

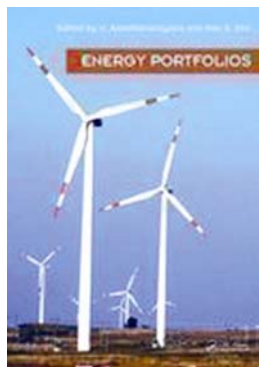
acid, BMP and Wnt pathways are reiteratively used during endoderm organ development. Study of gonad development across species brings out certain interesting facts, for example regardless of sex determining mechanisms, adult testes and ovary structures are similar across species. Also, adult testes and ovary are significantly plastic and this plasticity can be influenced by hormones, loss of germline and social conditions.

The volume includes interesting articles on vernalization in plants, quantitative time-lapse fluorescence microscopy in single cells and innovations in undergraduate biology teaching. The last is aimed at improving 'American competitiveness' but probably has some lessons for us in India. The author W. B. Wood recommends innovative ways (e.g. research-based teaching, student-faculty interactions in class and out-of-class learning activities) to make undergraduate students either aware of life processes (that will help them in their future life as managers, tax-consultants, engineers, technocrats, etc.) or prepare them for a career in biology (scientists, biotechnologists, etc.). Such efforts are beginning to be initiated in India (for example, in the IISERs) but one wonders how and when such innovations could be enjoyed by the large number of students opting for biology in hundreds of colleges across the country.

In summary, the 25th volume of ARCDDB keeps up with the high standards of the series and almost every biologist will find at least parts of it interesting and of useful reading. After careful perusal of this book, my feeling has been that of one who has just finished an intense aerobics session: exhausted but with a feeling of exhilarating satisfaction. If you like the feeling or think that you might, go ahead and read the book.

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**Energy Portfolios.** U. Aswathanarayana and Rao S. Divi (eds). CRC Press, Balkema, AK Leiden, The Netherlands. 2009. 334 pp. Price: US\$ 124.95.

Energy is essential for economic and social development of a region or a nation. The availability of secure and affordable energy supplies decides the stability and prosperity of a nation. However, consumption of fossil fuels is the major cause of air pollution and climate change. Five countries (USA, China, Russia, Japan and India) account for 55% of the global energy related carbon emissions. The threat posed to sustainability by greenhouse gas emissions and deterioration of the natural resource base (for example, oil crisis and fuelwood scarcity) has caused worldwide concern. Improving energy efficiency and de-linking economic development from energy consumption (particularly of fossil fuels) is crucial for sustainable development of a region. The energy sector, on one hand, is a part of the economy and on the other hand it itself consists of parts such as energy supply and energy demand interacting with each other. Both these interactions are of immense complexity. Energy is required for all the economic activities. Energy supplies are necessary for both intermediate production as well as final consumption. So, economic development is dependent on the energy system of the country. In turn, the implementation of technologies or improvement of the energy system is dependent on economic factors such as capital costs and energy prices. Also, the demand-supply balance involves the flow of energy from source as primary energy to service as useful energy. At each stage of the energy flow, technologies are involved with different conversion efficiencies and losses.

Energy has always been a major component in the day-to-day life of humans. More than a billion people in industrial-

ized countries (about 20% of the world's population) consume nearly 60% of the total energy supply whereas about five billion people in developing countries consume the other 40% of the total energy supply. The two billion low-income people (US\$ 1000 annual income per capita or less) scattered in rural areas and scanty towns use only 0.2 toe (tonne oil equivalent) of energy per capita annually, whereas about a billion rich people (US\$ 22,000 annual income per capita or more) use nearly 25 times more, at 5 toe per capita annually.

