Green feedstock for the chemical industry – ambition and reality

One of the findings of the High Level Group on the Competitiveness of the European Chemicals Industry was that whilst the chemical industry will remain predominantly reliant on petrochemical-based feedstock in the next decades, there is definitely scope for an increased use of renewables as feedstock in the chemical industry. Currently renewable feedstock makes up about 7% of total chemical feedstock use. By 2020, the share of bio-based chemicals could reach - subject to the removal of various barriers - a level of 20% of all chemical products (in percentage of sales).

The European Commission and Council of Ministers have on various other occasions expressed support for improved access to renewable raw materials, for example in the Commission Communication on the Raw Materials Initiative of November 2008 and in the conclusions of the Competitiveness Council of May 2009. The EU 2020 strategy clearly points into the direction of reduced emissions and more sustainable resources and feedstock use. In the context of the announced EU 2020 flagship initiative "An Industrial Policy for the Globalisation Era", the Commission commits itself to working closely with stakeholders and "helping them seize the opportunities of globalisation and of the green economy", also in view of the international value chains, including access to raw materials. In addition, the EU 2020 Flagship of "Innovation Union" is addressing the Industrial Biotechnology within the HLG of the Key Enabling Technology, to identify policy initiatives to boost sustainable innovations.

Heavy dependence on fossil hydrocarbons, high oil and gas prices and the ambition to achieve a lighter carbon footprint have led to considerable efforts in the chemical industry to widen its feedstock base, in particular through greater use of bio-based raw materials. A prerequisite for chemical investments is that bio-based feedstock is economically viable based on long term supply and truly sustainable according to internationally recognized standards.

Valuable initiatives have been taken, such as the Lead Market Initiative Biobased Products and the BIOCHEM project in the framework of SusChem. **There are strong indications, however, that Europe risks missing opportunities to strongly increase the use of sustainable feedstock in the chemical industry and that these developments will take place in other parts of the world**. For example, there is a huge difference in the number of demo / pilot projects in US versus Europe, which is a key element to boost innovation, notably in the white bio sector. The lack of a venture capital market culture in Europe is definitely a disadvantage, especially in the step from pilot to commercialisation. While the EU is developing a market for greener products, the production of these products may thus well take place elsewhere. These arguments become significant more important if the full value chain impact is taken into consideration.

This paper does not envisage to exhaustively cover all developments in the area of bio-based feedstock, but rather to highlight some key barriers impeding much larger uptake of bio-based feedstock in Europe. For example, higher feedstock costs which lead to the placing of new investments outside Europe or to plant closures in Europe, etc. In particular it addresses problems caused by discriminatory effects of regulation or trade measures (e.g. measures favouring energy / fuel use over feedstock use, CAP related import barriers in the EU, export taxes in third countries). Again the full value chain needs to be taken into consideration, which puts significantly extra emphasize on the bio-based feedstock elements of the Biotechnology opportunities.

Examples

Bio-ethanol

For several chemicals within HS chapter 29, to date ethanol is already the single most important raw material. This is due to the very high input factors of ethanol for these products. In quantity terms current use is still very limited but there is a huge potential for greater use.

European industry has a fundamental competitiveness disadvantage because of lacking access to competitively priced ethanol. In Europe there are specific custom duties of 19.2 €/ hl on undenaturated ethanol (HS 220710) and of 10.2 €/hl on denaturated ethanol (HS 220720). Hence, the import duty on renewable ethanol ranges from 30 to 65% *ad valorem* in Europe. In the US, the industry has the choice to use locally produced ethanol or low-taxed imported ethanol, mostly from Brazil, for its industrial (non-biofuel) applications. In the US the custom duties on denatured and undenatured ethanol for industrial use are only 1.9% and 2.5% respectively. Even for fast developing countries like Korea and China the import duties are close to zero.

