Preface

As the harsh and highly contentious scientific disputes are finally winding down, there is now little doubt in the scientific community that the world is transitioning to a warmer and more severe climate with less reliable water and energy sources. It is now a scientific certainty that our ecosystems will have less species, our oceans will see increases of acidity and dead zones, and our land will contain less fertile soils. The recent global economic downturn is also adding pressure on the efforts to reduce global warming on a planet that is increasing its population. In less than fifty years the number of human beings on earth has grown from 3 billion to 7 billion, reinforcing the fact that we are in the middle of the most rapid expansion of the world population in our 50,000-year existence, creating phenomenal pressure on both our economy and environment (Think Progress, 2011). The world is entering a very precarious period with significant environmental, energy, and economic challenges. There have been some very interesting linkages and comparisons between the economy and the environment (Yale, 2011a). The premise is fostered by the linguistic root of Eco. "Eco" is derived from the Greek word, *oikos*, meaning house, or household. Both Ecology and Economy describe the skill of managing or understanding the residence or environment you reside. Unfortunately the debates about economy and ecology today are all centered on the cost of protecting the environment; or the cost of the sustaining the ecological footprint. The recent Koyoto disagreements highlight how the global economies cannot support a sustainable environment.

To understand the linkage between the two, you must first understand how interrelated the two actually are. Looking at the global economy, one of the biggest problems is the debt crisis. The debts of both governments and consumers are completely out of control and data is showing that we are spending much more than we actually have available. According to the USA Reserve's G.19 report on consumer credit, released July 2011, the total U.S. consumer debt is $2.43 trillion. This is not a US only problem. Consumer debt in the United Kingdom (UK) has also soared to an all time high. In 2011 the National Audit Office revealed that personal debt has reached £1.5 ($2.35) trillion mark. This phenomenon is turning out to be unsustainable and consumers in many countries are following this disastrous trend. This problem is not isolated to individuals; governments are also in the same predicament. The debt problems governments such as the US, Greece, Italy, and Ireland face are well publicized. The problem is compounded by the tight interconnection of the global financial system. When one country defaults on its sovereign debt. Peripheral private debt becomes at risk in other countries and banking systems of creditor nations encounter significant losses. For example, in October 2011, Italian borrowers owed French banks $366 billion (net). This global economic crisis being played out in 2012 is analogous to the environmental crisis. We are using far more resources than we can afford to take from the environment. Although each country decides and sets limits on emissions, fishing, logging, and fresh water access, the fact that the environment, just like the economy, are interrelated makes a mockery of the whole process.

One measure to quantify our ecological footprint is using the per capita CO2 emissions. Measures and studies are revealing that we overdraw our global CO2 budget just as we are economically overdrawn.

According to the Institute for Climate Impact Research, beginning today the average human being must not emit more than 2 tons of CO2 per year in order to avoid dangerous global climate change. But the average Chinese citizen is emitting 4 to 5 tons per year, the average German 11 tons, and the average American more than 20 tons. That means we're overdrawing our CO2 budget by a factor of 2 to 10 (Think Progress, 2011). It is a stark fact of life that we are living well beyond our means, living off money that is at best an imaginary notion that will eventually lead to bankruptcy. We are also plundering natural resources that are non-renewable, and eventually, we will create environmental bankruptcy leading to dead zones in the ocean, climate change, devastation of species, and extreme poverty due to droughts and water shortages. To make the situation worse, the world population is expected to keep on growing. Experts from the United Nations and the U.S. Census Bureau are projecting that the world population will peak at 9.5 billion to 10 billion later this century and then gradually decline as poorer countries develop. There is another train of thought that believes these projections are merely optimistic (Yale, 2011b). There is no evidence that suggests the human population will not continue to rise as we have seen in recent decades creating a count of 12 billion or more by 2100, as previously estimated by the UN. The implication of this would be calamitous for the planet if the recourses are managed as they currently are. Even at the 10 billion mark, which is a number that seems to be considered as inevitable, there will be immense social and environmental repercussions, enormous stress on the world's food and water resources, spurring further loss of wild lands and biodiversity, and hastening the degradation of the natural systems that support life on Earth.

