



Sustainable use of and creation of value
from renewable raw materials for biobased
industrial production such as biomaterials
and green chemicals in Flanders

*Options and recommendations for an integrated economic and innovation
policy, in coherence with other policy areas and EU regions*

Summary

Sustainable use of and creation of value from renewable raw materials for biobased industrial production such as biomaterials and green chemicals in Flanders

Options and recommendations for an integrated economic and innovation policy, in coherence with other policy areas and EU regions

Summary of the study

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1. INTRODUCTION

What is now generally referred to as a “biobased economy (BBE)” is the use and/or conversion of renewable raw materials for biobased products and energy. It can generally be regarded as the non-food pillar of the bioeconomy. It is an economy in which the basic elements (the so-called “building blocks”) for industry and energy are derived from renewable resources (including waste from food and agriculture) instead of fossil non-renewable resources (mainly petroleum). This includes the production and the use of enzymes and biocatalytic processes. Although this study focussed on the “biobased economy”, it also examined the broader context, including the production of biomass and its use in various applications in which the primary focus of agriculture is of course food. It also looked at a possible strong potential synergy with the food sector in which adding value to waste streams can be one of the most important assets.

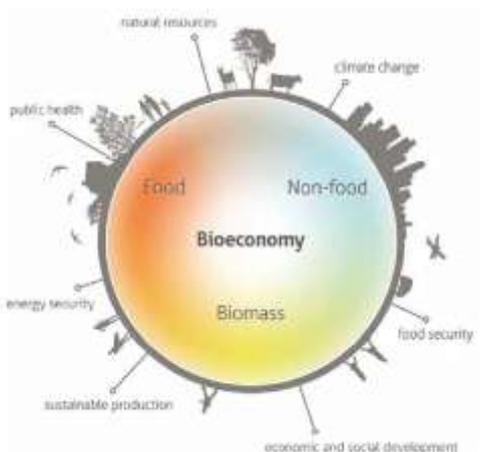


Figure 1 : Presentation of the bioeconomy

The aim of this study is to support the Government of Flanders in developing its own strategy for a biobased economy (BBE) and to draft recommendations for an integrated and sustainable economic innovation policy. In order to develop this strategy, Flanders’ assets must be identified and used as the basis for defining policy choices for the BBE; in other words, how can Flanders optimally use its positive starting position with a strong chemical industry, a limited (in terms of surface area) but highly intensive agricultural and horticultural and thus likewise food industry, and a high population density with large and well-managed waste streams, in the transition to a sustainable BBE?

2. Strategies for a biobased economy in Europe

In February 2012, the European Commission approved a strategy and an action plan to increase the use of renewable resources in our economy and for them to be used in a more sustainable manner: **“Innovating for Sustainable Growth: a Bioeconomy for Europe”**. The strategy and action plan for a bioeconomy must pave the way for a more innovative, sustainable and competitive society that reconciles food security with the use of renewable raw materials for industrial purposes. The action plan outlines the most important measures the European Commission will take to achieve the strategy’s objectives for the bioeconomy. Member States are called on to participate in this plan. The action plan is based on three pillars: the development of new technologies and processes for the bioeconomy; the development of markets and competitiveness in bioeconomic sectors; and encouraging policy makers and other stakeholders to work together more closely across industrial sectors.

Several member states and regions have already developed a strategy for a biobased economy or have started designing one. We notice here that the focus of interest may vary from one country to another. A number of countries such as Germany and Finland have adopted a broader approach to bioeconomy as a whole, while most countries - such as the Netherlands, Sweden and some regions in France - lay an emphasis on biobased economy itself. By contrast, Norway and the United Kingdom concentrate their attention primarily on industrial biotechnology and biorefinery. A number of countries such as Denmark and Ireland have not developed a specific strategy for biobased economy or bioeconomy to date, but have incorporated elements in support of this into a broader approach with the aim of stimulating "green growth". Very strikingly, most countries took the initiative to start developing a specific vision and strategy for biobased economy at the urgent request of stakeholders (industry, scientific world, agricultural organisations,...).

