How environment friendly and economically advanced materials processing and design can accelerate the worldwide implementation of hydrogen and fuel cells

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Hydrogen and Fuel Cells on their way to commercialisation

Today's path to produce hydrogen, and their distribution, storage and utilization is following the line of more or less conventional and known technologies. Starting from primary energies like coal, fossil fuels, natural gas or wind energy, hydrogen is produced by means of electrolysers or reformers. It will than be transported either liquid, gaseous or stored in metal hybrid tanks and finally used in fuel cells to produce electricity for mobile, transport and stationary applications.
The "advanced" way of looking at the sources, production, distribution, storage and utilization of hydrogen with a new approach needs at least one new feature in each of the above stages to come to a final worldwide "breakthrough", which has been the goal of thousands of scientists, physicians, chemists, researchers, engineers and craftsmen worldwide for decades.

Direct Hydrogen Production from Renewables – with Nanotechnology – without electricity

At the moment, all technologies are using electrolysers or reformers in order to produce the hydrogen to be used in the fuel cells for production of electricity. Therefore new technologies have to be found who are sophisticated (and in the end: easy) enough to produce hydrogen directly from renewable energies, without producing electricity first. This could be done for example directly at the axle of a windmill in utilising nanostructures and even nano-kinetics. In the future, direct production of Hydrogen - without electricity - by using renewable energies might be the only alternative to avoid all kinds of mechanical, transfer and electrical losses.

Direct Hydrogen Production from Solar Energy

Another possibility to produce hydrogen directly - without the use of electricity is the direct use of solar energy. This is for example already done by a commercial company in Germany, based on electrochemical photolysis. Direct production of solar hydrogen is also tested in southern Spain since the seventies, at an EU funded big-scale test facility; however, this idea has to be downscaled with the aids of nanotechnologies and nanostructures in order to be implemented into the daily life.

Virtual power plants with direct solar hydrogen and Fuel Cells

The technology for the direct hydrogen production from solar energy has to be downscaled with the aids of nanotechnologies and nanostructures in order to be implemented into the daily life. As a Virtual Power Plant, these applications can be installed in family houses, small enterprises, public facilities, (or even at the bodies) etc. These applications, which do not exist today, will produce hydrogen to be used in fuel cells for heating, cooling and electricity production.

Energy Balance Germany 2005

This statistic shows the high amount of flaring and transmission losses, which are more than a quarter of the primary energy being produced in Germany alone and bought from other nations, being used inside Germany in 2005. Should all the energy be used for the German industry alone be eliminated to ZERO, this still would save less than the flaring and transmission losses (83.7 compared to 115.7 t.c.e - Tonnes Coal Equivalents). This knowledge should accelerate all our activities to decrease these transfer-losses from today. The most efficient way to increase the efficiency here is to change to a decentralised energy and electricity supply. The electric power plants of today have a very bad efficiency even in Germany. Image how the Energy Balance are looking like in other countries, who are not so technology "advanced" as Germany seems to be... Just think of the energy production in China or India but also in the US…

Energy Balance Germany 2006

This statistic shows the data of the Energy Balance Germany in 2006.

Energy Balance Germany 2005 compared to 2006

In 2006 the primary energy consumption increased by 2.5 percent to 497.8 million t.c.e. This can be seen in the Energy Balance 2006 for Germany from the Arbeitsgemeinschaft Energiebilanzen e.V. The energy imports of electricity (+ 1.3 percent) were partially replaced by indigenous production (+ 2.6 percent), especially by the use of renewable energies (+ 22.8 percent).
Despite the efforts of Germany to be one of the advanced countries to reduce global warming, it demanded 2.1 percent more energy in 2006 than in 2005 followed by 5.8 percent more flaring and transmission losses. This increase in the final energy consumption is primarily because of the rise in energy consumption by the industry (+ 6.5 percent). Should all the energy be used for the German households and for half of the trade, commerce and service sector be eliminated to ZERO, this still would save less than the flaring and transmission losses (115.75 compared to 122.4 t.c.e).

Revolution in the Garage

Looking at today’s so-called “western” countries, if all worldwide registered cars (more than 800 Mio in 2007) would be equipped with a fuel cell system, they could (all together) easily take over the function of all today’s existing stationary power plants. This is due to the fact that the total power installed in the car engines exceed the capacity of existing stationary power plants by 20-35 times. Just calculate with a medium moderate power of 50 kW, which is not much for a car, but much in electricity. In average, cars are only being used running less than one hour per day. This allows a good utilization to create virtual power plants out of the car pool.

In the first implementation stage, the hydrogen needed to power this system will most likely come from natural gas which is currently widely available in most countries. Eventually, it will come from a direct-solar production of hydrogen from renewable energies. The individually produced hydrogen (pH = personal Hydrogen) will be stored in a tank inside the personal garage and also in a high density, high efficient tank in the car, made from hybrid nanostructures. The fuel cells in the cars produce DC, which will be used directly with nearly all today’s advanced home appliances like computers, TV and plasma screens, mobile phones and so on. The heat generated by the fuel cell in the car will be captured and used in heat exchangers based on

nanotechnology to warm homes in winter. In summer, the captured heat from the fuel cell will be converted by means of nanotechnology heat exchangers for cooling. This system will eventually replace all residential boilers and air-conditioning units. This idea is not new and it has many „fathers“, Amory B. Lovins to mention just one, and is also just an example of where the hydrogen and fuel cell economy and even better: The Hydrogen and Fuel Cells Society has to apply these technologies in combination with already existing systems. By implementing these technologies, the user of the energy will also be his/her own energy producer. Surplus electricity can be transformed to AC (if needed - there will be a complete new DC grid worldwide, because DC is what is needed by the consumers) This electricity can be sold by the car owners to the grid and/or to neighbour properties like homes, offices, apartment houses, conference venues and/or hospitals.

35 locomotives could not fly, or:
Evolution in the Aircraft Industry 1903-2005

In 1903, 35 locomotives with a weight of 16 tonnes each could in fact not fly. However when you compare the Wright’s Flyer with today’s Airbus A380 over the past 104 years, big changes took place, both in services, daily usage, technology and infrastructure.
When Orville and Wilbur Wright left their plane after the first powered flight (lasting 57 seconds) in Kitty Hawk, North Carolina, on December 17th, 1903, they, and nobody else, could imagine at that time, that only 100 years later there would be commercial aircrafts carrying more than 800 passengers over a range of more than 8,000 miles at an altitude of 33.000 ft. These technologies have created today’s worldwide biggest industry: Tourism with more than 8 Mio. commercial aircraft passengers each day. Starting from zero in 1903 we now have also 4,000 active commercial airports worldwide. Today’s status of the hydrogen and fuel cell emerging industry compares with that at the time of the Wright Brothers in 1903. There are more dramatic developments coming in the future of hydrogen and fuel cells than anyone can imagine today, hopefully, in less than 100 years.