The chemicals in chapter 29 have only customs duties of maximum 6,5% due to the chemical tariff harmonization agreement concluded in the Uruguay Round. This means that there can be a negative effective protection of the production of these chemicals in Europe when they are based on ethanol. Concretely this means that, all other things remaining equal, it is 10.16% to 54.02% less expensive to produce these chemicals outside of Europe and to export them into Europe, and ethanol is by far the most important cost factor. It has to be noticed that the margins for bulk chemicals are typically lower than this.

Due to the development of the market as well as the disadvantageous European companies position on the market, EU chemical companies may be granted a maximum three-year duty exemption under the “Processing under Customs Control” procedure (PCC). Today, to the best of our knowledge, only 250 kt / y of bioethanol is imported under PCC for use in existing chemical applications. This solution has been adopted by the Council as an attempt to restore a level playing field. Nonetheless this time-limited exemption does not allow European companies to invest nor to do long-term development in this sector or in new sectors.

New opportunities for bio-ethanol

There is an increasing demand for plastics made from renewable raw materials: examples are polylactic acid and starch-based plastics. However, technological opportunities are being developed to manufacture commodity plastics like polyethylene from renewable raw materials, namely from bioethanol, hydrous or anhydrous, converted by dehydration into bioethylene, used as monomer for "green" polyethylene.

Potential use of ethanol is high in comparison with traditional processed products, running under PCC; best, still conservative (10% of green ethylene for only 50% of plastic applications), ethanol use estimate amounts to 1500 Kt / year in Europe. To make these new applications possible, access to ethanol at world market prices is an absolute requirement. Once the EU import duty on bio-ethanol is removed the sky is literally the limit. It would open the door for bio-ethylene projects, for example along the ARG ethylene grid, allowing for 1-2 million MT additional capacity. A bioethylene business case study made in 2009[1] convincingly shows the potential of this route. A price premium for bio-ethylene will have a limited impact on the prices of end products as its cost contribution is low (1-5%). The most likely source of ethanol would be sugar cane ex-Brazil. Anyhow a full life cycle assessment on this bio-ethylene route is required to ensure that such sugar to ethanol, followed by dehydration process is sustainable on its various aspects: with regards to natural resources (forests and soils) preservation, but also energetically speaking. Certification schemes such as the *Better Sugar Cane Initiative* (BSI) are paving the way towards the required extensive and objective monitoring of sustainability criteria. In case user industries tap the bioethylene from, for instance, a pipeline grid, green claims could be made via a so-called 'mass balance" system. This example cases demonstrates that renewable <u>feedstock approach</u> is capable to bring the strongest "Greening" – contribution.

Proposed solutions:

- elimination of the import duty on bioethanol destined to chemical end-uses (fuel applications excluded); alternatively, free import of bioethanol could be agreed in the context of the EU – Mercosur trade negotiations;
- creation of a separate tariff line in the EU Combined Nomenclature;
- Increase Innovation Funding programs to stimulate bio feedstock implementations: present EU 2020 Flagship objectives are fully aligned with this.

Isobutanol and other building blocks

In transportation fuels it becomes clear that isobutanol will become a major biofuel next to bio-ethanol[2]. Isobutanol has a higher value in the fuel pool than ethanol so there is a great economic incentive to go that way and it appears that yields are very acceptable now.

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[1] Accenture, Nov.2009, Bio-ethylene business case conducted for the Biorenewable Resources Platform (NL).

[2] Notably through developments driven by BP / Dupont, with a first plant in Hull (UK) for start up end 2010 and Gevo (Denver, Col.) to produce in 2011.

The chemical industry can profit substantially from large scale isobutanol availability also in the feedstock pool as it uses isobutanol either as such, but also as input for isobutylene, which leads to various chemical routes, such as rubber for instance, could become bio based. From isobutylene one can subsequently go to bio-paraxylene and from bio-paraxylene companies can produce for instance PTA, so the whole PET chain - which amounts to 50 million tons globally driven by textiles and packaging demand - could be greened. In addition, bio-isobutylene together with bio-ethylene will also give bio-propylene according to existing technology[3].