It is clear that the world needs different ideas and concepts to ensure the planet does not go bankrupt. These ideas are not necessarily new, but rely on renewable energy technology implementations and sustainable development concepts to be employed. The chapters presented in the *Global Sustainable Development and Renewable Energy Systems* book aim to shed some light on the issues and propose options for moving forward. The book is separated into three sections. Section 1 is entitled "Renewable Energy and Energy Applications and Concepts." The first chapter is entitled "Encouraging the Development of Renewable Energy: The Role of Cooperatives" by Eric Viardot from Spain. The chapter discusses how the development of renewable energy has become a major societal challenge, and although the renewable energy is progressing at an astronomical rate, the general public has been slow to adopt it. This chapter explores the growing role of renewable energy cooperatives that are appearing around the world. They have been created to act as social entrepreneurs in utilizing the social capital of a community to engage the public. The chapter describes actions of cooperatives to develop the adoption of renewable energy that ultimately lead to the diminishing of the RE costs, the use of educational campaigns, and the setting of renewable energy projects at local level. The second chapter is "Productive Use of Renewable Energy (PURE) for Economic Development in Developing Countries" by Phillip Olla and Nkemdilim Onwudinjo. This chapter discusses how the growth in renewable energy projects along with technological innovations is leading to lowering costs, which is making available an array of renewable energy options to developing nations to address the Millennium Development Goals (MDGs). Although Africa's main discussions on renewable energy have been focused on large-scale grid-connected power systems, this chapter presents the arguments that several renewable energy technologies are well suited to provide modern energy services for low-income people. The chapter presents a comprehensive framework that highlights how to scale up a broad portfolio of micro-renewable energy solutions that can make a major contribution to achieving the MDGs. The third chapter is entitled "Energy Management System

Concepts" by Adam Bedford from the United Kingdom. The chapter will discuss how world energy is rapidly approaching a point of transition where the traditional types of generation will be replaced with distributed generation. This will put an enormous strain on existing power grids and, if not properly management, may lead to brownouts, blackouts, and enormous expenditures to upgrade the grids. The fourth chapter entitled "Review of Energy Efficiency Adoption Literature from a Demand Side Management Perspective: Taxonomy of Research Approaches" authored by Ibrahim Iskin and Tugrul U. Daim aims to introduce research efforts in the context of energy efficiency from a utility demand side management perspective. A collection of energy efficiency related concepts and terms, ongoing research streams have been collated in order to provide a comprehensive landscape analysis. Selected research papers have been analyzed, subjected to research methodologies and data gathering methods, and energy efficiency technologies and end users studied. The outcome of this chapter is expected to benefit both academic and practitioner colleagues by providing more refined information about the ongoing research initiatives in the field as well as lead the next wave of research efforts. The final chapter in this section entitled "Renewable Energy Scenario of Pakistan for Sustainable Development" authored by Asif A. Shah, Arabella Bhutto, S. M. Qureshi, Ambreen Shah, A. A. Shah, and Wajiha Shahd, from Pakistan. This chapter explores why Pakistan has abundant resources to achieve sustainable development and renewable technology, yet these notions are currently considered to be an unrealistic idea within the country. This chapter explores this scenario in depth by finding the root causes responsible for creating such assumptions. The current status of sustainable development through RE on theoretical as well as on practical grounds is analyzed and a framework is developed in which the theoretical background covered on the basis of policy documents is integrated with the real life scenario responsible for the diffusion of renewable energy technologies in Pakistan.

The second section is entitled "Sustainable Development Concepts." The first chapter in this section is entitled "Approaches for Measuring Sustainability" authored by Evangelos Grigoroudis, Vassilis S. Kouikoglou, and Yannis A. Phillis. The chapter explores how the concepts of sustainability and sustainable development have received much attention among policy-makers and scientists, as a result of the existence of limits to growth and the dramatic environmental changes. Due to the fact that there is no universally accepted definition and measuring technique of sustainability, these different models lead to different assessments. This chapter aims to present a discussion of the sustainability indicators, aggregation tools, and data imputation techniques used in each approach. The second chapter in Section 2 is entitled "The Drivers for a Sustainable Chemical Manufacturing Industry" authored by George M. Hall and Joe Howe from the United Kingdom. This chapter describes the current situation of the chemical manufacturing industry and looks to the future demands on the sector such as sustainability, the advent of new bio-based feedstocks, the need for improved energy management, and the implications of these demands on the sector. The chapter emphasizes the important role of chemical (or more generally, process) engineers in delivering bio-based sustainable solutions and also suggests a new way of thinking about the discipline to bring about the next paradigm shift with concomitant education implications. The next chapter is entitled "Are Biofuels a Factor of Sustainable Development in a Food Insecurity Context in Africa? Case Study of Burkina Faso" by Marie-Hélène Dabat, Joël Blin, and Elodie Hanff from Bukina Faso. This chapter discusses the opportunity for substituting fossil fuels with biofuels in Burkina Faso. Biofuel opportunities are discussed taking into account technical, agronomic, and land potentials in this country. However, if they are to generate sustainable socio-economic development, biofuel projects need to be mindful of food security and economic incentives, and should be part of national agricultural strategies. The chapter shows a number of conditions that must be met to ensure the advantages of biofuels