Every country is striving for economic growth through energy intensive paths. Energy intensities are useful indicators in describing the energy used for entire production chains. The combination of sectoral energy intensities with demands for sectoral outputs provides insight into total energy use in an economy. Changes in energy use reflect the combined effects of changes in energy intensities in various sectors and changes in the volume and structure of demand. Energy needed per unit of production (referred to as energy intensity or specific energy consumption) shows the sensitivity of products or sectors to changes in energy prices. Temporal analyses or a historical study of energy intensities provides information about changes caused by energy-price changes and their effects on total energy use. The paradox when dealing with energy is that it is needed for man to live and develop, and at the same time, unplanned developmental activities focusing more on fossil fuels is affecting the environment he is living in. Moreover, the evolution of societies, the economic growth and the way countries develop lead to an increasing demand for energy. Two problems arise with increasing energy consumption: first, pollution associated with energy consumption increases leading to unknown changes in world climate that could have tremendous repercussions, and second, fossil fuels commonly used are not renewable. Even if people are concerned about the future of the planet, the power of money and need for economic growth dominate the debate. Studies have been made on the different resources, nuclear power and environment-friendly energies like solar, wind and others in order to replace fossil fuels, and more generally on non-renewable energies<sup>1</sup>.

The energy use per capita has been used as an index of a nation/region's

development. Energy per capita is quite small for developing countries and high for developed countries. However, this approach does not reveal any picture of development or efficiency of usage. To achieve this, it is necessary to look at the energy intensity, which is energy/GDP. The energy consumption per GDP gives the efficiency for the energy sector. The energy intensity of a process (energy consumed per unit of output) is the inverse of the energy efficiency of the process (output per unit energy consumed). The impact of more efficient energy use in reducing energy demand, and the overall prospects for restraining energy-demand growth, are important issues in the context of environmental policy. Energy intensity is directly related to price signals whereas energy efficiency depends more on diffusion of the most cost-effective technologies. It is important to point out where the loss of energy is highest in order to reduce it. It happens that some developed countries have lower or similar energy consumption per capita and a much higher gross domestic product (GDP) per capita than some developing countries. Energy services will be fulfilled only if GDP grows in a sustainable manner. Such economic growth will require the provision of corresponding energy related services at an affordable price, with no reasonable expectation to break the linear relationship between GDP growth and increase in energy demand that has been experienced so far<sup>2</sup>.

The publication under review provides a comprehensive knowledge base pertaining to energy sources and technologies to facilitate informed choices with regard to energy sourcing and energy technologies. This would help planners to evolve appropriate strategies for achieving a job-led, low-carbon economic growth. The publication becomes relevant in the context of initiatives to limit the global temperature increase to 2–2.4°C above the preindustrial temperature. The global economy is projected to grow four-fold between now and 2030 and countries such as India and China are expected to achieve ten-fold increase. This entails much greater use of energy. The continued dependence on fossil fuels for electricity generation and transportation would impart unsustainable pressure on natural resources and has implications for climate change and the environment. The adverse effects could be avoided by

decoupling economic growth from energy demand and reduction in the use of fossil fuels. Green power, end use energy efficiency and carbon capture and storage (CCS) are emerging as effective strategies in recent times to stabilize carbon emissions.

The book has five sections (on coal, oil and natural gas, nuclear power, renewable energy sources and *quo vadis?*) focusing on the use of technologies to optimize energy productivity and minimize carbon emissions and adverse environmental and health effects. These sections also include country studies for principal energy sources, apart from details on the optimal sizes, capital costs, operation and maintenance costs of power plants, adverse environmental and health consequences and ways of mitigating them in respect of low carbon energy options.

Section I focuses on technologies for maximizing the efficient use of coal while minimizing carbon emissions and related environmental implications. This section is mainly based on the author's work and publication of the International Energy Agency<sup>3</sup>. It begins with a discussion on the formation of coal, followed by coal bearing sedimentation sequences, emissions, coal mining technologies, environmental impact of coal mining and waste from coal industries, and concludes with a discussion on new power generation technologies. Technologies that are presented include super critical and ultra super critical pulverized coal combustion that can attain efficiencies greater than 50%. Circulating fluidized bed combustion (CFBC) which allows *in situ* capture of SO<sub>2</sub>, integrated gasification combined cycle (IGCC) from which CO<sub>2</sub> can be captured and stored, and fuel cell-IGCC hybrid systems that are characterized by higher thermal efficiencies with lower emissions of NO<sub>x</sub> and SO<sub>2</sub>.

