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PREFACE

The symposium at which the papers in this volume were presented was the first major event in what, it is hoped, will be a long-term Soviet/American collaboration on energy-conservation research. The week-long meeting of technical specialists in energy conservation took place in Moscow in June 1985.

One of the first steps leading to this symposium was a visit by Academician Evgenie P. Velikhov, Senior Vice President of the Soviet Academy of Sciences, to the Center for Energy and Environmental Studies at Princeton University in December 1983. This was followed by an informal meeting in Moscow in September 1984, organized by Dr Viktor M. Maslennikov, head of the Power-Technology Complexes Laboratory, Department of New Energy Sources, at the Institute for High Temperatures (IVTAN) in Moscow. IVTAN is a major national laboratory of the Soviet Academy of Sciences, comparable in size and accomplishments to a major national laboratory in the United States. During that meeting, Academician A. E. Scheindlin, Director of IVTAN, proposed that IVTAN host a symposium on energy-conservation research in Moscow in June 1985.

In the winter of 1985 the symposium program was organized, largely at a meeting in Princeton involving Professor Evald E. Shpilrain, of IVTAN and the Moscow Power Engineering Institute, Dr Maslennikov, Dr Robert H. Williams of Princeton, and both of us. At that time, Professor Sol Penner, editor of *Energy—The International Journal*, generously offered to publish the proceedings of the symposium in a special issue of the journal.

There are three compelling reasons for organizing the symposium and publishing this volume. First, it is important for scientists, engineers and other specialists from the Soviet Union and the United States to meet and to establish working relations, as an antidote to the hostile fantasies which have been engendered by the militarization of the relationship between our two countries. We would like to think of our activity as an example of the kind of collaboration which can occur in many areas of mutual interest.

Second, the energy problem is global, in several senses: (1) The world oil market responds to levels of production and use in every country, and the markets in other energy supplies respond to the world oil price. (2) The most important long-term environmental impact of energy use is likely to be the build-up of carbon dioxide in the global atmosphere, which will change regional climates everywhere; the global atmosphere cannot tell the difference between Soviet and American carbon dioxide molecules. (3) The nuclear weapons connection to nuclear power is strongest through the link of recycled plutonium in civilian commerce; as Feiveson explains in his essay in this volume, the length of time one can delay the recycling of plutonium is sensitive to the rate of use of energy on the globe, and further global energy conservation can increase the period of risk-free delay (a period which already exceeds 30 yr, thanks in part to the global energy conservation accomplished in the past decade). For these reasons and for many others, the interests of the United States are served when the Soviet Union uses energy more efficiently, and vice versa.

Third, the Soviet Union and the United States have complementary expertise about the energy problem. The experience in the West with energy conservation and energy demand since the 1973 oil shock has given Western energy specialists a surprisingly different perspective than they had in 1973. Many of these insights could be very useful to energy specialists in the U.S.S.R., because users of energy in the Soviet Union did not experience major price increases in the 1970s. In addition, some potentially important energy-conservation technologies have recently been developed in the U.S. and Western Europe as a result of research, development, and invention following the 1973 oil shock.

Conversely, the Soviet Union has an extraordinarily large and strong system of national laboratories focused on what can be called civilian technology, both under its Academy of Sciences and under various industrial ministries. There has been relatively little contact

between researchers in the U.S. and U.S.S.R. since the late 1970s, so there is much for energy specialists from the U.S. to learn about energy end-use systems, energy supply systems, and energy policy concepts recently developed and under development in the U.S.S.R. To give just one example of technology transfer from the Soviet Union to the United States, the novel Soviet work on direct contact heat exchangers discussed in the paper in this volume by Akhmedov *et al.* has become the subject of research at Princeton University.

We are happy to report that this effort of mutual exchange is continuing. The participation of Americans in this activity has significantly broadened, thanks to the spring 1986 decision of the (U.S.) National Academy of Sciences to take responsibility for the American side of this exchange and to be the host for a follow-on symposium. That symposium has now been held, August 23–27, 1986, at the Wingspread Conference Center in Wisconsin; both delegations contained veterans of the Moscow symposium as well as newcomers. The momentum generated by the combined effect of these two symposia is probably sufficient for this exchange to increase in scope in the immediate future.

