

Developments in Economic Geology, 10

WORLD COAL RESOURCES

METHODS OF ASSESSMENT AND RESULTS

by

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PREFACE TO THE ENGLISH EDITION

The availability of energy at reasonable costs has always been a condition of industrial growth, economic and social progress, and the improvement of the standard of living of the world's population. Coal was the world's most important fuel for many years; and was intimately associated with the Industrial Revolution in Europe, after replacing fuel wood as the primary source of energy.

Though coal lost its dominant position to petroleum during this century, it has recently once again been recognized as one of our most important fuels. This revival is due not only to the increased uncertainty created after the "energy crisis" but also to doubts over the ultimate size of hydrocarbon resources and the potential contribution to energy needs by renewable sources. Though coal is only one of the options as a replacement for oil, it can be more than just as "bridge" between an era dominated by hydrocarbons and a world with unlimited renewable sources, despite coals environmental problems, its bulkiness, which hinders easy handling and transport, and the need for new technologies to expand the range of possible coal uses.

Coal mining, processing and transportation operations exceed those of other fuels and minerals (except oil) in regard to tonnage, value of output, employment and contribution to the economy in general. Within a decade, world coal production is likely to be about 5 billion tons annually, distributed among more than 60 countries. Two of the largest producing countries, the United States of America and the Peoples Republic of China, have announced plans to double output during the next ten years; many countries continue to rely on coal for a large segment of their growing energy requirements; and developing countries, many of which have not been major coal producers in the past, have embarked on an accelerated programme of exploration and development. Increasingly, coal is becoming an internationally traded commodity, not only for metallurgical uses but also for power generation.

Research and development activities have been reinforced to make coal a "clean" fuel, compatible with present and anticipated environmental standards. Gasification and liquefaction technologies are in an advanced stage, and various other technologies are being tested. Though many problems remain to be resolved, these new technological developments may ultimately change the quality requirements which coal to be used in the future will have to meet.

Because coal is a fossil fuel, it is not renewable and is therefore subject to eventual exhaustion. There is general agreement that the world's coal re-

sources are vast in relation to present consumption and to the resources of other fossil fuels. But there is also wide-spread disagreement on the actual size of these resources, the quantity of useable coal which is determined by the technical and economic conditions of its extraction, and the methods applied to measure resources. *World Coal Resources*, translated from the German *Weltkohlenvorräte* for which in 1976 the author was awarded the State Price for Energy Research of the Republic of Austria, deals with these questions from a position of knowledge and authority. This book not only presents detailed coal resources estimates for several countries and the world but also describes and evaluates the methods used to calculate them. The author's conclusion that coal is not as abundant as might have been thought, although a surprise to most, is not as much a minority view as it may seem and deserves to be taken seriously.

The book addresses not only the specialist but also the general public interested in problems of energy supplies. This participation of a wider public is essential since the impact of decisions made among alternative choices will be felt by all of us. I hope that the publication of an English translation will help to accomplish this.

February 1979

Wolfgang Gluschke

Centre for Natural Resources, Energy and Transport
United Nations Secretariat, New York

9. FOREWORD TO THE ENGLISH EDITION

Four principal questions are discussed in this publication:

- ▷ What are the viewpoints for the techno-economic assessment and for the classification of mineral occurrences in general, and with special reference to coal?
- ▷ What can we learn from these viewpoints for the assessment of world coal reserves and resources?
- ▷ What is therefore the total of economically significant resources of coal in the world?
- ▷ How can we improve the terminology of mineral occurrences in order to achieve better data for decision making?

The author has dealt with coal reserves and resources since the start of his professional career as a mining engineer and mining economist in the early fifties. The present book has grown out of a paper "Contributions to the Assessment of World Coal Resources or, Coal is not so abundant" which he submitted to the First IIASA Conference on Energy Resources in Laxenburg near Vienna in 1975.¹ A particular characteristic of the book is related to its origins: it is aimed at a relatively heterogenous group and is therefore intended to act in an interdisciplinary manner. The only thing that the audience at Laxenburg had in common was their interest in the energy field.

The book was first published in 1976 with the heading "Weltkohlenvorräte, eine vergleichende Analyse ihrer Erfassung und Bewertung" (World Coal Resources, a comparative analysis of their identification and assessment) for German speaking readers. The English text as it is presented now is an unchanged translation of the German edition.

Of course, in the interval, there have been developments with regard to both main items of the book, – the field of classification of mineral resources, and the knowledge of world coal occurrences. The author has also submitted papers in these topics.²

¹ In: Grenon, M., editor: First IIASA Conference on Energy Resources, a) CP-76-4, International Institute for Applied Systems Analysis, 2361 Laxenburg, Austria, 1976. b) Pergamon Press, London 1979. – The International Institute for Applied Systems Analysis (IIASA) at Schloß Laxenburg near Vienna was founded in 1972 and is supported by the Academies of Science or comparable establishments of 17 countries, including the USA and the USSR. Energy research is one of the projects on which it is engaged.