Section II by Rao, on energy from oil and natural gas, is a compilation of information from the United States Energy Information Administration (EIA), the United States Geological Survey (USGS) and the International Energy Agency (IEA). Fossil fuels (coal, oil and natural gas) account for 88% of the global commercial primary energy. Burning of fossil fuels leads to the production of climate relevant emissions of CO<sub>2</sub>, CH<sub>4</sub>, NO<sub>x</sub>, CO and VOC (volatile organic compounds). This section profiles the geographical distribution, reserves and resources. Oil and natural gas

are products of the burial and subsequent transformation of biomass over millions of years, and are characterized by their intrinsic qualities of extractability, transportability, versatility and cost. The projection based on the analysis of historical data of consumption and demand shows the continued dominance of oil in the future energy portfolio of the world. The projection shows that world consumption of petroleum product will grow to 118 million barrels per day by 2030 and oil will continue to be a major source of energy in the future. The contributions of oil and gas to the year 2030 emissions are 482 and 111 MMT (million metric tonnes) respectively.

Section III by Aswathanarayana deliberates on the energy from atoms. The author's affinity to the subject is evident from the discussions of factors driving the so-called 'resurgence' of nuclear power. Considering issues (such as safety and disposal of waste) of public concern, this section focuses on technologies for vitrification of radioactive wastes, design of fail-safe reactors in which melt down is not possible, and nuclear fuel cycles which generates less waste.

Section IV focuses on renewable energy sources that include renewable combustibles and waste (solid biomass, charcoal, renewable municipal waste, gas from biomass and liquid biomass), hydro, solar, wind and tide energy. As per estimates, renewable energy sources account for 12.7% or 1493 Mtoe (millions of tonnes of oil equivalent) of the world's total primary energy supply. Presently, hydropower accounts for 90% of the renewable power generation and is estimated to go up by 1700 GW producing 5000–5500 TWh/year by 2050. The global installed capacity of wind power stations is 94 GW producing 152 TWh of electricity, which is less than 1% of the global electricity supply. The subsection on bioenergy projects major share of bioenergy: about 700 Mtoe/yr for transport biofuels, about 750 Mtoe/yr to generate electricity (2500 TWh/yr) and 2200 Mtoe to produce biofuels, heating, cooking, etc. This section also emphasizes the bright prospect for biofuel from algae, which has greater potential. Much research is being done at the Indian Institute of Science to develop sustainable technologies and for cultivating specific diatom strains for gasoline production<sup>4</sup>.

Section V provides the database which individual countries can make use of to

customize their energy portfolios, by choosing the precise mix of CCS, renewable and nuclear technology to decarbonise the power sector, to suit their resource position, and biophysical and socioeconomic environments. Considering that safe sequestration of carbon dioxide and radioactive wastes requires a good understanding of the complex interactions between the pressurized fluids and porous rock, the author emphasizes the need for a great deal of basic and applied research to underpin the new technologies.

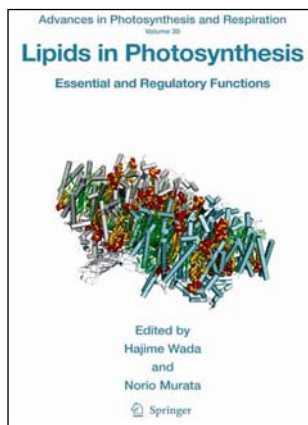
The octogenarian author has done a commendable job in bringing together a variety of techno-socio-economic considerations to focus on energy portfolios. This is a good reference book for energy researchers, university students and policy makers across the globe. Consolidated references provided at the end of each section will help researchers. Lucid presentation of these diverse concepts is the hallmark of the author's blend of vast knowledge and experience. I read this publication twice and I am sure many readers will experience the same temptation of referring to this practical publication many times. Policy makers especially from developing countries should take serious note of the author's suggestion of the need for decoupling economic growth from energy demand, reduction in the use of fossil fuels and improvements in the energy economy through efficient use of end use energy, greater use of renewable sources of energy, CCS on a massive scale and development of carbon free transport.

