

# Radioactive Waste

Technical and Normative Aspects  
of its Disposal

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of its Disposal

 Springer

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The Europäische Akademie zur Erforschung von Folgen wissenschaftlich-technischer Entwicklungen GmbH is concerned with the scientific study of consequences of scientific and technological advance for the individual and social life and for the natural environment. The Europäische Akademie intends to contribute to a rational way of society of dealing with the consequences of scientific and technological developments. This aim is mainly realised in the development of recommendations for options to act, from the point of view of long-term societal acceptance. The work of the Europäische Akademie mostly takes place in temporary interdisciplinary project groups, whose members are recognised scientists from European universities. Overarching issues, e.g. from the fields of Technology Assessment or Ethic of Science, are dealt with by the staff of the Europäische Akademie.

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### **Acknowledgement**

The project "Radioactive Waste. Technical and Normative Aspects of its Disposal" was supported by the VGB PowerTech e.V. The content of the book is only the authors' responsibility.

## Preface

The Europäische Akademie zur Erforschung von Folgen wissenschaftlich-technischer Entwicklungen Bad Neuenahr-Ahrweiler GmbH is concerned with the study of the consequences of scientific and technological advance both for the individual and social human life and for the natural environment. It intends to contribute to find a rational way for society to deal with the consequences of scientific and technological developments. This aim is mainly realised by proposing recommendations for options of action with long-term social acceptance. The result of the work of the Europäische Akademie is published in the series “Ethics of Science and Technology Assessment”, Springer Verlag.

The issue of disposal of radioactive waste is attracting an immense public interest and has been in the focus of the Europäische Akademie GmbH since a long time. Now, though the realisation of the project started in a relatively calm phase of the debate, the project was completed and the present study was published occasionally at a time when in the sequence of the Fukushima disaster the debate, at least in Germany, altered considerably. It is an open question where the debate will lead to, but I am sure that the survey of the scientific basis the study provides, and the concise recommendations developed by the project group on this basis, will be a helpful contribution.

I would like to extend my thanks to Professor em. Dr. rer. nat. Dr. med. h. c. Christian Streffer (group chair) and my fellow group members Professor Dr.-Ing. Wolfgang Kröger, Professor em. Dr. jur. Eckard Rehbinder, Professor Dr. rer. pol. Dr. h. c. Ortwin Renn and Professor Dr. rer. nat. Klaus-Jürgen Röhlig for their good cooperation and persistent commitment as well as to Dr. phil. Georg Kamp for coordinating the project on behalf of the Europäische Akademie GmbH.

Special thanks go to the VGB PowerTech e.V. for financially supporting the Europäische Akademie GmbH and thus enabling us to initiate the project.

Bad Neuenahr-Ahrweiler, June 2011

Carl Friedrich Gethmann

## Foreword

In consequence of the accident in the Japanese Fukushima Daichi nuclear power plants an intense and hot debate about the use and ethical justification of energy production by nuclear power reactors has led the German Federal Government and Parliament to decide to leave off nuclear power and to shut down the last nuclear reactor in 2022. However, independently of these decisions the responsibility remains to care for the disposal of radioactive waste from installations used in medicine, research institutions and technologies. This is especially the case for the high level radioactive waste from nuclear power stations. Although this demand is strongly accepted by a large majority of people in all countries using nuclear power including Germany the search for a site of a repository for nuclear high level waste has not been successful due to a severe resistance of the population and other organizations at the local site which is under investigation.

The present debate which has been ongoing in Germany since the seventies of last century does not give a clue for a solution. For this unsatisfactory situation an attempt is undertaken in the present study to analyze the situation and to look for possibilities in order to move the complex situation into a more favorable direction. It seems that such an effort cannot only be based on scientific and technological grounds for the construction of a repository with a long-term safety for the disposal of radioactive waste, but also ways have to be found to establish acceptance of such a repository including consideration of the legal regulation. Such an undertaking can only be pursued by a group of experts from various pertinent disciplines.

