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Book Review

RENEWABLE ENERGY
Sustainable Energy Concepts for the Future

Roland Wengenmayr, Thomas Bührke (Eds.)

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The book *Renewable Energy. Sustainable Energy Concepts for the Future* contains 19 contributions written by experts into diverse renewable and alternative energy fields and is focused on two big areas: (1) Rapidly enhanced production of energy from renewable sources and (2) increased energy efficiency, especially of buildings where a large amount of our total energy need is generated. As was said into the preface written by Eicke R. Weber, Director of ISE Institute for Solar Energy Systems, Freiburg – Germany "this volume provides an excellent, concise overview picture of renewable energy important area, combined with interesting details for each topic for the specialists". The main discussed topics include photovoltaics, solar thermal energy, geothermal energy, energy from wind, waves, conventional hydroenergy, bioenergy, hydrogen technology with fuel cells, building efficiency and solar cooling.

The catastrophic climate change and a secure energy supply in an intelligent manner are the principal aspects that must be taken into account when is discussing the world future into an optimistic, hopeful and simple vision. Renewable energy is a key concept for the 21st century. The increasing number of wind power plants, solar collectors and photovoltaic installations demonstrates that many innovations for tapping renewable energy sources have been performed. Hydroelectric plants will continue to produce electric energy and represent the second industrial revolution of widely-available electrical energy grids. The use of geothermal heat that is abundantly available almost everywhere are entering the stage of large-scale pilot projects. The development of using the renewable and alternative energy supplies was so dynamically in the last few years, and the interest for the principal renewable energy supplies have been taken into consideration for the safe and progress of our Earth. In this context, the future will search for possibilities to allow us to make more intelligent use of the valuable energy resources and to save and conserve energy for people live.

The man-made changes of atmosphere composition, especially the concentrations of carbon dioxide (CO_2), laughing gas (dinitrogen monoxide, N_2O) and methane (CH_4) are the principal factors that impose the increasing of renewable energy uses instead of the conventional useful energy production with conventional fuels (coal, petroleum products etc.) that discharges into atmosphere important gaseous emissions. Also, if the efficiency of depollution techniques applied for these gaseous emissions is high enough, the concentrations of CO_2, N_2O and methane are in good agreement with the international requirements and have no toxic or other important secondary effect on atmosphere pollution. But, the recent report of the Intergovernmental Panel on Climate Change (IPCC) and the agreements of the Bali Climate Summit in December of last year (2007) demonstrate that the world starts to face the technological and political challenge poised by the requirement to reduce the emission of these gases by 80% in the next few decades.

All the authors of this book are from Germany, since the German Federal government has massively subsidized renewable energy technologies for many years, more than any other industrial nation thus far. Thus, German scientists, engineers and companies have conquered a leading position worldwide in many areas of renewable energy sources, for example in wind and photovoltaic conversion.

The first contribution of this book entitled "*High-quality, First-hand Information*" (authors: Roland Wengenmayr and Thomas Bührke) is a summary of all the next contributions on renewable energy supplies, containing important information about production, potential for saving energy, and how renewable energy can be efficiently stored, transported and converted into useful forms (mechanical work, thermal and/or electric energy) into Germany in comparison with other European state or high industrial developed state.

The second contribution: "*The Development of Renewable Energy Carriers. Renewable Energy Sources on the Rise*" is focused on the progress of renewable energy strongly promoted in Germany in order to fulfil the established requirement that the share of renewable energy in the total energy consumption of the EU must increase to 20% until 2020. Nevertheless, the rise of renewable energy is remarkably dynamic in many European countries (e.g. Belgium, in the central and eastern European acceding countries such as Hungary and the Czech Republic). The wind energy usage has experienced a remarkably dynamic bloom between 2002 and 2006, when the installed power has more than doubled to approximately 48000 MW and two thirds of European wind power are installed in Germany (28 % global market share) and Spain (15.6 %). The global market suggests that the third largest market for wind energy plants is represented by USA (15.6 % global market share). The leading wind energy plant manufacturers include Danish and German companies, particularly the German example shows how massive support of renewable energy promoted the rise of completely new high-tech industrial sectors that have grown to economically successful global players. In 2005, the heating from renewable energy sources in Germany was 5.4%; biomass is the unchanged leader, with annually almost 76.5 TWh; the traditional wood burning is complemented by modern methods, for example wood-pellet heating systems; solar thermal heating using collectors on roofs and other surfaces is also growing rapidly, more than double increasing (comparison with 1990, the increase has been more than twentyfold); the German automobile engines consume small fraction of biogenic fuels, mainly biodiesel, and small amounts of bioethanol (3.4% of overall fuel consumption); the "small-scale water power" still has limited possibilities for further development. By 2050, the proportion of primary energy obtained from renewable sources could reach 50 % in Germany (estimation of Dr. Harald Kohl, author of this article).

