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Developments in Power efficient dissociation of CO2 using non-equilibrium plasma activation

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Sustainable energy generation by means of, either photovoltaic conversion, concentrated solar power or wind, will certainly form a significant part of the energy mix in 2025. The intermittency as well as the temporal variation and the regional spread of this energy source, however, requires a means to store and transport energy on a large scale. In this presentation the means of storage will be addressed of sustainable energy transformed into fuels and the prominent role plasma science and technology can play in this great challenge. The storage of sustainable energy in these so called solar fuels, e.g. hydrocarbons and alcohols, by means of artificial photosynthesis from the feedstock CO2 and H2O, will enable a CO2 neutral power generation infrastructure, which is close to the present infrastructure based on fossil fuels. The challenge will be to achieve power efficient dissociation of CO2 or H2O or both, after which traditional chemical conversion (Fisher-Tropsch, Sabatier, etc.) towards fuels can take place. A promising route is the dissociation or activation of CO2 by means of plasma, possible combined with catalysis. Taking advantage of non-equilibrium plasma conditions to reach optimal energy efficiency we have started a solar fuels program at the beginning of 2012 focusing on CO2 plasma dissociation into CO and O2. The plasma is generated in a low loss microwave cavity with microwave powers up to 10 kW using a supersonic expansion to quench the plasma and prevent vibrational-translational relaxation losses. New ideas on the design of the facility and results on power efficient conversion (more then 50%) of large CO2 flows (up to 75 standard liter per minute with 11% conversion) at low gas temperatures will be presented.