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Level Playing Field for Bio-based Chemistry and Materials

Authors: Michael Carus (nova-Institute), Dirk Carrez (Clever Consult), Harald Kaeb (narocon), Jan Ravenstijn (biopolymer consultant) and Joachim Venus (ATB)

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Autors: Michael Carus (nova-Institute), Dirk Carrez (Clever Consult), Harald Kaeb (narocon), Jan Ravenstijn (biopolymer consultant) and Joachim Venus (ATB)

Over the last ten years numerous studies have demonstrated the impressive potential of bio-based products[1]: The production of bio-based chemicals and materials can create ten thousands of new green jobs (Bio 2010, Carrez 2010), increase resource efficiency and make a considerable contribution to climate protection and innovation. Despite these benefits the investment in industrial biotechnology and biorefineries in Europe remains low. The political and economic framework in the EU does not support the industrial material use of biomass – this is in contrast to bioenergy and especially biofuels, which has expanded rapidly in the EU over the last ten years. The European "Innovation Union" needs to establish a level playing field for bio-based chemistry and materials in order for the EU to realize the potential of greening its process industries.

Making the best out of limited biomass!

The impacts of using biomass as an energy source or a material source are quite different. The analysis of recent studies on the macroeconomic effects of the non-food uses of biomass show that the potential benefits of the material use in terms of employment and value added are significantly higher than those arising from the use of biomass for energy. Material uses can directly support 5 to 10 times more employment and 4 to 9 times the value added compared with energy uses. These comparisons relate to the same raw material or the same-farmed area, respectively. This is due to the significantly more complex and longer supply chains arising from material uses. (Carus 2010)

This is even true for traditional applications of wood: Using wood for particle boards or pulp & paper supports greater employment and value added compared to the production of energy pellets (Pöyry Forest 2006).

High resource efficiency in the use of renewable resources can only be achieved with bio-based materials (higher input – output efficiency than biofuels) and strengthened through "cascading utilization". This starts with single or multiple uses (recycling economy) followed by energy use at the end of life. Material use first, then energy – you only burn it once!

Most LCA studies show that the material use of biomass delivers GHG mitigation at least equal to first-generation biofuels (each based on the same acreage). Most deliver higher benefits and the best are significantly higher than the benefits of second-generation biofuels (Patel 2008, Carus 2010). The environmental assessment will be even more favourable to material uses if the effects of longer-term carbon storage and the potential of cascading utilization are included. Also economies of scale in production and the technical optimization of processes will further improve the carbon balance. There is still a huge potential for innovation – involving thousands of SMEs and multinational companies.

While there are numerous options for the provision of renewable energy such as solar and wind energy, hydropower and geothermal energy, the situation in the supply of raw materials to industry is precarious. The material use of biomass is a key technology to secure the supply of industrial raw materials, and its importance increases continuously. The use of biomass for material use is as essential as their use in food – if the oil price reaches new record levels. Especially the chemical industry depends on carbon-based materials in the production of organic compounds, and biomass is the only renewable source of carbon

EU: Low investment in biorefineries and industrial biotechnology

Currently, there is only a low investment in biorefineries and industrial biotechnology in Europe – compared to America and Asia. For investment, companies need:

- Secure sustainable renewable raw material supply for reasonable prices.
- Binding political framework for supporting the bio-based economy: Which political instruments and what kind of political environment will be established in a long lasting manner?

Bio-based materials are in competition for feedstock with energy. In contrast to bioenergy and biofuels, there is currently no similar European policy framework to support bio-based materials. Bioenergy and biofuels not only receive high support in R&D, pilot and demonstration plants, but also receive strong ongoing support during commercial production (quotas, tax incentives, green electricity regulations and more). Without comparable support bio-based materials will suffer from underinvestment from the private sectors. The recent policy leads to a market distortion regarding feedstock availability and costs.

Even biorefineries that are producing energy and materials will not be able to truly overcome this problem. If the energy market is more attractive because of related incentives and support, biorefinery development will be disproportionately on energy as the main output – without realizing the huge potential of bio-based materials.

Market distortion – Competition for biomass for energy versus industrial material use

In several EU member states there is in addition to the European biofuel quota of 5.75% by 2010 a considerable support for bioenergy[2], but almost no support for the industrial material use. With the existing political framework it is much more attractive to use biomass for energy – a misallocation of biomass in terms of resource efficiency?

Already today we see competition between both sectors in Europe.

