Case 87

Plastics from Pollution

By Gunter Pauli

This article introduces a fresh approach to CO_2 as one of the 100 innovations that shape "The Blue Economy". This article is part of a broad effort to stimulate entrepreneurship, competitiveness and employment.

The Market

The carbon markets across the world were valued €98 billion in 2011, up 4 percent compared to 2010. The European Union Emissions Trading System (ETS), the world's biggest carbon market is good for €76 billion. The overall traded volume in EU Allowances (EUA) reached 6 billion tons last year, a 17 percent increase over 2010. The EUA prices dropped to €6.3 per ton, half their value a year earlier. The UN issued Certified Emission Reductions (CER) were valued last year at €17.8 billion, down 2 percent from 12 months earlier. The North American carbon market also declined in value from €367 to €221 million for 2011.

While there is a price on carbon under the climate change schemes, there is also a market for purified carbon dioxide (CO_2). The CO_2 market for hospital uses is forecast to reach $292 million by 2017. The biggest industrial consumer of CO_2 is the soda drinks industry. The CO_2 makes the drinks more acid, tastier and the carbonic gas also serves as a preservative. Since drinks hold more CO_2 at low temperatures than at higher temperatures, the drink makers suggest that their products are preferably served very cold offering the customer a stronger taste. A company like Pepsi sold one billion cases of fizzy cola last year, consuming an estimated 160,000 tons of pure CO_2. Worldwide, well over a million tons of CO_2 is pumped into soft drinks which are all subsequently released back into the environment. The cost of pure CO_2 delivered liquified at the factory can reach €2/kg.

Attempts to connect the high level of emissions from energy and industry by burning fossil fuels with this industrial demand was originally received enthusiastically by all parties, until problems with quality control forced the industry to retreat from the recycling of low concentration CO_2 from energy generation, industrial and agricultural processes like the making of magnesium from dolomite or the burning of lime for cement. The demise of this opportunity to channel one million tons of CO_2 from the environment to the industry, offered on the other hand fresh growth opportunities for traditional gas companies like Air Liquide, the largest supplier in the sector with nearly €5 billion in turnover.

The Innovation

The use of CO_2 as the by-product of industrial and agricultural processes requires a major breakthrough since the discovery of contaminated carbonic gas in Coca Cola drinks in Belgium caused uproar questioning the quality control of major corporations. Whereas there

are numerous companies prepared to undertake the concentration and the purification of food grade quality CO_2, the supply chain management of multinational corporations prefer to opt for the extraction of the gas from the production of hydrogen or ammonia from natural gas or coal, and recently from the fermentation of sugar cane into ethanol. Corn to ethanol also releases large volumes of CO_2 increasingly recovering it for industrial use. Unfortunately, corn as a fuel and a source of carbonic gas competes with food. Therefore, even when the raw materials are from a biological source, it cannot be considered sustainable.

Geoffrey Coates was born in Evansville, Indiana. He obtained a degree in Chemistry from Wabash College (Indiana), and graduated in 1994 from Stanford University, California in inorganic chemistry. He undertook a post-doctorate at California Institute of Technology. Since 1997, Geoff is a member of the Cornell University Faculty. He built up an academic career as leader in the field of polymer synthesis with an emphasis on catalytic transformations. He observed that the predominant source of carbon for approximately 30,000 chemical compounds are produced worldwide from a basic set of around 300 chemical intermediaries. Ultimately, nearly all these intermediary molecules come from fossil fuels. Geoff was interested to find new routes to take bio-renewable resources into polymers. He realized that the key to success is not the availability of the raw materials, but rather the identification of catalysts that exhibit the reactivity required for polymerizing CO_2.

Carbon dioxide is an ideal feedstock since it is abundant, inexpensive, low toxic and non-flammable. Geoff observed that Nature uses CO_2 to make over 200 billion tons of glucose by photosynthesis each year, but chemists had until recently little success in developing a process that exploits this attractive raw material. Geoff and his team developed zinc- and cobalt-based catalysts that convert CO_2 under mild conditions into an intermediate feedstock for chemicals products. The opportunity to recover both the zinc and cobalt-based catalysts is a challenge that still needs to be overcome in order to make this a closed-loop operation that does not increase our already excessive reliance on mining.

Geoff built up a strong research team at the University of Cornell. However the scope and the depth of these catalysts, and the need to take this innovative approach to polymers from greenhouse gases to market, required special attention. He went on to create Novomer (new polymers) based on an exclusive license to the catalyst patents from Cornell, and mobilized $6.6 million in investments including from DSM the Dutch chemical group. This was an ideal partner in search for innovations since the management decided that 50 percent of all its total sales will be from ecoproducts by 2015. Physics Ventures, the spin-off fund from Unilever matched the investment from the DSM group.

The First Cash Flow

The Novomer team has successfully transferred the catalyst technology from the laboratory to the demonstration scale and is now developing the capability for both batch and continuous large scale commercial production. The portfolio of opportunities is so vast that

the product developers are testing the CO_2-based polymers in a wide range of applications including thermoplastics, binders, electronics, coatings, surfactants and foams. The opportunity to replace blow molded bottles not only caught the attention of DSM, but also of Unilever, one the world's largest consumers of plastics. Tests by Unilever, and its declaration of interest in this novel way of converting pollution into plastics was instrumental for Novomer in getting an $18.4 million grant from the United States Department of Energy to pursue this pathway to commercialization. The test production of extruded thin film offered another component in the overall drive to have packaging produced from pollution. Geoff and his team got the necessary financial breathing space to get the products and the production processes right.

The Opportunity

Unilever sees a great benefit in producing packaging that is cost competitive without subsidies, carbon taxes or a cap and trade system. This is not because the company is against, the future of these political decisions is uncertain and therefore business cannot rely on innovation as a strategic option when its final faith is determined by politics and international agreements. The Novomer owns a platform technology that goes beyond packaging. It could redefine hundreds of products as diverse as diapers or paints. Now, we see the opportunities to combine clusters of technologies on this innovative platform driven by this novel insight in catalysts. Competing on the market without subsidies, converting waste into a resource, and perhaps even get paid to take it out of the air, are typical characteristics that strengthen the Blue Economy proposal.

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… Further information on the 100 innovations at www.theblueeconomy.org

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