An other important contribution: "*Wind Energy. A Tailwind for Sustainable Technology*" confirms the rapid increase in the utilization of wind energy within the past fifteen years as a result of technological developments and a favourable political climate. Prof.Dr.Ing. Martin Kühn points that alongside the continued improvement of efficiency and economic competitiveness of the wind energy systems, political aspects are now becoming more important. Among these is integration into the national and international power grid and into the international energy economy, as well as a societal consensus concerning energy policy. Power generation from wind energy is in transition from an alternative to mainstream energy source and can make a decisive contribution to a climate-compatible and economically feasible power generation system.

The flowing energy is described into the contribution of the science journalist, Mr. Roland Wengenmayr, "*Flowing Energy*" that underlines the importance of Kaplan turbines with a low head of water into power generation. Also, the Francis turbines are used for moderate hydraulic gradients and Pelton turbines for very large gradients with high flow velocities. These are river power plants and storage power plants that can convert the kinetic energy of the water into electrical energy with up to 90 % efficiency.

Professor Robert Pitz-Paal discussed into the topic "*Concentrating Solar Power Plants. How the Sun gets into the Power Plant*" the three types of construction of concentrating solar power plants that collect sunlight, like giant-magnifying glasses, and use it to drive thermal engines for electric power generation. These constructions are commercially available systems with sun-tracking, silvered parabolic troughs (for descentral application, parabolic mirror dishes with a Stirling motor) which concentrate the solar radiation onto a central absorber tube, through which a heat-transfer medium flows. In the central-receiver systems, a field of sun-tracking mirrors focuses the sunlight onto the top of a tower, while a receiver passes the heat energy to a thermal-transport medium.

The science journalist Roland Wengenmayr has another contribution into this book entitled "*Photovoltaic Energy Conversion. Solar Cells – an Overview*" that remarks the rapidly growing of the market share of photovoltaic, but in absolute terms, the photovoltaic cells contribution is still rather small and the required investment costs are high.

About modern solar cells discusses also Dr. Giso Hahn into the scientific contribution: "*New Materials for Photovoltaic Energy Conversion. Solar Cells from Ribbon Silicon*" and confirms the use of crystalline silicon as basic material of modern solar cells, with a tendency towards less expensive multicrystalline wafers. Ribbon silicon makes use of a different preparation technology to avoid this material loss, and so yields considerable cost savings. In terms of efficiency, solar cells made from ribbon silicon wafers are already nearly competitive with conventional cells and can be integrated into existing production lines for solar cells on a crystalline silicon basis.

Dr. Nikolaus Meyer presents the structure and function of CIS thin-film solar cells (Copper Indium diSulfide – CIS, a thin-1 μm semiconductor film as absorber into a glass substrate) considered as day-solar modules into the scientific contribution: "*CIS Thin-film Solar Cells. Photovoltaic Cells on*

Glass". The fabrication of these CIS photovoltaic cells demands an complex process technology, consumes a large quantity of materials and has been developing as an alternative cell technology by Hahn-Meitner Institute (HMI) in Berlin. The SulfurCell Solartechnik GmbH enterprise, founded on the basis of the HMI technology, is now setting up for pilot-plant production. CIS modules are estimated to be about 50 % cheaper to energy produce than current silicon solar cells.

Another form of renewable energy - geothermal energy - is discussed into the contribution of Dr. Ernst Huenges entitled: "*Geothermal Power Generation. Energy from the Depths of the Earth*". He considers that the Earth contains enough heat to permit geothermal electric power generation that requires water temperatures over 150° C. A simulation technology of geothermal electric power generation was successfully tested by the GeoForschungZentrum Potsdam at a 4,309 m deep borehole at the German Geothermal Laboratory in Groß Schönebeck and has as the principal elements an injection well system, a hydraulic stimulation system, a production well system and an electric power plant circuit (vapour generator- turbine-electric generator-condenser).

The next contribution: "*The Karlsruhe Process bioliq®. Synthetic Fuels from the Biomass*" written by Dr. Nicolaus Dahmen, Dr. Eckhard Dinjus and Dr. Edmund Henrich underlines the concept of centralized production of synthetic gas and fuel and the main process steps: (*i*) *descentral stage*: 1- rapid pyrolysis of biomass and 2- slurry production followed by (*ii*) *central stage*: 3- high-pressure flow gasification, 4- gas conditioning, 5- synthetic fuel production. Synthetic fuels from biomass can provide an important contribution to a renewable energy economy. The Karlsruhe BTL concept bioliq aims at bringing decentral production in line with centralized processing on an industrial scale. The bioliq process was distinguished with the BlueSky Award by the UN Organization UNIDO in 2006.

An other contribution in the field of biofuel entitled "*Biogas and agro-biofuel. Does the Future Belong to Biogas* ?" summarizes the well-known idea that the production of biogas in many small agricultural enterprises provides a great potential of producing heat, electrical power, and even automobile fuel on a predominantly climate-neutral basis. The author, Roland Wengenmayr – a reknown editor and journalist, concluded that the production of biogas is particularly attractive in places where farmers can feed the biogas into an existing natural gas grid. The so-called first generation agro-biofuel, i.e. bioethanol and biodiesel, requires growing high-energy plants such as canola or corn, consuming large amounts of valuable soil and water, and in particular, considerable fertilization. The so-called second generation agro-fuels will have a better promising ecobalance as they use the complete plant not only its energy-rich seeds (e.g., a native prairie grass delivering five times more energy stored in bioethane as its production consumes, and no fertilizer demand).