1 Bio-based products – chemicals and materials (pre-norm CEN/BT/WG 209: "bio-based product = product wholly or partly bio-based (="derived from biomass")") include all kind of bio-based chemicals, bio-based plastics and additives – biodegradable and durable, bio-composites like wood plastics composites and natural fibres reinforced plastics and insulation material, and also the traditional products of the timber industry. Bio-based products are used in construction & insulation, packaging, automotive and consumer goods. From a technical point of view almost all industrial materials made from fossil resources could be substituted by their bio-based counterparts.

2 The EU has targeted that 20% of energy should be renewably sourced by 2020. This will direct member states to increased support for bioenergy.

High subsidies for energy crops lead to high biomass and land prices that make industrial material use unattractive. In Germany for example the financial support of bioenergy is between 20% (biodiesel) to 80% (bioethanol, small biogas) of the turnover.

Establishing a high-volume bio-based economy, including bio-based chemistry, bio-based plastics and composites, lubricants and others, feedstock shortages can be foreseen.

A new political-economic framework is needed to rebalance the financial support for energy and industrial material use of biomass. This new framework should be linked for all applications to climate protection, resource efficiency, employment and innovation. Principle of equal treatment and product parity!

Risks of the existing policy framework

With the existing policy framework, Europe will not be able to realize the huge potential of the bio-based economy – probably in contrast to Asia and the US. The region, which is balancing and optimising the support between energy and material use first, will have the best starting point to high added value, green jobs and bringing innovation to the market.

Another risk is to drive out the existing wood pulp & paper and board industry from Europe. European high-level wood industry will switch to low-level energy pellet industry with the lowest added value and employment.

In the last decade, the share of biomass used for material use has already decreased compared to bioenergy as a result of the existing framework in several member states. This unbalanced support could lead to less innovation, less resource efficiency, less climate protection, less investment and fewer jobs.

New policy – Principle of equal treatment

In principle, the applied policy on bioenergy and especially biofuels was appropriate and a success story. But the global framework changed, biomass is now more limited than several years ago and new technologies have been developed. For the future we need a new policy to be able to use the potential of biomass most efficiently and most productively.

The European Union needs a new agricultural raw material policy to rebalance the support of bioenergy and biofuels versus industrial material use. This means to search, screen, develop and evaluate (new) political instruments, which could secure access to sustainable renewable feedstock, well balanced between bioenergy and bio-based products. (LMI 2011)

This new framework should cover all industrial applications and should be based on climate protection, resource efficiency, employment ("green jobs") and innovation. A higher focus should be put on resource efficiency and climate protection regarding the use of land and the biomass flow. "Cascading utilization" (the sequential utilization of biogenic raw materials for material and energy uses) could be one option for future support (LMI 2011). Priority should be given to using biomass for bio-based materials, followed by recycling and later its use for biofuel and bioenergy.

For a new policy and new strategies, a comprehensive study is urgently needed to get sufficient, adequate, detailed and solid data about the industrial material use of biomass in the EU, incl. a periodic update. (See side note 1: Only very limited data on industrial material use of biomass in the EU)

Instruments that could provide a level playing field for bio-based products

Currently, mainly necessary, but weak instruments like R&D support, standardization and information tools are discussed for bio-based chemistry and materials – whereas bioenergy receives a strong ongoing support during commercial production via quotas, tax incentives, green electricity regulations and more.

Bio-based chemicals and materials will only thrive, if strong instruments are implemented in a new political framework to rebalance the support of energy and material use. Bio-based products need at least a level playing field in order to get started.

During the last ten years no political instruments have been developed to support bio-based chemistry and materials during commercial production. This is strongly needed.

The list in the appendix is a summary of instruments that have been discussed in different workshops over the last years and that could be theoretically implemented – the most important will be to realize a binding political framework to support the bio-based economy in a long lasting manner.

Outlook

The new policy framework for the EU has to be coordinated by European Commission, European Parliament, member states and regions – incl. all involved sectors like agricultural, enterprise, energy, environment and R&D – to find the most efficient instruments to support the industrial material use until a level playing field with bioenergy, esp. biofuels is reached. To identify the most efficient instruments, extensive consultations of stakeholders from the wide field of industrial material use of biomass, from SMEs to multi-national companies, is required.

The same political discussions are taking place in North America and Asia, since the phenomena of a non-level playing field for both sectors is a worldwide phenomena occurring over the last 10 – 20 years. Now, with visibly limited biomass resources the most efficient use of land and biomass is a crucial challenge.