² Suggestion for an international classification system of coal occurrences. As contribution to discussion in: Coal Exploration, Proceedings of the First International Coal Explora-

With reference to the current discussion of classification systems, the author keeps to his suggestion of a tripartite total of calculated mineral occurrences into Reserves, Other Resources and Other Occurrences, whereby Reserves are economically mineable at present, Other Resources may be additionally of economic value in a foreseeable future of about two generations of man, and Other Occurrences include all geologically estimated amounts beyond the first two categories, which would mean huge proportions in the case of coal. The author therefore modifies the proposals of this book only as far as he now prefers using the term "Other Occurrences" instead of Resources Base, taking into account that Resource Base is already too broadly used in English as synonymous for the concept of Total Occurrences or even the Crust Content. The dispersed minerals in the Crust Content are not considered in this book.

The data for the total of world coal resources – or preferably coal occurrences in the terminology of the author – have increased by about 15 % since the German edition of the book which can undoubtedly be explained

tion Symposium. W. L. G. Muir, editor. Miller Freeman, Publications Inc., San Francisco 1976. – Warum unterscheiden sich Vorratsangaben? (Why do data on reserves and resources differ?) a) Erzmetall 30 (1977) p. 9-15, b) Berg- und Hüttenm. Mh. 122 (1977) Vol. 2a (In honour of the 70th birthday of Prof. W. E. Petrascheck), p. 24-30. – Wie groß sind die in absehbarer Zeit nutzbaren Kohlenvorräte der Erde? (How large are the usable coal resources of the earth in the foreseeable future?) Glückauf 113 (1977) p. 589-600. – Proposal to distinguish between occurrences and resources of mineral commodities with special reference to coal, Third IASA Conference on Energy Resources, Pergamon Press, London 1979. – Quality and "Bonität" of mineral occurrences as factors of mineability, Third IASA Conference on Energy Resources, Pergamon Press, London 1979. – Assessment of world resources of coal, prospects for the production of different types of coal in relation to dwindling supplies of other fossil energy, Preprint of General Report A of the International Symposium on the gasification and liquefaction of coal of the Coal Committee of the United Nations' Economic Commission for Europe in Katowice, Poland, 23.-27. April 1979, Geneva 1979, 19 p. – Coal Reserves and Resources, Preprint of the Preliminary Report on Section I: Reserves and Resources, of the United Nations Symposium on World Coal Prospects, Katowice, Poland 1979, 48 p. – Together with L. Bauer und W. Fiala: Energie, Vorräte und Quellen, Klassifikationsschemata und ihre Bedeutung für die Abschätzung von Energiedargeboten, Österreichische Zeitschrift für Elektrizitätswirtschaft 30 (1977), p. 385-396. – Classification Schemes and their Importance for the Assessment of Energy Supplies, Proceedings of the Tenth World Energy Conference, Istanbul 1977. – Über die Verfügbarkeit von festen mineralischen Energierohstoffen (On the availability of solid energy raw materials) Radex Rundschau 1979, Volume 3. – Die Situation der Vorräte an Kohle und Erdöl unter Berücksichtigung von Gewinnungs- und Transportproblemen (The resource situation of coal and oil with reference to problems of production and transportation). Berg- und Hüttenmännische Monatshefte 124 (1979) Volume 8.

by the growing attention dedicated to coal for good reasons in this years.³ It remains to be seen whether this fits the picture given by the author in Chapter 6.3.10 that coal resource data may follow a pattern of oscillation when approaching realistic values.

Nevertheless the author's opinion is that things have not changed enough to justify at present a full revision of the book and, thus, automatically, to delay the English edition. Indeed, recommendations have come from several sources including international organisations to make the text soon available in English. Furthermore the mentioned changes have not affected the technical annexes and the general considerations on methods of assessment and classification which form the biggest part of the book. To emphasize this point of view, i.e. the predominance of the general discussion in the book, the sub-title of the English edition is the only major difference to the German text.

In the course of the period that has elapsed since the preparatory work for the paper at Laxenburg, and the completion of the manuscript of the present version, the author has received support from various sources for which he is very grateful. These thanks go primarily to his colleagues at the Institut für Bergbaukunde der Montanuniversität Leoben (Institute for Mining at the Montanuniversity Leoben), and to those of members of other institutes; also to the following ladies: Dr. Erika Augustin, abs. geol. G. Bernt, E. Einödmaier, I. Karpf, and Ch. Schaidt, and gentlemen: Dr. mont. E. Brennsteiner, Dipl.-Ing. O. Gäminger, Dipl.-Ing. M. Hoscher, cand. ing. Walter König, Dr. mont. S. Polegeg, J. Rechling, Dipl.-Ing. E. Schenk, Dipl.-Ing. G. Schön, Dr. P. Stangl and Dipl.-Ing. Ch. Weber, who deserve special mention. The author should also like to thank his colleague at the Institute for Mining, Prof. Dr. mont. E. M. Lechner, from the retired Head of the Institute for Prospection, Lagerstättenerschließung und Mineralwirtschaft (Institut for Prospection, Exploration and Mineral Economics), Prof. Dr. F. Hermann and Prof. Dr. L. J. Thomas from the Broken Hill Division, University of New South Wales, Australia, who visited Leoben in summer 1979 für several weeks, for the assistance they so kindly provided.

