development of rockets, which in turn made possible instant communication between people on any place on the globe.

This raises the question of whether the lack of a consensus on how to respond to the UN declaration of emergency is due to disagreement about the most effective engineering solutions; or merely squabbling about the distribution of the necessary sacrifices among the various nations. It is our view that the former question needs to be answered before there can be any hope to achieve a global sociopolitical consensus.

Given the huge global energy demand to maintain our standard of living, there are only three renewable energy sources that can satisfy this demand, namely, solar, water, and wind. The development of the global hydropower plants started already in the late nineteenth century and therefore leaves little room for further substantial contributions. The major contributions will have to come from solar and wind power plants. Indeed, the solar and wind power engineering industries have experienced impressive growth in the past half-century. To wit, wind turbine blades are now longer than the largest airplane wings. However, there is a generally accepted view that solar panels and solar and wind power plants require a solid foundation and therefore need to be land-based or at most offshore based in shallow coastal waters. This view eliminates two wind energy sources from consideration, namely, jet streams and winds over the oceans.

Aerospace engineers have a tendency to look for challenging problems in their field. In 2009 we published a proposal on how to capture the wind energy in both the jet streams and the winds over the oceans. We soon realized that the jet stream capture is too challenging and therefore concentrated on the ocean wind capture problem. We approached it with the attitude that we would have to show technical feasibility before worrying about costs. To our surprise, we found that the technical elements needed to convert wind over water into storable energy were readily available, although they certainly required further development and identification of the optimum combination of the many parameters that have an influence. We were fortunate in attracting the interest of Professor Peter Pelz at the Technical University of Darmstadt, Germany. He and his Ph.D. student Mario Holl subjected our energy ship concept to a techno-economic multipole systems analysis. It revealed not only the optimal extractable energy as a function of wind speed, wind angle, sail area, ship and turbine drag, electrolyzer efficiency, etc., but also provided a hydrogen production cost estimate. As expected, it showed the need for minimizing the ship drag and the personnel costs, thus pointing to the operation of autonomous hydrofoil boats as the most effective energy ship.

It is our view that enough information is now available on our "wind-over-water" energy conversion concept to summarize its present development status in this book for the purpose of making it accessible to a wider readership. To this end, we divided it into two parts. In the first part, we briefly summarize the nature of the climate crisis and its potential irreversibility, the current status of renewable energy technologies and efforts, as well as our reasons for proposing the energy ship concept. In the second part, we provide brief summaries of the essential technologies needed for the implementation of the concept. These summaries are merely meant as "appetizers" for the technically interested reader to stimulate more detailed study by consulting the listed references.

In our view, the lack of a consensus at COP25 is partly due to the lack of appreciation for the opportunities offered by the exploitation of the wind energy over the oceans. It requires a combination of aeronautical, hydronautical, and power engineering to develop efficient air-sea interface vehicles. We like to call this new engineering discipline, "aero-hydronautical power engineering." It is our great hope that this new discipline can make a significant contribution to the alleviation of the climate emergency declared by the UN Secretary General.

This book evolved from lectures we gave every year over the past ten years in a seminar course to first-year UC Davis students for the purpose of making them aware of the challenges presented by the climate change and of potential engineering solutions to these challenges. During the past 2 years, 20 senior design students worked on renewable energy design projects in our innovative Power Generation

Systems (iPGS) laboratory. Also, one of us (MFP) benefited greatly from the feedback he received during lectures at the Royal Institute of Technology in Stockholm, the Graz University of Technology, the Istanbul Technical University, the Eskisehir Technical University, the University of Stuttgart, the Tsinghua University of Beijing, and the Hong Kong University of Science and Technology. He expresses his gratitude for the hospitality extended by Professors Fransson, Jericha, Sanz, Unal, Karakoc, Vogt, Song Fu, and Wei Shyy at these universities. He is also grateful for stimulating discussions with Professors Hobson and Gannon at the Naval Postgraduate School and Professor Turner at the University of Cincinnati.

Davis, CA, USA

Max F. Platzer
Nesrin Sarigul-Klijn

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