

**BOOK REVIEW**

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# Review of *Biofuels: Meeting the Energy and Environmental Challenges of the Transportation Sector* by Daniel Ballerini

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## Book details

Ballerini, D

*Biofuels: Meeting the Energy and Environmental Challenges of the Transportation Sector*

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With the book *Biofuels, Meeting the Energy and Environmental Challenges of the Transportation Sector*, Daniel Ballerini published a comprehensive overview of biofuel production and markets. It is a revised and translated version of the book *Les Biocarburants - État des lieux, perspectives et enjeux du développement*, which was first published in 2006 but has been only available so far in French. Changes in the world energy context, the increasing awareness of the environmental stakes and the development of research into the production of second- and third-generation biofuels have created a need for a new book to be written. The back cover of the book proclaims that it provides a detailed state-of-the-art description of first-generation biofuel production technologies. Furthermore, it describes the new second- generation pathways that use lignocellulosic biomass as a raw material and have been found to have industrial applications. The book also provides a technical update of the algae-to-energy pathway (third generation) and the production of methane and hydrogen via biochemical pathways.

To comply with this aim, Daniel Ballerini gathered 22 experts in the field to contribute their knowledge as authors. Many of the authors are affiliated with the French IFP Énergies nouvelles, which is surely a reason why the elaborations on biofuels are well connected to general issues in the petrol industry. Figures and tables adequately complement the text. Each chapter is followed directly by a list of references, of which only few are French

publications. A five-page index may serve for navigation in the book.

The book's seven chapters follow a pragmatic structure. The first chapter is an introduction to the topic. Chapters two and three deal with current biofuels for spark ignition engines and diesel engines, respectively. Chapter four gives an introduction to 'lignocellulosic biomass resources'. Their conversion into biofuels via thermochemical and biochemical pathways is treated in chapters five and six, respectively. Finally, chapter seven covers 'other biomass-to-energy biochemical pathways'.

Chapter one provides a comprehensive introduction to the controversially discussed topic of biofuels. It starts with a short historical background of biofuels, beginning in the 1960s, which were envisaged to be the main energy carriers of choice in the early days of motorised transport. It then gives a good overview of the competitiveness and different interests and concerns of many of the stakeholders that are involved in biofuel production. Amongst the topics discussed are safety issues in handling and production, environmental and ecological impacts of biomass production and biofuel use. The visions of the refining industry as well as the car manufacturers towards biofuels are also elaborated. Moreover, a short overview of the situation in the mid-2000s is given for the most important regions, such as America and Europe, with some insight into other global regions.

Chapter two addresses the production of ethanol from sugar and amylaceous crops as well as ether fuels. A brief overview of current ethanol production practices is followed by energy balances and a list of improvement options for these processes. To find a whole section about ethers, such as ETBE, MTBE, TAME and ETAE, in a book about biofuels expands the horizon to the possibilities for an incorporation of bio-based compounds like ethanol into the petrol industry. Moreover, the most important industrial players and the state of global ethanol production are briefly addressed, however, only until

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2008. Sections about fuel standards, impacts on engine behaviour and conversion of ethanol into other chemicals and fuels will finally lead us to the environmental and economic aspects of ethanol and ethers.

Chapter three discusses the production, utilisation and environmental and economic aspects of the so-called first-generation biofuels for diesel engines. Starting with an introduction to vegetable oils as a raw material, biodiesel production via transesterification is mainly covered. This is partnered with a short introduction to diesel fuel production via hydrotreatment and hydroisomerisation. Again, some of the most important industrial players and the state of global ethanol production are briefly addressed, unfortunately only until 2008. The direct combustion of plant oils in diesel engines is also presented but with the conclusion that manufacturers do not tolerate the resulting risks. A rarity in the main chapter is the subchapter on the use of biofuels for aviation, which addresses different fuel options.

Chapter four sets the stage for the following chapters by elaborating on the different types of lignocellulosic biomass, their composition, technical potentials and accessibility. Most advantages and disadvantages of second-generation biofuels can be deducted from their feedstock characteristics.

Chapters five and six are dedicated to the production of the so-called second-generation biofuels.

Chapter five deals with thermochemical conversion such as pyrolysis, torrefaction, gasification and hydrothermal conversion. In logical succession, it also contains the synthesis of a number of liquid biofuels and hydrogen from bio-based syngas. The gasification section includes a lot of issues linked to synthesis focussing on Fischer-Tropsch synthesis. The quite important section on gas treatment is less comprehensive and does not adequately include the many different options for gas cleaning and treatment to syngas. For hydrothermal processes, only HTU<sup>®</sup> is considered while other alternatives of hydrothermal carbonisation and liquefaction are also part of research and development (R&D) in Europe. The section on synfuel covers the most important syntheses to liquid fuels (methanol, DME, Fischer-Tropsch) and hydrogen but does not even mention the internationally relevant gaseous fuel, synthetic natural gas via syngas methanation (e.g. demo plant in Güssing). For the mentioned project references, the past few years have shown a dynamic development (e.g. some demo plants have not yet run, such as in Freiberg/Germany).

Chapter six deals with both the biochemical conversion to ethanol and the biochemical conversion using acetobutylic fermentation (ABE). For the ethanol part, the many options of how to disintegrate, hydrolyse and ferment lignocellulose are shortly presented. Some of the biochemical issues of cellulase production and pentose fermentation are also highlighted. A closer look at

the recent developments in this sector, with numerous demo plants in operation and (semi) commercial scale plants announced, would have been perfect. Finally, a historical and technical overview of ABE (acetone-butanol-ethanol) fermentation is given.

Chapter seven deals with the fermentative options for the production of biomethane or hydrogen. While biomethane via biogas upgrading is a commercial technology implemented across Europe, the hydrogen options are on an early R&D level. Moreover, algae production is included, which also addresses different algae options and the extraction of algae oils.

Finally, it can be concluded that this book stands out from a number of published books with similar titles in the last years by being more than a collection of stand-alone articles. By treating almost all of the relevant biofuel options, it provides a valuable background on technical, environmental and economic aspects for anybody who is interested in the complex topic of biofuels. Ballerini's *Biofuels* is well structured, informative and should prove to be a good reference book for both students and professionals from the industry and research, dealing with alternative fuels.

#### Competing interests

Both authors declare that they have no competing interests.

#### Authors' contributions

FML conceived the book review and participated in its design and coordination. AG carried out the major part of the review and drafted the manuscript. Both authors read and approved the final manuscript.

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