The present volume consists of 28 articles, 14 with Soviet authors, 12 with U.S. authors, and 2 with Swedish authors or co-authors. Ten of the papers involve broad issues of energy use and energy policy, including 2 papers each on environmental and nuclear energy issues. The remaining papers reflect the vision shared by all participants: that research directed toward increased efficiency in specific uses of energy is an extraordinarily powerful approach to solving the problems associated with increasing costs of producing energy. Thus, each paper focuses on some aspects of one of the principal sectors of energy use: buildings, transportation, and industry. Energy conservation in industry receives special emphasis because industrial energy use is relatively large in both countries.

One thing we learned from this effort is of general interest. There is more important and relevant work going on in each country than was at first recognized in the other. This lack of appreciation arises from the difficulties of communication between Soviet and Western energy-conservation specialists. At issue are the technologies of energy use in all areas of the economy, involving formidable special vocabularies. There are also major differences in the structure of technical descriptions. Moreover, in the past decade there has been very little scholarly interchange between the two countries, oral or written. As a consequence, although the Soviets read deeply in the English-language professional literature in their field, and are familiar with the English equivalent of many terms, the oral and written translations of Russian articles contained vocabulary and conventions which were quite confusing to us.

One of the central confusions, of course, concerns energy units. It takes practice to absorb energy data in units of 'tonnes of coal equivalent,' or tce (1 tce is exactly 7×10^9 calories, or about 29.3×10^9 joules). In the Soviet articles here, SI and Soviet units are presented, side by side, The reader who wishes the Soviets would abandon the tce can be assured that they would be happy to see Americans abandon the Btu.

To give just one example of a linguistic landmine, the Russian word *avtomobil* means land vehicle, including both cars and trucks; in the presentations of Soviet work on energy conservation in transportation (both the talks in Moscow and the first English translations of the papers) this distinction was blurred, and the very interesting Soviet work on saving energy in trucking was largely missed by the American delegation.

It goes almost without saying that none of the American or Swedish participants in the Moscow Symposium possessed a working knowledge of technical Russian. [Thanks to this collaboration, however, one of us (RHS) has resurrected his college Russian and has found it indispensable in the editing process.] Working these past months with the 14 Soviet papers, we have been impressed generally with how much we failed to understand initially and how consistently we tended to underestimate what was being done.

We believe we have overcome much of this communications barrier, for readers of English, with the Soviet articles in their present form, but we are sure that there are still significant problems in conveying the information developed by our Soviet colleagues.

Many people have helped bring the Moscow Symposium proceedings into this form.

We would like first to acknowledge the immense help of Thomas Norton, a graduate student in Mechanical and Aerospace Engineering at Princeton University, who brings to this task a superb sense of clarity of presentation, a wonderful orderliness, and competence in Russian. In clarifying the content of the Soviet manuscripts we have received crucial help from Dr Sven Eketorp, Dr Thomas Mix, Professor Frank von Hippel, and Dr Robert Williams, all of whom participated in the Moscow Symposium. Williams is particularly responsible for identifying the novelty and importance of the Soviet work on advanced direct contact heat exchangers, partially buried in the original version of Akhmedov *et al.*, and now made more prominent. Later stages of editing were facilitated by careful readings by Professor Nicholas Grant of MIT and by Stefano Consonni, a graduate student at Princeton. For her keen sense of exposition and for her indefatigable attention to detail, we are deeply grateful to Ms Krysia Kolodziej, a freelance editor. Mr John Samu was also of considerable help in preparing four translations.

The Moscow Symposium marked the culmination of a small two-year effort to convey the excitement and importance of energy-conservation research to leading Soviet scientists. Particularly effective in this effort were Thomas Johansson (Lund, Sweden) and Frank von Hippel and Robert H. Williams (Princeton).

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