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EDITORIAL

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Solar radiation striking the earth amounts to 178’000 terawatt. This is about 14’000 times the world’s current ‘technical power consumption’ (0.007%) which is in the order of 13 terawatt (1 TW = 1000 GigaWatt). Of the total amount of solar radiation, 20% accounts for wind and powers the water cycle, 0.056% drives the photosynthesis of green plants – our food and oxygen source. The geothermal contribution is small in comparison to solar radiation – but is nevertheless three times more than the actual ‘technical power consumption’ – while the contribution of the tides (earth–moon gravitational energy) appears to be less important. This is the basic information to be considered when thinking about renewable energy sources.[1]

In this issue of CHIMIA we focus on solar radiation striking the earth; hence, we should consider the ‘interaction of light with matter’. Light can be reflected, it can be scattered or absorbed. The energy of absorbed infrared light goes in a first step into specific movements of the nuclei, while visible and near UV light is stored for a short time as kinetic energy of the electrons. In a next step the kinetic energy of the nuclei and some of the electrons are transformed into heat, which is random movement of the atoms. It drives thermo chemistry and is used for thermal solar energy conversion. It is this part of the energy input which drives the wind, the water cycle and hence, controls the climate. Stored kinetic energy of the electrons can be emitted as light quanta, *i.e.* luminescence and plays an important role *e.g.* in lighting. Stored kinetic energy of the electrons can generate electron–hole pairs in semiconductors which can then lead to a photocurrent. This process is the basis of modern optoelectronics. Stored kinetic energy of the electrons can also be used as a reagent for material changes, which is photochemistry. These processes are used in quantum solar energy devices and they are the basis of natural photosynthesis.

Quite surprisingly, the share of renewable energy has remained constant at about 13.5% (of the worldwide energy consumption) over the period from 1971 to 2001, despite of the fact that the total energy consumption nearly doubled during this period. The amount of renewable energy in Germany increased by a factor of nearly four since 1990, despite of the fact that hydropower remained constant. Interestingly, the main growth started less than 10 years ago.[2] How much land would be needed, if we aim to supply our ‘technical energy consumption’ by 2050 exclusively by means of a solar driven 10% efficiency process? Probably it would be less than the land that is currently covered by highways, streets and parking lots.[3] Hence, land is an important but certainly not a limiting issue on a global scale.

In October 1973 a new war between Israel and its Arabic neighbors broke out. On October 16 of the same year the oil exporting countries decided to use oil as a weapon, when it became clear that the Arabic attack would not lead to the expected victory.

Oil exports were stopped immediately. As a consequence our societies finally became aware of their enormous dependence on oil. This first oil crisis triggered the first serious attempts to promote the technical utilization of solar energy. Our society was, however, lazy in taking consequences out of this first energy crisis. A few more crises had to follow before we became aware of the opportunities and challenges of renewable

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energy sources. Among them photovoltaics is the most elegant way to transform solar radiation in electrical energy. Photoactivity of plants is dormant in deep winter. However, artificial photoactive devices can still work well, and they provide us *e.g*. with electrical power. While better utilization of biomass is highly desirable, agriculture for fuel production should not be supported, because of its very low conversion efficiency and of its disastrous social impact. The solar cell market has been growing very rapidly over the last 15 years. In 2006 about 1.6 GW peak power was newly installed and the growth rate is in the order of 40%, most of it based on silicon technology.[4] The durability of good solar cells is more than 25 years. (This corresponds to the guarantee from the manufacturer.) The world record efficiency of tandem solar cells has already surpassed the 40% barrier. With these facts in mind – high stability, fast growth rate, impressive maximum efficiency – we should ask: Is there any room left for innovative science? The answer is definitively YES. Storage as a chemical fuel is still a challenge! Concentrators are needed to realize the effectiveness of available tandem cells. The future belongs to thin layer and high efficiency solar energy conversion devices! Making efficient low cost and stable thin layer solar energy conversion devices remains a considerable challenge both for science and technology. These are the problems addressed in this special issue on quantum solar energy conversion devices.

[1] *Scientific American* Sept. **1990**, p. 24.
[2] H. Kohl, *Physik in unserer Zeit* **2006**, *37*, 126.
[3] N. Armaoli, V., *Angew. Chem., Int. Ed.* **2007**, *46*, 52.
[4] *http://www.pv-era.net/* and *http://www.eupvplatform.org/*

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