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17. March 2011

Silicon Fire methanol fuel: Spearhead of a new regenerative energy economy

1. Demand, availability and storage of energy

Energy is the natural ability to cause changes: Changes of all types, e.g. temperature (keyword room heating), spatial locations (keywords transport and traffic), state of motion (keyword drives), chemical compositions (keyword materials), aggregate state (keywords melting, freezing, vaporising, drying) or the electrical state (keyword electronics).

It is therefore not surprising that, with the increase in living standards over the past decade, intangible to many people, energy consumption has also increased strongly; it has tripled per inhabitant, e.g. in Germany, since 1950 despite numerous, effective energy saving measures.

Despite the great support for regenerative energies over the last decades, the fossil fuels coal, oil and gas still account for 78 % of energy requirements in Germany (2010), while nuclear energy accounts for 11 % and renewable energies just 9.4 %. This "energy mix" gives rise to concern about supply security with regards to fuels, about nuclear safety and about the environmental and climate effects caused by the carbon dioxide released during the combustion of fossil fuels.
Great hope is placed for the future on wind and solar energy. The solar energy reaching the surface of the earth is 7000 times more than the current global human demand for energy.

The main problem in the use of wind and solar energy is their discontinuous availability because, as is the case with all requirements, including energy requirements, it is having the necessary quantity of energy available when you need it, and not just sometimes.
For instance, in a very conventionally built 100 m^2 flat, the solar energy passing through 10 square meters of glass surface, e.g. a conservatory, would be sufficient to cover the annual heating requirement. In reality, however, this type of heating would be far too hot in summer and far too cold in winter.

The decisive problem is the storage of the energy! Storage of various type of energy (e.g. potential, thermal, motion, electrical energy) is generally possible with various methods (e.g. pumped storage, thermal storage, flywheel storage, battery storage), but is very expensive and therefore very limited for large quantities of energy, both practically and economically.

One exception is the storage of chemically bound energy. Chemical reactions take place with the acceptance or discharge of energy, therefore an appropriate arrangement of reactions accepting or discharging energy, not taking into account nuclear energy, can store significant amounts of energy based on the volume or weight of materials. All fossil fuels contain the solar energy stored over the period of millions of years and this is released during combustion.

The traditional lead battery, present as the electric battery in our vehicles, still has the best price-performance ratio as an electric storage medium for most applications, but only stores approximately one quarter of the energy, based on weight, that is released as heat during the combustion of fuel or heating oil.

Energy storage is the main problem for wind and solar energy. The current state of the art technology for utilising these energies on a large scale is conversion into electrical energy and feeding this energy into the existing electrical grid. However, in the electrical grid, generation and consumption must at all times be balanced so that the network frequency remains constant within the very tightly specified tolerance. This means that, for each wind and solar energy plant that could drop out of the grid at any time, a similar sized reserve and control capacity must be available in the grid. This capacity so far consists mainly of thermal power stations, whose output must then be appropriately adjusted. This means that wind and solar energy plants cannot replace existing power stations, just allow them to save fuel.

The increasing percentage of wind and solar power plants in the grid significantly increases the problems of safeguarding grid stability. Serious discussions are currently ongoing about the construction of new, cross-Europe power lines designed for very large transmission powers with which wind, solar and hydropower can be distributed and exchanged across Europe, thereby stabilising the electrical grid.

Questions arise on the one hand about the economics and the general feasibility of such new, enormous power lines while, on the other hand, the fact remains that the uncertainty of power stations driven by wind and solar power means they cannot render other generation capacities in the grid superfluous.

In consequence, the question should be posed whether there are not far better, more economic and ecologically sensible methods of utilising wind and solar energy than trying to squeeze these methods into the inflexible corset of the electrical grid, as so far propagated and implemented, despite the resulting enormous problems and costs.

The assumption is that, for the foreseeable future, all current energy sources, including fossil fuels, will be needed to contribute towards covering energy requirements, even when the regenerative energy proportion rises strongly. Power generation for the electrical grid, which needs to follow consumption fluctuations precisely at all times, should therefore primarily use the available energy sources that can enable demand-appropriate control and, where possible, local, close to consumer generation with low transmission losses and costs. Waste heat utilisation in the form of rational cogeneration is also possible in the case of thermal power stations. These energy sources are water power, but above all fossil and biogenic fuels.

The aimed-for comprehensive utilisation of discontinuous wind and solar energy should be pre-destined for such applications where such discontinuity plays a subordinate role, and where such applications in particular are easily realisable conversions into chemically bound energy in the form of easily stored and transportable combustibles and fuels.

