SEMINAR

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The scientific and technological challenges in the transition from fossil to renewable energy

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The limited reserves of fossil fuels and materials as well as the effects of the CO_2 emission, pollution of water and waste deposits on the environment and the climate require to close the materials cycles globally. Renewable energy is readily available and converted to electricity or usable heat by solar thermal plants, photovoltaics, wind turbine or in hydroelectric power stations for a competitive cost. However, the intermittence and seasonal variations of the renewable sources require massive storage, which is expensive and materials demanding. Seasonal storage and mobility, especially aviation, are the main challenges for renewable energy storage and only few energy carriers or fuels are feasible, i.e. batteries, hydrogen, synthetic hydrocarbons, ammonia and biomass [1]. Beside the scientific challenges in developing new energy materials and processes the economic feasibility is determent for the technology of the future energy economy.
The storage of electricity in batteries is efficient (90%) but the gravimetric and volumetric energy density is low (0.2 kWh/kg) and the material and manufacturing are expensive (100 $/kg). Hydrogen is produced efficiently by electrolysis (82%) and the storage of hydrogen reaches an energy density an order of magnitude higher than batteries (<2 kWh/kg). However, the conversion back to electricity suffers from a low efficiency of 40 – 50%. Synthetic hydrocarbons exhibit the same energy density as fossil fuels (10 kWh/kg) but more than 60% of the electricity are sacrificed in the direct air capture of CO_2, hydrogen production and the synthesis of the hydrocarbon [2]. All current applications are possible with synthetic hydrocarbons, especially also aviation and the storage are an established technology [3].

References:

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[3] Andreas ZÜTTEL, Noris GALLANDAT, Paul J. DYSON, Louis SCHLAPBACH, Paul W. GILGEN, Shin-Ichi ORIMO, "Future Swiss Energy Economy: the challenge of storing renewable energy", Frontiers in Energy Research: Process and Energy Systems Engineering, accepted (2021)

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