The region in the world which will optimize and balance the support of the use of biomass for energy and material first, will profit from a considerable growth, investments, green jobs, innovation, increased resource efficiency and additional climate protection.Let Europe be the region to profit!

Limited biomass should be used most efficiently: Do more value added and create more employment – with less biomass: Bio-based Products.

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Jan Ravenstijn is a graduate from the Delft University of Technology. He has 33 years experience in the chemical industry (Dow Chemical and DSM) of which 15 years in executive global R&D positions in engineering plastics, epoxy resins, and elastomers in three different countries. He has started a biopolymers platform at DSM. Started his own business on bio-based polymers as visiting professor at universities in China, Ireland, and The Netherlands, is a consultant to biopolymer companies, biorefineries, OEMs in EU, US, and Japan, and to investment and consulting companies, completed an extensive Bioplastics review paper (January 2010), wrote Bioplastics articles in several magazines, and is co-author of a Bioplastics book for SMEs (Q2 2011).

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Harald Kaeb is a chemist, holding a PhD of the University of Wuerzburg, Germany 1991. From 1992 to 1997 he was project manager at C.A.R.M.E.N., a government-tasked organisation promoting renewable raw materials for non-food uses in Bavaria. 1998 he founded narocon, a consultancy offering services for business development in innovative green product areas such as bio-based chemicals or plastics. Since 1993 Harald Kaeb is supporting European Bioplastics, the association of the bio-based and biodegradable polymers industry in Europe. From 1999 to 2009 he was chairing the Board of European Bioplastics. Harald dedicated his working life to the growth of the bio-based products industries.

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Side Note 1

Only very limited data on industrial material use of biomass in the EU

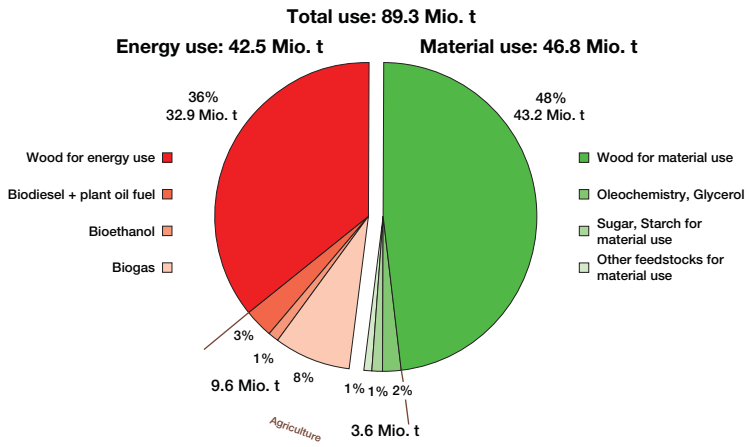
Data on biomass for material use for Europe are limited to estimates based on the statements of experts, which are rarely updated. A periodic gathering of these figures does not take place, therefore the available data is insufficient and inadequate for a full analysis.

Newer extensive and meaningful data on material use of renewable raw material (RRM) are only available for some industrial areas and not in all member states of the European Union. Most experts on material use of RRM say, that there are no statistical data on material use of RRM or bio-based products in their countries. All agreed that it would be very important to have those data, especially for the future political and research framework.

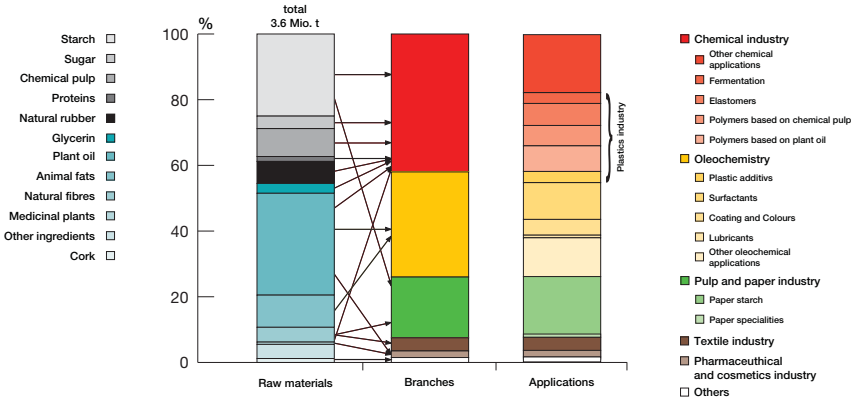
Remark: Future biomass potential studies should not only use "Joule" as (energy) unit, but in addition "Tons" (mass).