Although the most important action point seems to be "innovation" each time (in the broadest sense of the term), most authorities are designing an "integrated" policy. For instance, while the accent is on biomass production, innovation, sustainability and a consistent policy in the Netherlands, Sweden places an emphasis on innovation, market introduction, SME support and a general supporting policy. Germany in its turn has established a national "Bioeconomy Council" with focus on economy, innovation, education and policy.

An important part of most strategies involves establishing and supporting a specific cluster and/or public-private partnership. Examples thereof are BE-BASIC in the Netherlands, and the regional clusters in Germany (such as CLIB2021 and BIOM WB) and France (IAR).

Recently, we have also noticed an increase in the number of partnerships between the clusters and PPPs in Europe, or even with regions outside Europe. A clear example which is also supported by the European Commission, and in which Flanders is already active, is ERA-Net Industrial Biotechnology¹. Norway and the United Kingdom have agreed to jointly support research in the field of industrial biotechnology and biorefinery. The French cluster IAR has formed official partnerships with the Wagrallim cluster (Wallonia), CLIB2021 (Germany), and clusters from Canada, Finland and Hungary, while BE-BASIC (the Netherlands) has signed cooperation agreements with Brazil, Malaysia, the United States and Vietnam.

¹ <http://www.era-ib.net/>

3. Biobased economy in Flanders

3.1. Biomass and biomass streams in Belgium and Flanders ²

An overview of the consumption and end-use in Belgium for grains, sugar beet and rapeseed is given in the table below.

Table 1: Consumption and end-use in Belgium for corn grains, sugar beet and rapeseed (2010 data)

| | Consumption in Belgium (2010) (million tonnes) | End-use in Belgium (%) | | | | | Soil |
|---------------|---|------------------------|-----------|------------|-----------|--------|------|
| | | Food/ feed | Chemistry | Bioethanol | Biodiesel | Energy | |
| Wheat grains | 5.0 | 77.7 | 3.0 | 16.5 | | 0.3 | |
| Barley grains | 2.2 | 97.0 | | 3.0 | | | |
| Maize grains | 1.3 | 76.0 | 7.0 | 1.5 | | | |
| Sugar beet | 4.5 | 37.5 | 0.3 | 1.3 | | | 6.0 |
| Rapeseed | 2.1 | | | | | | |

In 2010, 5.0 million tonnes of wheat grains, 2.2 million tonnes of barley grains and 1.3 million tonnes of maize grains were consumed in Belgium. 17.7% of the total amount of grains is used for non-food applications, of which 14.3% is used for the production of bioethanol, 3.2% for chemical applications based on starch (bioplastics in particular) and 0.2% for energy production. Belgium and Flanders produce their own grain crops, but grain import (especially from France) is very important.

In 2008, wood waste supply in Flanders was 1.6 million tonnes (1.2 million tonnes from industry and households, increased by import from abroad or from other regions), while the theoretical demand was 2.9 million tonnes. This shows an important wood waste deficit in Flanders, leading to tensions in this market.

The Belgian pulp producers use approximately 0.8 million tonnes of wood per year, a large part of which is imported. In 2010, the Belgian paper manufacturers used 0.6 million tonnes of fresh pulp, 40% of which was imported. 1.3 million tonnes of old paper were used by paper industry in 2010. Paper industry produces each year approximately 0.6 million tonnes of waste and co-products, which are used in agriculture/for composting (37%) and energy (36%).

In Belgium, 4.5 million tonnes of sugar beet were consumed, the larger part by the food and feed sector. Sugar beet production primarily comes from domestic production (1.5 million tonnes in Flanders and 2.9 million tonnes in Wallonia). In Belgium, also 2.1 million tonnes mainly imported rapeseed were used for food, feed and biodiesel in 2010. In 2010, Valorfrit collected 27590 tonnes used animal fats and vegetable oils. Furthermore, large quantities of used oils and fats are imported

² Based on:

- OVAM (2012). Verkennde studie naar de inzetbaarheid van biomassa en biomassareststromen in bioraffinageketens in Vlaanderen. A VITO study conducted by order of OVAM.
- Devriendt, N., Gorissen, L., Vanbroekhoven, K., Pieper, H., Roels S., Pieret, N, Hauzeur, E. (2012). Studie ter kwantificering van de biomassastromen geproduceerd en geïmporteerd in het territorium van het Belgische koninkrijk met het oog op de productie van energie en van industriële producten. By order of the Federal Public Service for Public Health, Safety of the Food Chain and Environment.

and exported. The total consumption of used oils and fats in Belgium was 3500 tonnes of animal origin and 77680 tonnes of plant origin.