In addition, the author has received valuable information and comments from people and establishments in Australia, Austria, Belgium, Canada, France, the Federal Republic of Germany, Great Britain, Hungary, Poland, South Africa, USSR and USA. The collaboration with the editors and the publishers was no less profitable. The author would like to take this opportunity to thank all of them here.

In a very high and special degree the author is thankful to all people who

³ World Energy Conference: World Energy Resources 1985-2020. IPC Science and Technology Press, Guildford, UK, and New York, USA, 1978.

kindly made this English edition possible. First of all this refers to a high degree to the team which undertook and accomplished the translation.

This work has been put together from the point of view of mineral economics. Nevertheless, it is based (as it must be) on geological foundations. The author is therefore dedicating the book to two geologists, working from Leoben, who have made decisive contributions towards these foundations, to the memory of Prof. Dr. Wilhelm Petrascheck, 1918 to 1949 Professor for Geology and Economic Geology, and to his successor from 1950 to 1977 Prof. Dr. Walther E. Petrascheck, foremost mining authority at the Leoben University. Austria's contribution to the first international survey of world coal resources in 1913 came from Wilhelm Petrascheck. His work "Kohlengeologie der österreichischen Teilstaaten" from 1926 is still a major reference, not only regarding regional geology, but also in respect of general coal geology. Walther E. Petrascheck has also made major contributions to regional and general coal geology, also in the field of classifying reserves and resources of minerals as discussed in this work.

There is a sentence in a book by W. E. Petrascheck published in 1956 entitled "Kohle, Naturgeschichte eines Rohstoffes" (Coal, the Natural History of a Raw Material), which might serve as the motto of the present work: "We shall thus have to use this raw material increasingly sparingly and rationally, especially in Western Europe."

Leoben, May 1979

Günter B. Fettweis

1. INTRODUCTION

1.1 Questions under consideration

Since the appearance of the book by Meadows on "The Limits to Growth" (23)¹ in 1972 sponsored by the "Club of Rome" and his pessimistic view of the future, and particularly since the Arab-Israeli war in 1973, the discussion of questions concerning the supply of mineral and particularly of energy raw materials has increased throughout the world and equally among experts and laymen alike. With regard to the fossil fuels, in spite of differences in the individual statements, it is generally agreed that the earth holds extraordinarily large resources of coal. According to Rolshoven in 1972, they are "hardly exhaustible" (34). Although by contrast Hubbert expressly pointed out their non-renewability in "Resources and Man" in 1969, he nevertheless assumes the total quantity available of coal recoverable in the final analysis as being 4.3 to 7.6×10^{12} t relying on data from Averitt (21).

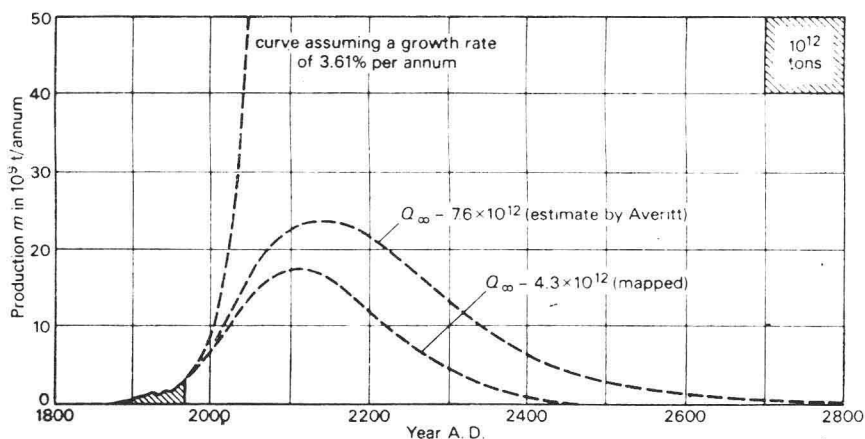


Fig. 1. Development of global coal production for two values of world coal resources Q_{∞} from King Hubbert (21).

Accordingly, coal could serve as a major source of energy supply for about 400 or 500 years, not being completely exhausted until the second half of the next millenium. According to Fig. 1 the peak world coal production figures are assumed to occur during the century from 2 100 to 2 200, which

¹ The figures in brackets refer to the bibliography at the end of each chapter.