

Chapter 11

FINAL REMARKS

In principle, two different and independent areas have been covered in this report: on the one side hydrogen as an energy carrier and its application in a future large-scale hydrogen energy economy, and on the other side: nuclear power which represents an important option for providing primary energy for hydrogen production. The combination of both nuclear and hydrogen is not necessarily required but it represents a reasonable and a feasible option to facilitate the emergence of a hydrogen economy. Both areas will help to reduce global impact on the atmosphere. Hydrogen faces economic problems and possibly public acceptance problems. Nuclear faces public acceptance problems.

Many research activities still need to be done in both areas in terms of an economic breakthrough of hydrogen and its link to nuclear process heat. Since hydrogen is merely used today as an energy carrier, research is ongoing in all subsections encompassing technological development of components (storage, infrastructure, etc), safety-related investigations, and regulations. Nuclear power is used for hydrogen production by providing electricity for use, e.g., in electrolysis and by providing process heat, e.g., for conversion and upgrading fossil fuels. The former, electricity production, is a mature technology well established worldwide. The latter, however, process heat provision, for which the HTGR represents the ideal option, requires further research on plant components, material problems, as well as safety of the system permitting risk assessment for a whole industrial nuclear process heat complex, in particular, with a view to a large-scale hydrogen economy.

The limited efforts on the further development of a new energy technology as has been observed over the past decade is due to the fact that the price level for conventional energies is currently relatively low with even falling tendency, also the energy reserve situation is no concern, and no change is expected for the next years.

On the other hand, upheavals in the international political and economic scenery – collapse of the socialistic world, economic rise of the Asian countries, beginning crisis of the world economy – have occurred at the expenses of enhanced activities in the protection of environment and climate. Furthermore an accelerated international entanglement (globalization) has taken place which leaves national systems in a structural and efficiency crisis. Within the tight international competition, energy costs have become an increasingly more important issue reducing the chance for new technologies with benefits in the long run. Environmental and climate aspects seem to lose societal attention lowering the pressure on the political actors by a worried population; a climate change is too far away to be perceived as a threat. The present goal of energy politics is the achievement of a high level of congruence between supply security, economy, and environmental compatibility meaning an optimized, not necessarily minimized, energy consumption.

After the Kyoto summit in 1997, the reduction of greenhouse gas emission is considered just one among several strategies. There is hope that by means of the new political instruments (tradeable emission certificates, joint projects between industrial and developing countries, and others) of the climate protocol, the political actors will proceed slowly,

but steadily to take internationally sound actions and direct the powerful transnational economy and finance markets towards a low-emission economy and acquire acceptance and the readiness of accepting the expenses by those who are concerned.

The keywords that characterize the strategy for a transition into the world's future energy economy are: conservation, substitution, and diversification strategy, necessary to reduce the burning of fossil fuels and to improve efficiencies, to replace them by environmentally benign energy carriers, and to avoid new and too strong dependencies.

Of course, hydrogen as an energy carrier will be just one contender on the energy market competing with others, e.g., electricity, and at the present stage facing economic problems. The key issues, however, that are able to promote an innovative energy technology based on hydrogen are its environmental benefit in a world with still increasing demand for energy, its safety compared with other fuels, and, in the long run, its potential of mitigating the jeopardy by a critical energy supply situation in future. Also nuclear power represents but one contender among the non-fossil energy carriers, although providing an environmentally benign primary energy source which could be used for hydrogen production. Its major problem is its lack of public acceptance.

Various activities on a larger scale have been described in the report representing important steps in the process of solving the world's energy problem. Highly ambitious projects are currently being pursued with the "World Energy Network" in terms of hydrogen as the future principal energy carrier and with the process heat concept of the HTTR reactor in terms of nuclear as a primary energy provider.

The overall aim of all activities is an exchange of information among all interested parties. The goal could be achieved by establishing international working groups to cover the critical aspects:

- Introduction of "advanced systems", e.g., fuel cells in the conventional field and HTGRs in the nuclear field;
- Definition of a sound safety and risk assessment methodology of non-nuclear technologies including experiments on hydrogen safety;
- Feasibility of the combination of nuclear power plant / chemical plant;
- Analysis of the nuclear hydrogen production potential;
- Definition of fall-back positions with established systems.

Some of these activities are already underway, e.g., in an IAEA Co-ordinated Research Program on Design and Evaluation of Heat Utilization Systems for the HTTR (CRP-4), which is scheduled from 1994 to 1999. International support of these activities is essential.