Those developments are in their early stage and quantities will be limited by 2020 but thereafter the perspectives are extremely significant, in particular in case cheap second generation fermentables become available on a large scale.

Beyond this case, a significant number of downstream chemical chains presently derived from fossil - based ethylene or propylene - the two main building blocks of the petrochemichal industry – could be derived in the future from bio-ethylene and bio-propylene. Including some part of the chlorine chain, notably the PVC chain, where, including the salt and using green power for electrolysis, and bio-ethylene for ethylene dichloride, all the basic feedstock would be then bio-sourced. These developments offer new perspectives for PVC. In this respect the EU Commission has endorsed in April 2010 within FP7 a major four-year R&D programme, BIOCORE (BIOCOmmodity REfinery), involving 24 partners to develop an industrial concept of biorefinery to convert agri and forest biomass into biofuels, chemical building blocks and biodegradable polymers, including the development of a biosourced PVC based on cellulosic bioethanol.

Carbohydrates

Life sciences and biotechnology are advancing at a breathtaking pace thanks to the research efforts and innovations of biotech companies. The fermentation industry which manufactures strategic and innovative products such as penicillin, other anti-infectives, enzymes, amino acids, vitamins, food preservatives, biodegradable plastics, detergents, food and feed, and polysaccharides (some examples of innovative products are provided below) is a key force in this process with unique investments of approximately 300 million euros in R&D (around 10% of total turnover of the EU fermentation industry per year).

The "Knowledge-Based Bio-Economy" is set to become one of the most important components of the EU efforts to green industrial value chains as foreseen in the EU 2020 strategy. To this end, the fermentation industry is active in a number of platforms, working groups and scientific forums in the field of life and food sciences and white biotechnology.

However, the European fermentation industry is still unable to secure its feedstock supplies at prices corresponding to world market prices. This is even more so important as feedstock prices are the determining factor in the calculation of the end

[3] Source : Biorenewable Resources Platform (NL).

price of fermentation products. Consequently, this reduces the attractiveness but also the viability of production in the European Union. This is demonstrated by the following table outlining the recent closures of production facilities as well as the relocation of production to third countries:

Closing Down of Production Units in Europe	New and/or Extended Capacities Outside Europe (by Foreign Based Companies and by European Producers)
Germany: Vitamins (Roche; BASF) and Insulin (Pfizer) UK: Citric Acid (Tate & Lyle), Astaxanthin (Tate & Lyle), Penicillin (ACS Dobfar Ltd) and Xantham Gum (CP Kelco) Spain: Glutamate (Peniberica) and Lactic Acid (Purac) Italy: Glutamate (Biacor), Citric Acid (Palcitric; Biacor) and Lysine (Ajinomoto) Czech Republic: Citric Acid (Activa) France: Yeast (DSM) and Xanthan (Danisco) Portugal: Yeast (DSM) and Penicillin (DSM) The Netherlands: Penicillin (DSM), Gluconic Acid & Gluconic Derivatives (Purac) and Lactic Acid (Purac) Ireland: Citric Acid (ADM)	USA: Lactic Acid (CSM/Cargill; Cargill/Dow), Enzymes (Novozymes), Lysine (Cargill/Degussa) and Arachadonic Acid (DSM) Canada: Citric Acid (Jungbunzlauer) China: Lactic Acid (BBCA, Henan Jindan and Galactic), Enzymes (Novozymes), Penicillin (DSM), Lysine (Global Biotech, BBCA and others), Citric Acid (DSM, BBCA, TTCA, RZBC, Ensign), Glutamate (Meihua, Fufeng, Juhua, Global Biotech over 500 KT new capacities…), Xanthan Gum (Fufeng, GCC Inc), Vitamins Brazil: Enzymes (Novozymes), Lysine (Ajinomoto), Citric Acid (Cargill) and Lactic Acid (Purac) Mexico & India: Penicillin (DSM) Chile, South-Africa & Cuba: Yeast (DSM) Thailand: Lactic Acid (Purac) and Citric Acid Vietnam: Glutamate and Lysine (Vedan and Ajinomoto)
These changes and closures took place over the last five years. This list is not exhaustive and other examples can be found.	