At the end of 2008 Professor Dr. phil. Dr. phil. h.c. Carl Friedrich Gethmann (University Duisburg-Essen, Germany, Europäische Akademie GmbH, Bad Neuenahr/Ahrweiler), Professor Dr.-Ing. Wolfgang Kröger (ETH Zurich, Switzerland), Professor em. Dr. jur. Eckard Reh binder (Goethe-Universität, Frankfurt am Main, Germany), Professor Dr. rer. nat. Klaus-Jürgen Röhl ig (Technical University of Clausthal, Germany) and Professor em. Dr. rer. nat. Dr. med. h.c. Christian Streffer, as elected Chairman (University Duisburg-Essen, Germany), started their cooperation in the interdisciplinary working group. From the third meeting on Professor Dr. rer. pol. Dr. h. c. Ortwin Renn (Technical University Stuttgart, Germany) joined the group and broadened the group's intellectual spectrum. The project group was very effectively co-ordinated by Dr. phil. Georg Kamp (Europäische Akademie GmbH, Bad Neuenahr-Ahrweiler) who also contributed actively to the project group's work as co-author, as valuable partner in the discussions and as collaborator in the final shaping of the project.

After a phase of general discussion and joint planning, the members of the project group prepared draft texts from the perspective of their disciplines. The drafts served as the basis for a mutual criticism in an interdisciplinary discussion of the group leading to a stepwise integration of the parts into a whole opus that reflects the scientific-technological, the sociological, legal and the normative aspects on the problem. This interdisciplinary cooperation resulted in an intense debate in order to work out a compilation as well as recommendations of general agreement across the boundaries of disciplinary preconditions and apparent biases.

The working group was formed in order to contribute to the debate on disposal of radioactive waste from the scientific point of view and to work out rationally justified criteria for the evaluation of the existing options and to give recommendations that allow for a long-term, resilient solution that is not only justifiable against the present generation but to future generations as well. In any step, the group worked in scientific independence which is a precondition not only for the reliability of the results but also for the society's trust in the recommendations. To ensure that the work is state-of-the-art and representative, plans, preliminary overviews and later on an extended outline of the study were presented to external experts and broadly discussed with them in two feedback meetings and on other occasions. On this basis the project group would like to thank Dr. Klaus-Jürgen Brammer (GNS Gesellschaft für Nuklear-Service mbH, Essen, Germany), Professor Dr. rer. nat. Michael Decker (Karlsruher Institut für Technologie/ITAS Karlsruhe, Germany), Professor Dr.-Ing. Daniel Goldmann (Institut für Aufbereitung, Deponietechnik und Geomechanik, TU Clausthal, Germany), Dr. phil. Axel Gosseries (University of Louvain, Belgium), Bengt Hedberg (Swedish Radiation Safety Authority, Stockholm, Sweden), Dr. rer. nat. Stephan Lingner (Europäische Akademie GmbH, Bad Neuenahr-Ahrweiler, Germany), Dr. Bernd Lorenz (Gesellschaft für Nuklear-Service mbH, Essen, Germany), Professor Dr. rer. nat. Rolf Michel (Leibniz University Hannover, Germany), Dr. Hans G. Riotte (OECD/NEA, Nuclear Energy Agency, Paris), Dr. rer. pol. Walter Schenkel (synergico, Zürich, Switzerland), Dr. Jochen Schulze-Rickmann (Niedersächsische Gesellschaft zur Endlagerung von Sonderabfall mbH, Hannover, Germany), Detlef Sprinz, Ph.D. (PIK Potsdam Institute for Climate Impact Research, Potsdam, Germany), Dr. Annie Sugier (IRSN, Institut de Radioprotection et de Sûreté Nucléaire, Paris, France) Dr. rer. nat. Karl A. Theis (VGB Powertech, Essen, Germany) and Dr. rer. nat. Michael Weis (VGB Powertech, Essen, Germany) for their fruitful cooperation. Their contributions have promoted the discussion of the group immensely and the study owes a lot to their valuable advice. After 13 meetings of the group and several meetings of some group members on special topics at the end of two and a half years work the project group approved the text as it appears in the present book.



Although the study focuses on the situation in Germany, it is mainly written in English, since the group is convinced that the main aspects of the presented contents are invariant to the special national preconditions and that the recommendations may be helpful for the task of a reasonable radioactive waste management in other countries. Nevertheless, the project group has permanently taken the international references into consideration, as shown in the legally comparative survey of the situation in relevant states in the Annex. The Introduction, Executive Summary, Conclusions and Recommendations have been written both in German and English.

Our acknowledgements are also very gratefully addressed to Friederike Wütscher of the Europäische Akademie GmbH who was responsible for the proof reading of the final text and did this very efficiently, as well as to Margret Pauels of the Europäische Akademie GmbH who very effectively and always helpfully took care of our meetings in Bad Neuenahr-Ahrweiler.

Bad Neuenahr-Ahrweiler, June 2011

Christian Streffer

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