Challenges for Future Energy Usage

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In the history of mankind, during the last 2000 years the world's population and the average per capita energy consumption have increased continuously, the former at a rate even greater than exponential. By now a situation has been reached in which energy resources, which for a long time have been treated as though they are almost inexhaustible, are running short. The ongoing growth of the world's population and a growing hunger for energy in underdeveloped and emerging countries mean that the yearly overall energy consumption will at least double, if not quadruple by 2050. This massive energy consumption has led to and is progressively leading to severe changes in our environment and is threatening a climatic state that, for the last 10 000 years, has been unusually benign. The coincidence of a shortage of conventional energy resources with environmental hazards is a dangerous threat to the well-being of us all, but simultaneously it is a challenging opportunity for improvements in our energy usage.

On a global scale, conventional methods as the burning of coal, gas and oil or the use of nuclear fission will still dominate for some time. In their case, the challenge consists in making them more efficient, environmentally benign and using them only where and when it is unavoidable. Alternative energies must be expanded and economically improved. Among them, promising technologies such as solar thermal and geothermal energy production should be promoted from a shadow existence and further advanced. New techniques, for instance nuclear fusion or transmutation of nuclear waste, are also quite promising. Finally, careful analysis of the national and global energy flow systems and intelligent energy management with emphasis on efficiency, overall-effectiveness and sustainability will acquire increasing importance. Thereby, economic viability, political and legal issues as well as moral aspects like fairness to disadvantaged countries or coming generations must be taken into account as important side conditions.

In this lecture, first a short summary of the present energy situation and the resulting challenges will be presented. Then we try to identify the most important measures that can and should be taken up.