The reasons underlying these closures of production facilities as well as the relocation of production to third countries is not due to a reducing market, on the contrary. Europe is a growing market for renewable applications and the demand is still increasing. The reduced production in Europe is compensated by an exponential growth of third country imports.

Main reasons for the delocalisation

The basic feedstock for the European fermentation industry account for a very substantial proportion of total manufacturing costs (up to 50-70%). It is therefore the utmost important element in the competitiveness of the sector. The substances produced from a fermentation process, like any other chemical, are globally traded goods and compete on a global scale. The EU has low customs duties for chemicals (average 4%) due to the Chemical Tariffs Harmonisation Agreement. Any significant price differential in the raw material is therefore key in the success of gaining market share.

There is a real lack of competitive carbohydrates (sugars, starches, etc.) supply in Europe. The existing mechanisms are not working. Since the sugar reform the main supply comes from so called “industrial sugar”. As there is no third country competition (‘only one supermarket’ principle), the industrial sugar prices are well above the world market prices. It is even not possible for European sugar suppliers to compete with most of the third countries due to the intrinsic fact that sugar beets are harvested once a year and the sugar production process is only taking place during a couple of months whereas the cane sugar can almost be produced the whole year through. Europe has become recently as well a net importer of sugar and this will not change in the future.

We have seen that since the opening of a 400 Ktons / year duty-free sugar quota, import prices became more competitive. But the measure is not on a permanent basis and limited to 400 Ktons / year per year. Since operators have to invest in hardware to receive and process imported dry, solid sugar as opposed to processing liquid sugar solutions produced in Europe, the repeated temporary import quota which implies a high insecurity about annual renewal, may refrain from this investment hence prevent the real ability to import. Any strategic planning in Europe is therefore difficult. A fermentation process facility based on sugar will therefore no longer be preferably based in Europe although the market is in Europe (example: lactic acid is produced from the fermentation of sugar. Polylactic acid is a biodegradable plastic). Due to the reduced sugar production, molasses - a by-product of the sugar manufacturing process and a formerly very cost-effective source of sugar for fermentation - has become scarce and the prices increased dramatically.

The recent publication of the regulation EU No 72/2009 abolished the production refund system on starch. It is true that the starch production refund was zero due to extremely low ceiling and did not meet the objective, closing the price gap, for what it has been established. This was highlighted several times by the fermentation industry but without succeeding in the revision of the calculation method.
So both raw materials, sugars and starches, are not available at competitive prices in Europe, and this situation has even deteriorated since the increasing use of these raw materials for the bio-fuel production. The bio-fuel program has put in place a kind of unfair competition via either tax break or mandatory incorporation. This resulted in higher prices of the raw materials and further deteriorated the competitive position of the European fermentation industry. There is as well a growing demand for crops (food) as Asia has become a net importer of different types of cereals. This contributes as well to the scarcity of the carbohydrates availability in Europe.

All the factors above resulted in a large gap between industrially used carbohydrate prices versus the world market price, especially the last 2-3 years.

Proposed solution

Cefic proposes to abolish all import duties on the different carbohydrates for chemical use. This measure should be done at once and be on a permanent basis. Only then the industry will be able to invest in the needed infrastructure and as well have a long-term vision on the supply of their raw materials. This will create new possibilities, boost innovation and create wealth and jobs in Europe.