The annual consumption of petrol and diesel fuels in Germany is currently approximately 50 million t. This means that fuels used for vehicle engines amount to 16 % of the primary energy requirements, so their replacement, even partial, by regenerative energies is a very worthwhile aim!

2. Silicon Fire methanol as a regenerative, climate-neutral and storable fuel

The new fuel must be regenerative and climate-neutral, easy to store as a liquid and handle, have good fuel properties and offer economic and ecological advantages when compared with fuels currently designated as regenerative fuels, e.g. bioethanol and biodiesel.

All these properties are fulfilled by the natural alcohol methanol CH_3OH (e.g. as precursor in alcohol distillation for beverages), which has already proven itself as a fuel for high-performance model and racing car motors, as as an additive in standard fuels, behaving as a fuel very similarly to ethanol C_2H_5OH. Synthesis from fossil-based synthesis gases has been a state of the art large-scale production for decades (annual global production 40 million t).

The disadvantage of methanol is its far lower heating value based on volume compared to petrol, which is partially compensated for by the advantages of the high anti-knocking property (octane number RON = 133 compared to 95 for four star petrol) and the greater interior engine cooling, enabling better engine performances and degrees of efficiency.

The idea to replace petrol with methanol as an engine fuel is not new. Large-scale government programs for fossil methanol in the USA and Germany carried out in the 80's and 90's with thousands of test vehicles impressively demonstrated feasibility, but did not lead to long-term success due to the general rejection by the vehicle and mineral oil industries.

Methanol fuel gained new scientific impetus in 2006 through the book "Beyond Oil and Gas: The Methanol Economy", written by the winner of the Nobel prize in Chemistry, George A. Olah. Methanol produced from coal is currently being introduced in great style as a vehicle fuel in China.

The **Swiss company Silicon Fire AG** has, together with the **Technical University Munich**, recently developed basic new process combinations with which the regenerative **Silicon Fire methanol fuel** is produced. In comparison to other bio-fuels also regarded as being regenerative, this methanol fuel has significant economic and ecological advantages without the disadvantages inherent in arable land utilisation and foodstuff competition.

The energy supplier for Silicon Fire methanol fuel is regeneratively produced **hydrogen** which is obtained through the state of the art electrolysis of water using regenerative electrical energy. The electrolysis performed by the system can adapt to the availability of the regenerative energy, contribute towards integrated grid stability by immediate switch off and can even be used for frequency control of the grid.

At the same time, Silicon Fire AG has also developed processes and plants for the generation of hydrogen from regeneratively obtained metallic **silicon**, which offers particular advantages for the long-distance transport of regenerative energy.

And the carbon for the methanol synthesis (low-pressure technology) is not obtained - as was previously the case - from fossil fuels, but from **carbon dioxide** CO_2 obtained from concentrated industrial sources (e.g. industrial process exhaust gases,large-scale firing, lime kilns, CO_2 waste from natural gas). This is CO_2 which would normally be emitted to the atmosphere. In the future, separation of CO_2 from the atmosphere will also be technically possible, which currently contains 385 ppm (0.0385 vol.-%) carbon dioxide.

This means that Silicon Fire methanol fuel is regenerative and CO_2 neutral.

The methanol synthesis is catalytic, based on the classic methanol production in reactors, e.g. as a **low pressure synthesis** at 80 bar and 265 °C.

Silicon Fire AG set up a corresponding pilot plant with a production capacity of 50 liters per day and this has been successfully in operation since autumn 2010. On this basis, a **Silicon Fire mobile station** producing 1000 litres per day has been developed to the production stage and mass production is planned. The Silicon Fire methanol fuel can very rapidly be made available to the market with the modular plants, which can be directly coupled to wind or solar parks.

The manufacturing costs of Silicon Fire methanol fuel could be drastically reduced if the requirement for 100% regenerative origin, which even the competing bio-fuels are far from fulfilling, is set aside. The EU guideline, which requires the addition of 5.75 % regenerative components (based on heating value) to petrol and diesel fuels by the end of 2010 within the EU-25, only sees a greenhouse gas reduction potential in these regenerative components of 35% compared to fossil fuels .

Based on research work carried out at the Technical University of Munich, Silicon Fire AG has combined the synthesis of regenerative methanol with classic methanol synthesis, e.g. from natural gas, which can be advantageously implemented as the oxygen liberated during the water electrolysis to produce hydrogen can be integrated in the process to product synthesis gas.

With this innovation, which has been secured by industrial property rights applications, the Silicon Fire methanol fuel produced in large-scale plants would cost less than half the price, based on heating value, for German bioethanol.

In order to meet the above-mentioned EU guideline for petrol within the European Union through the addition of Silicon Fire methanol fuel, approximately 14 million t would be required, equivalent to seven large-scale plants with a daily production of 6000 t.