Tim Radford 20 October 2013

Europe could find itself recycling the breath of life. Carbon dioxide, the agency of menace in a world of climate change, could soon also be perceived as a valuable resource. The catch is that chemists, physicists, engineers and materials scientists must first find new, competitive and compelling ways of exploiting the captured exhaust gases of industry and power generation, according to the final communiqué of the Fourth World Materials Summit in Strasbourg October 14-15.

The final communiqué read:

"We are a world in transition from fossil fuel dependence towards renewable resources. But there is no way to store power from wind or solar sources; the world will still need hydrocarbon-based fuels for the two billion cars expected by 2050; industry will still need hydrocarbon as a feedstock for manufacture. We urge decision makers, funding agencies and research institutions to consider new research into carbon dioxide as a power store, a raw material for synthetic fuel, and a resource that could be turned to new products. By using carbon dioxide twice, we could address all three problems. Such a step would increase energy efficiency; and at the same time continue to reduce greenhouse gas emissions. Captured and sequestered carbon dioxide could be a resource to accelerate the European transition to sustainability."

Consensus emerged after some persuasive argument and telling data from Jacques Amouroux, emeritus professor of chemical engineering at the Université Pierre et Marie Curie, who reminded the Congress first that the EU had committed the continent to carbon capture and storage, and second that with new techniques and imaginative use of catalysts, carbon dioxide could be used again, and perhaps again.

For several billion years, with the sun's energy and assistance from a porphyrin catalyst called chlorophyll, plants had been efficiently turning CO_2 into lignin, cellulose, starches and sugars. The challenge would be to find an economically competitive engineering technology and systems of industrial catalysis that could turn captured CO_2 back into methane or ethanol or some other hydrocarbon compound. These could then be used as routine energy storage for renewables when demand was low; or provide a second opportunity for combustion; or as a feedstock for chemical manufacture. In all three cases, these represented overall gains in energy efficiency and a way of containing greenhouse gas emissions.

That the proposition is likely to get a hearing was implicitly confirmed as the conference closed. In a video link from Brussels, Maria da Graca Carvalho, MEP outlined the Horizon 2020 programme for European science, talked of the pressures to confront climate change, and reminded delegates that European science was open for new business, new thinking and new partnerships. Congress delegates from beyond the European Union – and they included Philipp Rutberg from the Russian Academy of Sciences, Anton Naumovets from the Ukrainian Academy of Sciences, Jorge Guimaraes of CAPES, the Brazilian federal agency for the support graduate education, and Baldev Raj, president of the Indian Academy of Technology – all spoke of the value of international co-operation and the stimulus of partnership.

Carbon, carbon dioxide, hydrocarbons, hydrogen, energy and recycling provided linked themes for the whole conference, and in particular for the second and final day. This addressed how to get more power from constrained resources, either by finding new and more efficient materials, or by devising lighter and more enduring systems, or by enhancing new energy sources. There were presentations and detailed discussion of the difficulties to be overcome in the manufacture of synfuels, or synthetic fuels, in the complexities of catalysis in the use of carbon dioxide, and in the storage of energy from the sun.

The other solar pathway to fuel – biomass – consumed a whole morning's session; another group contemplated the difficulties of designing and making new forms of battery; a third turned to the potential of graphene , and a fourth session to the cars of the future.

The conference had already heard from Anton Chakhmouradian of the University of Manitoba, Winnipeg, on precarious and vulnerable supplies of rare earth elements – those "vitamins for industry" – and their uneven global distribution. In contrast, Rodrigo Martins, president of EMRS and professor of materials science at the New University of Lisbon, chose to talk about the technological possibilities of a material which the world was not likely to exhaust, a material that could be unrolled at a speed of 100 kilometres an hour - waste paper. Such a material fulfilled several requirements. It provided a flexible substrate, it could be processed at low temperatures, and every scrap could be recycled. It was lightweight, easily folded, and it had good dielectric properties. In cellulose form, it was the planet's most abundant polymer and above all, it was environmentally friendly.

He and colleagues had already devised a paper transistor and memory chip; a paper battery, a paper biochip: they had even printed a complementary metal oxide semiconductor (CMOS) on a paper substrate. A lab-on-paper would provide safe, self-sustaining, low-cost platform for diagnostic testing. It also offered a novel platform for nanoparticle-based DNA target detection. There could even be ways to develop solar cells on a substrate of paper rather than glass, at a saving of more than 20 per cent. "Smart paper" was no longer an idea from science fiction: in future, electronics could be printed on paper in a sustainable, low-cost way.

The congress had been reminded by Olivier Dubois, of FAO, of the difficulties presented by biofuels: would their development add to deforestation, or take valuable land away from food production? Was there a way of developing biofuel development to actually help small rural farmers in the developing world? But Reinhard Otten of Audi had a tentative answer to some of the concerns of the world summit, and one that linked all the themes of the day: innovation, sustainability, carbon dioxide and recycling.

He outlined progress towards e-fuel: the conversion of carbon dioxide to hydrogen to power the cars of tomorrow. E-fuels involved no fossil sources, no biomass, offered no competition with food production and they used recovered carbon dioxide as the raw material for the e-fuel and then used it again as raw material after combustion. Since, in Germany, solar and wind energy investments were high, electric cars could be powered from a sustainable source, and the Volkswagen group will have put €600 million into renewable energy by 2016. There were already local surpluses of renewable energy that could be stored in some form of battery, but the most effective solution would be a power-to-gas network based on captured carbon dioxide. Ultimately, cars could provide carbon-neutral mobility: the mix of sunlight, water and carbon dioxide and the agency of optimized micro-organisms offered a recipe for e-diesel, and e-ethanol.

No farmed biomass would be involved, and there would be no competition with food production because waste or desert land could be used. The process could use brackish, waste or salt water so there would be no extra demands on drinking water. Methane synthesized from such sources offered flexibility and ease of handling, and it was easier to store, all advantages over hydrogen as a fuel. Methane was already a universal energy carrier worldwide and potentially, it offered a source of hydrogen should such a market develop.