Animal fats

Renewable resources such as animal fats, vegetable oils, crude tall oil, etc. are used as raw materials in the chemical industry. Since these raw materials constitute biomass, their uses for the production of biofuels and electricity are incentivised by member states, leading to a reduction of their availability for industrial processes and thus their prices increased through the EU renewable energy legislation and the EU ETS Directive which provide incentives to use these renewables for the production of biofuels, electricity, and, soon, heating and cooling. The March 2007 EU Summit agreed that the promotion of renewable energy should avoid conflicts between different uses of biomass. Industrial users of biomass should have fair and equal access to biomass. Indeed, EU policy should, as a general principle, favour higher added value industrial activities.

For example, the oleochemical industry is a vital supplier of ingredients to a great variety of products and practically all types of industry. The raw materials used are renewable and sustainable. In Europe, the main raw materials used are animal fats. Prompted by subsidies or other financial incentives, animal fats are now being burned under the biomass definition for the production of bio-fuels, biodiesel, heating, mandatory blending for energy production etc. Those financial incentives and subsidies focused exclusively on biofuels applications are creating a competitive distortion versus other higher value applications such as oleochemicals. In the case of animal fats, the saving in carbon emissions given to animal fats (as opposed to other types of vegetable oils) makes it even more interesting to burn animal fats.

Economic effects: The oleochemical industry uses between 750,000 and 1.000,000 metric tons of animal fats per year. Animal fats are a by-product from the meat industry and have as such a limited availability. The usage of the animal fat as energy source, biodiesel etc. gets a varying financial support of 120-150 Euro/Mt. The oleochemical industry has to compete for those raw materials with limited availability in an unsubsidised way.

Consequences:

- Price increases for the animal fat from circa 300 Euro/Mt to 420-440 Euro/Mt;
- Scarcity of material;
- Price difference between cheap and more expensive fat used to be 75-85 Euro/Mt and is now 25-30 Euro; consequently more expensive raw materials have to be used for lower value applications; in fact, animal fats – and notably beef fats – have a chemical composition very close to palm oil and prices are therefore significantly correlated;
- Production of subsidised biodiesel creates a huge amount of glycerine. glycerine prices make a big contribution to the cost absorption in the oleochemistry;
- Refined glycerine prices came down from 1.500 Euro / Mt to below 500 Euro / Mt;
- Market distortion. Since the oleochemical industry is vital to the total European industry, it was needed to start replacing animal fat by palm oil. The South East Asian area imposes an export duty (15 up to 30 %) on the export of the palm oil whereas there are no export duties on the final oleochemical products they export. This is a critical market distortion for the European Industry.

Consequently, the European oleochemical industry is being forced today to either import palm oil or move the production to the South East Asia area. In case of move, what is at stake is:

- the 10.000 jobs in Europe;

- an added value in Europe of 1.5 billion Euro/yr;
- an increase of dependency of European industry on import since the locally available raw materials are simply burned in a heavily subsidised way;
- Loss of industrial and marketing know-how.

Environmental effects: The oleochemical industry is vital for the rest of the European industry. The burning under subsidised regime will force the oleochemical industry to look for alternative raw materials. The only valid replacement of raw material is palm oil. Even if they move their production site to SEA (South East Asia), there will be the need to replace the 750.000 up to 1.000.000 metric tons of tallow by equivalent quantities of palm oil. In order to get this quantity of palm oil to replace the animal fat, up to 300.000 ha of virgin rain forest has to be taken out. Besides the deforestation, loss of biodiversity, additional transport to Europe will create even bigger negative influence on the natural and delicate environmental balance.

Burning of the animal fat in its limited quantity available will release immediately all carbon dioxide in the air, whereas the end usage of the oleochemical products captures the carbon locked in the products for a long time. Oleochemical products are biodegradable and will eventually and gradually release the CO2 only.