The best available data come from Germany due to some recent projects. The following figures show some main results; very detailed information is available (Carus et al. 2010). Also the share of biomass used for industrial material use is decreasing in Germany year by year, in 2008 still more biomass (incl. wood) was used for materials compared to energy. In agriculture bioenergy is already dominating compared to biomaterials with a strong trend upwards: During the last ten years the cultivation area for bioenergy increased ten times over, whereas the area for bio-based products showed no increase at all – with critical impacts on employment and value added.

Use of renewable raw materials in Germany 2008



Industrial material use of renewable raw materials in Germany 2008 (without wood)



Source: nova 2011

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nova 2011: Running R&D project „Ökologische Innovationspolitik – mehr Ressourceneffizienz und Klimaschutz durch nachhaltige stoffliche Nutzung von Biomasse" (FKZ 3710 93 109), financed by The Federal Environment Agency (Umweltbundesamt), Germany, unpublished.

Side Note 2

New thinking can be found in recent papers world wide

"Indeed, its use in green chemistry and green materials is saving more CO_2/ha*y, is more resource efficient and leads to more employment than using the equivalent land area for the production of bioenergy." (Carrez et al. 2010)

"A recent study estimates that, by 2025, over 15% of the three trillion dollar global chemical sales will be derived from bio-derived sources. Yet another study highlights that over 90% of the annual global plastic production of 270 Mio tons is technically feasible for substitution by bioplastics. Many of these bioproducts would be manufactured in bio-refineries by the deployment of rapidly emerging industrial biotechnology." (Asian White Paper, Vijayendran 2010)

"Bio-based products can offer significant growth to the US economy and confer a competitive advantage in the chemicals and plastics industry. The industry can create tens of thousands of green jobs and provide a range of additional societal benefits to the United States, including a reduction in CO_2 emissions and reduced dependence on foreign oil. Cooperation among policy makers and industry leaders will be required to advance these high-potential industries." (US White Paper, Winter 2010)

"The bio-based markets with high demand and favourable legislative framework could make a substantial contribution to the EU's transformation into a more sustainable economy. The right legislation and framework conditions will however be needed to encourage uptake of renewable raw materials for industrial use (e.g. wood and paper, but also bio-plastics, bio-lubricants, pharmaceuticals) and ensure sustainability;" (EUROPEAN COMMISSION 2010)

Forest Products Association of Canada: "This approach is a win for jobs, the national economy, rural communities, and the environment. Governments can support the industry by establishing a coherent policy framework for bio-energy and bio-products that is market-driven, technology neutral – all technologies are treated equally – and enables the forest products industry to compete on a level playing field with other sectors." (FPAC 2010)

"As bio-based chemicals and polymers emerge out of the shadows of biofuels, a different set of policies and programs are required to address their unique benefits and needs. These policy frameworks must be internationally coordinated to assure their maximum benefit for all stakeholders. Current policies in leading countries tend to be an after-thought of biofuels subsidies, implemented before the very different value proposition of "bio-based, non-fuel products" had begun to emerge. (Chemicals and polymer resins from sugars and biomass have a 2–4x greater value, requiring a much smaller percentage of feedstock than biofuels, among other benefits.)" (Infocast 2011)

"The Economic Benefits of a Green Chemical Industry in the United States: A shift to the production of chemicals that are safer for workers, the environment and human health, supported by reform of the 1976 Toxic Substances Control Act (TSCA), can create American jobs and new market opportunities, reversing the decline in employment that has occurred over the past 20 years. ... This report estimates that if, for example, 20 percent of current production were to shift from petrochemical-based plastics to bio-based plastics, 104,000 additional jobs would be created in the U.S. economy even if the output of the plastics sector remained unchanged. ... However, a shift towards bio-based chemicals fundamentally changes these industrial linkages. Bio-based chemicals include a wide range of products, such as bioplastics, soy-based inks, biofuels, biocatalysts, and other chemicals and materials derived from renewable biomass. A recent report from the U.S. Department of Agriculture estimates that bio-based chemicals' share of the global chemical market will rise from its current level of two percent to 22 percent or more by 2025. Agricultural production and forestry products are more labor intensive than fossil fuel processing. Large domestic supplies exist in the U.S., reducing the dependence on imports. When we take these factors into account, the employment creation potential of bio-based chemicals is significantly larger than traditional petro-based chemicals." (PERI 2011)