The functioning principle of a solar updraft tower power plant (experimental prototype operating in Manzanares, Spain) is synthetically presented into the contribution "*The Solar Updraft Tower. Electric Power from Hot Air*". The authors, prof.Dr.ing. Jörg Schaich, Dr.ing. Rudolf Bergermann, Dr.ing. Gerhard Weinrebe, said that the combination of greenhouse effect with chimney effect permits to produce electrical energy from solar radiation but must have enormous dimensions in order to generate electricity economically.

Prof.dr.ing. Kai-Uwe Graw presents the tested prototypes of wave-motion power plants utilizing the technology of an oscillating water column (OWC) into his contribution "*Wave-Motion Power Plants. Energy Reserves from the Oceans*" and assumes that electrical power from wave-motion plants in EU would presumably cost about the same as wind-generated power.

The contribution "*Hydrogen as a Carrier of Energy. Is the Hydrogen Economy Around the Corner ?*" written by Dr. Gerd Eisenbeiß concludes that hydrogen is comparable to natural gas as an energy carrier but hydrogen will have a chance to become economically competitive only when natural gas becomes more scarce and more expensive per kWh than electrical energy. Hydrogen has an advantage only in the area of mobile applications for vehicles and for mobile machinery: this is due to its superior energy storage capacity.

In energy-supply systems with combined heat and power (CHP) generation, or also in combination with renewable energy sources, especially solar energy, the question often arises as how to store the thermal energy is discussed by Dr.ing. Silke Köhler, Dr.ing. Frank Kabus, Dr.ing. Ernst Huenges into their contribution: "*Seasonal Starage of thermal Energy. Heat on Call*". Seasonal storage can be applied successfully using structures such as hot-water storage in tanks and in gravel-water reservoirs. Underground storage has also been practiced, using borehole fields or aquifers.

Dr. Manfred Waidhas and Dr. Harald Landes are the authors of scientific contribution: "*Fuel Cells for Mobile and Stationary Applications. Taming the Flame*" and considers that fuel cells allow clean and resource-efficient energy conversion. Fuel cells have reached a high level of technical development (e.g., PEMFC, SOFC and MCFC have been already tested in plants of 100 MW and more) but a drastic cost reduction must be achieved, both for the fuel-cell stack itself and for the ancillary systems required for its operation.

The next two contributions "*Solar Air Conditioning. Cooling with the Heat of the Sun*" and "*Climate Engineering. A Super Climate in the Greenhouse*" are written by the same author, science editor and journalist Roland Wengenmayr, and are focused on the two basic methods of operating solar-

assisted cooling systems (e.g., *closed system* - cycle cooling-water circuit and *open system* – a high throughput of air into an open circuit) utilizing as absorption media the drying agents. This principle permits heat to be transported out of the buildings. Large modern buildings with glass facades need extensive air conditioning in summer and heating in winter. An intelligent architecture can overcome the waste of volume, energy and unhealthy environment, as the Post Office Tower in Bonn (Germany) with its 41 stories.

A case study of an intelligent overall concept of a new energy-efficient building organized into a therapy building for approximately 40 residents is evaluated into the contribution of Matthias Schuler and Christian Matt entitled "*A low-energy Residence with Biogas Heating. An Exceptional Sustainability Concept*". Large windows combined with good insulation use solar heat in winter and reduce electricity-consuming artificial lighting. Via an earth duct, the ventilation system beneath the new building preheats the fresh air in winter and cools it in summer. A neighbouring farmer provides heating and hot water from a biogas system with co-generation unit. This unitary concept reduces the total greenhouse gas emissions of the building complex including the farmhouse tremendously.

The last contribution "*Promotion of Renewable Energy in Germany. How Political Will Changes a Country"* by Dr. Thomas Bührke explains how some programs and measures of the German Federal Government promote renewable energy, saving energy and reducing greenhouse gas emissions for a number of years (e.g., the Renewable Energy Sources Act (EEG), development of cogeneration, the Energy Saving Ordinance (EnEV), improvement of rail traffic etc.).

A 2007 publication of the Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety mentioned that 12 % of the electricity and 5.8 % of consumed primary energy in Germany is originated from regenerative sources. In 2006 and 2007, the financial volume available in Germany for continuing renewable energy production and energy saving amounted to a total of 720 million euros, allocated to interest rate reduction and partial debt relief.

The editors of this book have as main goal to synthesize some critical rather than encyclopaedic points of view of some important experts in the renewable energy field covering the most important topics and technologies needed to reach efficient renewable energy production and building energy saving.

This book is necessary to people working into various fields of renewable energy and for those interested in finding new applications and actual information on new intelligent concepts on sustainable renewable energy, efficient and clean energy production and building energy saving. Also, the book is a real representative one into environmental education and will assist students who are in the process of selecting an inspiring, relevant topic for their studies and later their thesis research.

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