outweigh the disadvantages. The next chapter is entitled "Sustainability Assessment Approaches: Towards a Global Sustainability Development" and is authored by Fernández-Sánchez, and Rodríguez-López from Spain. This chapter summarizes and analyzes the different existing approaches and possible future developments for applying the sustainability concept. The ultimate aim of this chapter is to enhance the awareness of all stakeholders in the need for a more sustainable global development, considering actions not only in the immediate environment but also in indirect environments in space and time.

The final section is entitled "Renewable Energy Technologies Innovations." This section describes the technical and scientific innovations that are being conceived to improve renewable energy systems from around the world. This field is progressing at an astronomical rate, and the new innovations can have a significant impact on costs and also the ability to efficiently develop new energy from renewable sources. The first chapter in the section is entitled "Impacts of Wind Generators on the Dynamic Performance of Power Systems" authored by M. J. Hossain, H. R. Pota, and M. A. Mahmud from Australia. This chapter analyzes the changing nature of power systems and its dynamic behavior to identify critical issues that limit the large scale integration of wind generators and FACTS devices. The complexity of power systems has been increased in recent years due to increased utilization of the existing transmission lines using FACTS (Flexible AC Transmission System) devices and for changing the generation mechanism with more intermittent sources and lower inertial units. This changing nature of power systems has considerable effect on its dynamic behavior resulting from power swings, dynamic interaction between different power system devices and less synchronized coupling. The next chapter entitled "Genomics Perspectives of Bioethanol Producing *Zymomonas Mobilis*" authored by S. Sheik Asraf, K. N. Rajnish, and P. Gunasekaran, from India. This chapter focuses on recent efforts made to engineer Z. mobilis, transcriptomic, genome-based metabolomic studies, and bioinformatics exploitation of the available genomic data for the production of bioethanol. There has been phenomenal interest in biofuels in recent years; there has been continuous increase in demand for fossil fuels that led to the need of new potential fuel sources. The next chapter is entitled "Counter-Rotating Type Power Technologies to Exploit Offshore Energies" authored by Toshiaki Kanemoto from Japan. This chapter discusses the advanced technologies to successfully exploit the offshore marine and wind resources. An innovative approach is discussed in this chapter called Counter-Rotating Type Hydro/Tide Power Unit, which is composed of the tandem runners and the peculiar generator with double rotational armatures, is applicable to both rising and falling tides at the power station with the embankment, in place of the traditional bulb type turbines. The next chapter is entitled "Stability Analysis of Grid-Connected Photovoltaic Systems" authored M. A. Mahmud, M. J. Hossain, and H. R. Pota, from Australia. This chapter presents an overview Photovoltaic (PV) power generation and integration of PV systems with power grid. This chapter also presents a feedback-linearizing current controller to synchronize the PV system with grid. This controller is designed based on the feedback linearization technique. The reference current for the controller is generated from the maximum power point tracker. The final chapter is entitled "Energy from Waste: Present Scenario, Challenges, and Future Prospects towards Sustainable Development" authored by Kalpana Arora, Ashwani Kumar, and Satyawati Sharma. This chapter provides one key solution for two major related problems: energy crisis and waste management. Energy from biomass is a promising alternative for the fossil fuels which are becoming scarce and costly. Due to the significant amount of organic waste from agriculture, industries, and community sources collected annually, it can be converted to useful energy forms like biohydrogen, biogas, and bioalcohols through various waste-to-energy routes for sustainable development. This chapter provides a comprehensive review of

the technical, economic, and environmental aspects of various waste to energy techniques and focuses on the belief that this thermochemical conversion is a step forward towards sustainable development.

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