Employment Generated for Each $ 1 Million Spending on Output

Industry Supplying Raw Materials	Direct	Indirect	Direct + Indirect
BIO-BASED EMPHASIS			
Grain farming	8.4	4.4	12.7
Vegetable farming	4.8	5.3	10.1
Sugarcane and sugar beets	26.1	5.3	31.4
Fruit farming	10.5	6.2	16.7
Wet corn milling	0.5	8.8	9.3
Plastics	$ 3,335		1.3%
Transportation equipment	$ 38,221		2.9%
PETROLEUM EMPHASIS			
Petroleum and gas extraction	1.1	2.2	3.3
Petroleum and gas drilling	1.2	2.7	3.9
Petroleum refineries	0.1	1.7	1.8
Petrochemical manufacturing	0.2	2.5	2.7

Source: Author's estimates using the IMPLAN 3.0 input-output model. (PERI 2011)

Sources

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Vijayendran, B. 2010: BIO-BASED CHEMICALS: TECHNOLOGY, ECONOMICS AND MARKETS (White Paper).

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Most of the papers and studies incl. further information available at: *www.bio-based.eu/policy/en*

Appendix: List of potential instruments

The following list of potential instruments is not intended by the authors to be a proposal or recommendation for implementation. It is merely a summary of instruments that have been discussed in different workshops over the last years and that could be theoretically implemented. Which instruments actually are the most efficient and least market distorting will have to be discussed and evaluated in further studies and workshops including all relevant stakeholders.

Quotas, bans, public procurement and emission trading

- Indicative/mandatory targets and quotas for bio-based products by 2020 (as quotas already in place in Japan). *(see also: LMI Ad-hoc Advisory Group for the LMI bio-based products[3], EuropaBio[4]).*
- Open the EU biofuel quota to bio-based products (as the target for the share of renewables in transport was opened for electric cars in 2008). The contribution should be counted twice, as in the case of hemicellulose-based bioethanol.
- Bans on critical fossil based chemicals, plastics and additives which can easily be substituted by less hazardous bio-based chemistry.
- Implementation of strong green public procurement programs for bio-based products *(as in the US, see http://www.biopreferred.gov)*
- Ensure that bio-based products are incentivized in climate change/ carbon legislation including carbon trading and credits (ETS – Emission Trading System) (as discussed in the US and on UN level for harvested wood products (LULUCF)).
- Open all regulations, programs, and subsidy systems supporting bioenergy and biofuels also for bio-based chemistry and materials (as discussed in the US).

Taxes

- Support taxation of non-renewable carbon as input for the chemical industry; at present, a paradox system is implemented with double disadvantages for industrial material use of biomass: In the energy sector there are high taxes on fossil carbon sources and high support for bioenergy – in the material sector there are no taxes on fossil carbon and no support for biomaterials.
- Allow member states to reduce taxes for sustainable bio-based product categories (like the EU-framework for member states in the energy taxation directive).
- Comprehensive establishment of CO_2 taxes including all bio-based sectors (energy and material).

Agriculture

- The one-sided support of bioenergy and biofuels is mainly due to the policy of several member states.
- The CAP reform could be an option for rebalancing the support of bioenergy vs. industrial material use. But in the last CAP proposal (Nov. 2010), industrial material use, bio-based chemistry and materials were barely mentioned in one sentence. The level playing field for industrial material use should be implemented in the first and especially second pillar.
- Replace the former CAP "production refund" by an alternative incentive to support the use renewable raw materials for industrial uses.
- CAP should become an interface between agriculture and the bio-based economy, including bio-based chemicals and materials as a huge chance for the farmers.
- Integrate in the new CAP specific financial incentives for farmers to improve the logistical capabilities to collect biomass byproducts and residues from agriculture and forestry.
- All programs in structural funds and rural development that are being used to support and implement bioenergy and biofuels should be opened to bio-based products – all criteria for funding should be handled equally.

Additional instruments

- Use regulations like the EU End-of-Life Vehicle Directive for supporting bio-based products through waste legislations (consider bio-based materials as recycled regardless of how they are recovered) to make bio-based products attractive for the industry.
- Ensure that bio-based products can enter all waste collection and recovery systems, including composting, recycling and energy recovery. Bio-based plastics certified compostable according to EN 13432 should gain unhindered access to bio waste collection.

3 http://ec.europa.eu/enterprise/sectors/biotechnology/files/docs/bio_based_from_promise_to_market_en.pdf

4 EuropaBio input for a possible target for bio-based products in the EU 2020 Strategy and Innovation Strategy (July 2010)