<u>Proposed solutions</u>:

To remedy this situation:

- EU legislation should ensure that Member-States renewable energy support schemes should not distort the biomass market and that National Action Plans should specify how this will be achieved;
- Careful attention should be paid that the production of biofuels from waste, residues, etc does not affect raw material use of industries (waste in one process is raw material for another, i.e. animal fat);
- The mandate given to the Commission to monitor the impact on raw material prices because of the use of biomass for energy (Art. 20 of Directive) should be expanded to all categories of animal fats;
- Carbon emissions savings for animal fats should take into consideration the fact that animal fats will be replaced by “palm oil”, increased use of palm oil will lead to further deforestation, thereby reducing the actual carbon emission savings (ILUC – Indirect Land Use Criteria).

Conclusions and recommendations

A lot of attention is being paid to obtain complex molecules from biomass which have a high potential added value and which in most cases require R&D and development in innovation. This absolutely needs to be stimulated, however, the total volume from these developments will not have a great impact on the total volume of chemicals being produced.

There is a huge scope to increase the share of bio-based chemicals, from today’s 7% as share of chemical sales to 20% by 2020 or even much more, in line with the objectives set by the HLG on the Competitiveness of the European Chemicals Industry and in the EU 2020 Strategy. In order to reach such an ambitious goal, industry realizes that it needs to invest in biobased R&D, process facilities, demo

plants and eventually in production capacity. However, it should be a joint Public-Private Partnership or an Innovation Partnership Initiative effort and investment in which governments and the European Commission take alike responsibilities. The EU needs to develop an integrated policy to stimulate the European bio-based economy, covering the full value chain otherwise that ambition will not be feasible. Integrated means that the policies of the various relevant DGs, EC programs and potentially structural funds need to be synchronized and align, according to the Flagship approach rationale to create a favourable environment for a bio-based economy.
Furthermore, after completion of the multi stakeholder debate on the Lead Market Initiative on bio-based products the LMI recommendations should be fully implemented in EC's policies and the Commission should develop and implement a coherent strategy and action plan to capitalize on European bio-based economy investments made hitherto. In line with the LMI recommendations, the EU therefore needs to:

- develop legislation that promotes the biobased products market developments via positive measure (e.g. via targets, tax incentives, etc.);
- develop legislation related to biomass ('regulate' availability/price, invest in biobased infrastructure);
- define standards, labels & certification (international sustainability assessments, labelling);
- encourage green public procurement for bio-based products; and
- finance/fund R & D and demo plants, e.g. bio-refinery demo's.

In addition, Europe can only develop a robust bio-based economy when it has access to sustainable renewable feedstock in sufficient quantities, of guaranteed quality and at competitive (world market) prices. Distortions caused by regulations favouring fuel and energy over feedstock use should be removed and import duties for biobased feedstock should be as low as for fossil based feedstock. Therefore, the new Common Agricultural Policy (post 2013) should take into consideration all uses (food and feedstock uses).

The EU 2020 flagship initiative Innovation Union can help fill the funding gap. SusChem, with strong support from Cefic has proposed four public private partnerships, that covers biotechnology and specific renewables opportunities, that will ensure a stronger private role and engagement in executing program implementation and related call proposals.

To reach really high percentages, the chemical industry needs to get access to globally priced bio-based raw materials such as ethanol and isobutanol and thereafter it needs to implement a program of greening the basic building blocks of the chemical industry from methane, bio-ethylene, bio-propylene, bio-isobutylene, bio-paraxylene. Such a programme could take benefit of the great advantage that existing infrastructure and plants can be used. The impact of such a programme would be huge, knowing that it would at the end cover probably 80 % of the existing chemical products along the multiple downstream value chains at stake.

There is a thus a golden opportunity for Europe to combine the target of increased use of more renewable feedstock with competitiveness goals. Developments in other parts of the world do not stand still. If Europe doesn't improve the feedstock situation, we will soon see industry in other parts of the world seizing the market opportunities for renewable feedstock-based applications and exporting these to Europe.

Cefic therefore calls all stakeholders (European and national authorities, agro and chemical industries, chemical and biotech associations and NGOs) to work together to establish the basis for a sustainable and integrated EU biofeedstock policy.

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