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**Dr Mrs Malti Goel President, Climate Change Research Institute presents a book on “Solar Energy: Made Simple for a Sustainable Future” in Green Energy and Technology Series of Springer Nature**

Analyses solar technology developments, with emphasis on their applications in urban and rural environments

Empowers policymakers, researchers and communities to gain a greater understanding of the potential of solar energy

Contributes a chapter on India’s initiative on International Solar Alliance describing international objectives for climate-compatible development

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The book is quick reading for the experts, researchers and an inclusive knowledge resource to students, teachers and policy makers. It exposes them to recent scientific and technological breakthroughs in solar energy. The reader will learn from several applications that how science has provided tools for harnessing solar energy in its different forms as heat, light & chemical and how it can help toward a clean energy transition.



## Preface

...We should be using Nature's inexhaustible sources of energy—sun, wind, and tide... I'd put my money on the sun and solar energy. What a source of power! I hope we don't have to wait until oil and coal run out before we tackle that.

—Thomas Edison in 1931 in conversation with Henry Ford<sup>1</sup>

Solar energy is people's energy. The book *Solar Energy: Made Simple for a Sustainable Future* provides glimpses of vast application areas of solar energy. Its 14 chapters aim to create public awareness about solar energy, educate the youth about the fundamental principles of its conversion, and create understanding among the masses about its large-scale applications. Since ancient times, many world regions have harnessed Sun's energy for human comfort. Solar as an alternative for electricity generation became known in the last seventy years. The book explores new ways of harnessing solar energy as chemical energy, in addition to solar heat and light, and covers large-scale applications in buildings and cities. Fundamentals of solar collectors, and various other devices, being used in households and industry for power production, process heating, and cooling are described.

Progress in solar energy is helping us to meet our national commitments for international agreements and protocols such as Paris Agreement on climate change and achieving sustainable development goals. The book has a particular chapter on International Solar Alliance, an Indian initiative with a vision to realize “One Sun, One World, One Grid”. India being a tropical country, there is plenty of sunshine throughout the year, and “solar hotspots” are many. India has set a laudable target to achieve the installed capacity of 175 GW from renewable energy sources by 2022, out of which 100 GW is to be met from solar energy. A total of 48 GW has been achieved as of December 2021.

Dr. A. P. J. Abdul Kalam, late President of India, greatly appreciated the first author's book on Energy Sources and Global Warming published by Allied Publishers

<sup>1</sup>1987. *Uncommon Friends: Life with Thomas Edison, Henry Ford, Harvey Firestone, Alexis Carrel, & Charles Lindbergh* by James D. Newton (James Draper Newton). Quote Page ix. Harcourt Brace Jovanovich, San Diego, California.

## Chapter 1

### Solar Energy—Then and Now



#### 1.1 Solar Breakthrough

**A Solar Breakthrough**—In 2016, *Solar Impulse 2* landed back after a 25,000-mile trek worldwide. It was a feat in which a two-pilot team demonstrated the solar energy potential to take a round-the-world trip without using any fossil fuel and relying only upon the Sun as a fuel source.

The *Solar Impulse* was a commendable achievement since the first solar Aircraft demo by Paul Macready, who took a historic flight in 1981 from France to England, comprising of 1600 solar cells. *Solar Impulse 2*: in 2016, a solar-powered aircraft created excitement “*Solar Plane makes history after completing round-the-world trip*” as reported in *The Guardian* on 26 July 2016. After a 40,000 km journey with zero fuel, Piccard Bertrand and André Borschberg completed 118 h of flying. Using solar energy the plane reached its starting point in Abu Dhabi after nearly 17 months [1]. The navigation, which began on 9 March 2015, was made possible by using 2.3 tones solar battery. Sunlight constantly charged the 17,248 solar cells on board.

The *Solar Impulse* feat made possible what looked impossible; thus giving hope to mankind that solar energy is the energy of the future. As expected, solar energy technology is revolutionizing the energy scene. In the transportation sector viz.; solar cars, solar space crafts, solar two-wheelers, solar trains, solar buildings, and solar cities are the incorporating large-scale applications. Solar energy storage and solar hydrogen production is expected to accelerate the global clean energy transitions beyond our imagination.

#### 1.2 Solar Energy in Ancient Times

Sun has been a source of energy on earth from time immemorial. Almost all of the ancient civilizations worshipped Sun as God. The deities or Gods of Sun, as manifested in their place of worship, are *Helios* in Greece, *Surya* in India, *Apollo* in