TUT 2: Energy Concepts of the Future (AGjDPG, AKE)

„Energy“ is a widespread and often discussed topic – in sciences as well as in politics. Physicists have to answer the questions about power generation, energy storage, sustainability and safety. For new investigations, one has to combine physics with other natural, material and engineering sciences. Numerous technologies meet the future challenges. This tutorial gives an insight into four very different state of the art research projects:

Notebooks and other portable electronics are working with Lithium-Ion-Batteries. In order to use this technology in hybrid or electric vehicles they have to become less flammable and safer. New electrolytes are the solution.

Fuel cells are already used in spacecraft and submarines, so why is this technology not already widespread even though fuel cells are an efficient energy converter?

As energy demand increases so does carbon dioxide production. Plants and especially algae convert carbon dioxide into oxygen. This tutorial explains the physics of using the process of photosynthesis on an industrial scale in photobioreactors.

In order to reduce carbon dioxide production, renewable energy technologies are essential. The world's biggest project is DESERTEC. How does the solar thermal power system work? How to provide power day and night? What is the status quo? This international project has also some political and socio-economic implications, which will be discussed shortly.

Organization/Chair: Anna Bakenecker (Münster)

Time: Sunday 16:00–18:30 Location: HSZ 03

Tutorial TUT 2.1 Sun 16:00 HSZ 03

Electrolytes in lithium-ion batteries: state of the art and future trend — •Andrea Balducci — Institute of Physical Chemistry, University of Muenster, Muenster, Germany

Lithium ion batteries dominate the consumer portable electronic and telecommunications market and they are also indicated as the most promising option for the next generation of hybrid and electric vehicles (HV, EV). However, when the present lithium ion technology is considered, the safety of batteries appears to be one of the main drawbacks holding the introduction of this technology in HV and EV. The commercial systems nowadays available use electrolytes commonly based on organic carbonates (e.g. Propylene Carbonate, PC, Ethylene Carbonate, EC) but since these electrolytes are flammable their use poses a serious safety risk and strongly reduces the battery operative temperature range. For such reasons, alternative electrolytes have been proposed and tested in the last decade. Between them, ionic liquids (ILs) instead of organic carbonates appear to be promising.

Tutorial TUT 2.2 Sun 16:35 HSZ 03

Fuel cells — •Uwe Reimer — Institute of Energy and Climate Research / IEK-3: Fuel Cells, High-temperature Polymer Electrolyte Fuel Cells, Forschungszentrum Jülich, Jülich, Germany

Fuel cells are efficient energy converters that are believed to play an important role in the future concept of energy production and storage. The tutorial explains the basic principles of fuel cells and provides an overview over the present available types. The advantages and disadvantages of fuel cells compared to other energy converters are briefly discussed. Today's application of fuel cells include space crafts and submarines, hence it can be said that the technology is ready and reliable. The question 'Why is it not already widely used?' may be answered at the end. Nevertheless, more questions will be raised, which should inspire the audience to think about the role of energy supply of the future. The topic 'fuel cells' is highly interdisciplinary, since it combines the areas of physics, chemistry, material science and engineering .

Break (10 min)

Tutorial TUT 2.3 Sun 17:20 HSZ 03

Physical aspects of photobioreactors for growing biomass — •Hilmar Franke — Applied. physics, Univ. Duisburg-Essen, Duisburg, Germany

Using photosynthesis CO_2 can be converted in the presence of water and light into biomass and O_2. On hot summer days one may observe the blossoming of algae on seashores or lakes. Often this phenomenon occurs in the presence of high concentrations of nutrients. The function of photobioreactors is to transfer this blossoming or high growth rate of biomass into the laboratory or a large scale industrial plant.
The climate gas CO_2 is produced during the oxidation of carbon or hydrocarbon compounds.
On earth there are many natural and industrial sources for CO_2, but only few sinks. The process of photobiological fixation of carbon dioxide in photobioreactors may contribute to the installation of a recycling technology for CO_2!
In this talk we will focus on the different physical aspects of photobioreactors (PBR) which may lead to efficient large scale plants:
A major problem is the **light exposure**. The exposure has to be optimized with respect to the *wavelengths* and the *intensity*. Using sunlight or LED's as an efficient system for *collecting*, *guiding* and *distribution* of light has to be developed.
Microalgae in PBR*s form a suspension in an aqueous environment with various ions of dissociated water and nutrient components. There are algae with an electric charge distribution. Depending on their shape even in an aqueous ionic environment this may cause an *electric dipole moment*. The **electrical properties** of a microalgae suspension may be used for characterization of important process parameters or the control of the system.
Photosynthesis requires CO_2, while O_2 is formed. Therefore an additional gas phase is present in the PBR. Especially in high columns **gravitation** controls any sedimentation profile. On the other hand clouds of gas bubbles form the reactive interface and the rising speed of gas bubbles depends on the bubble size which again depends on the local **pressure**.

Examples for potential applications of these physical aspects will be discussed.

Tutorial TUT 2.4 Sun 17:55 HSZ 03

DESERTEC - an international approach to use renewable energies at large scale — •Michael Düren — II. Physikalisches Institut, Justus-Liebig-Universität Gießen, Gießen, Germany

The DESERTEC concept combines solar power, wind power and other sources of renewable energy in a large and efficient electrical super grid that spans distances of several thousand kilometres. Fluctuations of the individual sources and loads are averaged out to a large extend. A special emphasis in this concept is given to a large network of solar thermal power stations that are located in deserts of the sun belt of the earth to maximize the yearly solar energy yield at a minimum of costs. The solar thermal power plants are equipped with large thermal storage capacity so that they can provide solar power day and night in accordance with the actual demand. The lecture will give an introduction into the basics of the physical and technological concepts and of the political and socio-economic implications of DESERTEC.