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**Lipids in Photosynthesis: Essential and Regulatory Functions (Advances in Photosynthesis and Respiration: Volume 30).** Hajime Wada and Norio Murata (eds). Springer, The Netherlands. 2009. 474 pp. Price: US\$ 279.

An earlier volume on *Lipids in Photosynthesis: Structure, Function and Genetics*, edited by Paul A. Siegenthaler and Norio Murata, volume 6 of the *Advances in Photosynthesis and Respiration* (AIPH) series was published in 1998 (book review: *Current Science*, 1999, **77**, 457–458) and it was received very well by both experts and researchers working on photosynthesis and related fields.

The current volume 30 of the AIPH series *Lipids in Photosynthesis: Essential and Regulatory Functions*, edited by Hajime Wada (University of Tokyo, Japan) and Norio Murata (National Institute for Basic Biology, Japan) gives a uniquely new outlook and approach to photosynthesis research in lipids. As the two eminent editors state in their preface, in the past 10 years, great many advances and leaps forward have been made in areas involving genetics and genomic research, and the elucidation of the role of individual lipid species in regulation of photosynthesis. This new volume is thus new in content and concepts on the role of lipids in the regulation of photosynthetic processes and the importance of photosynthesis in regulating biosynthesis of both membrane and storage lipids. The book contains 20 'in depth' chapters contributed by 52 internationally known experts in the field. The following website provides a complete table of contents, including the front matter and the index of this book: <http://www.springerlink.com/content/978-90-481-2862-4>.

The introductory chapter (chapter 1), authored by the two editors who contributed immensely to the progress in the theme of the volume, tells us about the recent developments in techniques and provides information and knowledge in the field, namely genome – sequences mutagenesis and transgenics, revealing genes in lipid biosynthesis, crystallographic analyses of soluble and membrane bound proteins and also on the development of techniques in quantifying membrane fluidity, membrane protein trafficking and the role of membranes in stress signal perceptions.

The next five chapters (2–6) deal mostly with the biosynthesis of fatty acids, chloroplasts and mitochondria lipids, plant sphingolipids and, interestingly, with lipids in algae, mosses and lichens. The following three chapters (7–9) discuss molecular genetics of lipid biosynthesis, regulation of lipid synthesis in the model green alga *Chlamydomonas*, regulation in the lipid biosynthesis in cyanobacteria, besides the nitrogen fixing heterocyst envelope glycolipids and their biosynthesis.

Subsequent chapters (10–13) provide details on lipids in the structure and function of photosystem I (PSI) and photosystem II (PSII) as well as Cyt  $b_6/f$  complexes of photosynthesis. The lipid filled cavities in PSII and Cyt  $b_6/f$  complex are vital in protons and electrons flow in quinone/quinol exchange mechanisms. Also, the high lipid contents in PSII interior facilitates the ability of diffusion of oxygen from oxygen evolving Mn clusters. The key role of phosphatidyl glycerol in photosynthetic and non-photosynthetic function, importance of glycolipid in oxygenic photosynthesis, role of glycolipids in photosynthesis, and role of lipids in the lateral mobility of membrane components and phase transition features are brought out. The next chapter (14) gives a fascinating description of the architecture of thylakoid membranes, their 3D organization and their evolutionary hierarchy. Chapter 15 discusses the involvement of membrane fluidity in gene expression and stress tolerance especially cold, and more importantly in signal perception. The chapter 16 tells the story of lipid homeostasis and the nature of galactolipids as well as the importance of galactolipid precursor in signalling lipid biosynthetic pathways. Further, this chapter describes the molecular mechanisms of lipid trafficking involving glycerolipids.