We can conclude that although part of the biomass supply (grains, sugar beet, wood, rapeseed...) is domestically produced in Belgium and Flanders, a very important part comes from abroad. The grains and sugar beet are mainly used for food and feed and only a limited part for chemistry and bioethanol production. Wood waste is used for the production of chipboards and energy, but demand is much larger than supply. Since Flanders has a relatively limited area of agricultural crops and a strong expertise with regard to collection and processing of waste, it should concentrate more efforts on the high-value valorisation of side streams from biomass-related industries, such as food, feed, wood and paper industries before turning to energy valorisation.

Contrary to a lot of other raw materials and fossil energy sources, there is no universal commodity price for biomass. However, for many 'types of biomass', a form of (international) commodity price does exist. These biomass streams often have the status of a commodity. In this respect, we think of cotton, industrial wood pellets, sugar, roundwood or agricultural crops. For such streams, it becomes somewhat simpler to identify the price-setting factors.

Generally speaking, the prices of biomass commodities follow the ups and downs of the (global) economic cycle. In addition to general market trends, also international policy strategies can have an influence on the price of biomass raw materials and their derivatives. If one focusses on individual market segments, most studies reveal that the impact on prices is not that clear and is strongly dependent on the market segment and type. Some of the most important factors to consider are: the relative raw material consumption of the market segment, the purchasing power of the market segment, rapidity of response of the raw material (agricultural) sector to market signals, the availability of substitute raw materials, speculation, and confidence between market parties. Certain price impacts are often the consequence of a combination of factors.

3.2. Renewable energy within the biobased economy

The European Directive on Renewable Energy is the driving and 'binding' force behind the growth of renewable energy production in Belgium and Flanders. By 2013, Belgium must generate 13 % of its energy end-use from renewable technologies. The Belgian objective has not yet been broken down between the regions and the federal level. The Directive offers Member States the possibility to decide on which renewable technologies (sun, wind, biomass, geothermal resources,...) and on which energy vectors (electricity, heat/cooling, biofuels) they want to concentrate in order to meet the objective. Flanders developed a support framework for green power. In addition, a support framework for green heat has recently been developed but is still up for final approval. Apart from green heat and electricity support, which are competencies of the Flanders, the admixture of biofuels is legally provided for by the federal (Belgian) level. Below, the valuable role that biomass plays at present and will play in the future in renewable energy supply in Flanders will become clear.

The most recent data for Flanders (2010) show a total production of 37 PJ of renewable energy. The use of biomass as a renewable energy source is essential in this. 75% of the green power production and no less than 95% of the green heat production in 2010 originated from biomass. Solid biomass each time plays a leading role, representing a 50% share in green power and 68% in green heat. 90% of the biofuel production consists of biodiesel, and the other 10% of bioethanol.

For the production of these 37 PJ, 51 PJ of biomass was primarily used. Half of it was consumed by power plants. In comparison with 2000, the consumption of biomass has increased fivefold. In the total quantity of biomass used, solid biomass has a share of 47%. In addition, some 22% is derived from the organic part of waste.

In 2020, biomass will continue to play a major role and will generate an estimated 95 PJ of energy. Dependent on the scenario chosen, 70% of the green power production will still come from biomass in 2020. Also 76% of the green heat production is expected to come from biomass. Biofuels will account for 86% of renewable transport fuels, the rest will be provided by green power. So the role of biomass is crucial for achieving the renewable energy objectives now and in 2020.

For the production of this green heat and green power, approximately 120 PJ of primary biomass will be needed in 2020, broken down equally over the two energy vectors. The demand for biomass for the production of energy of 51 PJ (2010) and 120 PJ (biofuels excluded, 2020) was measured against the available biomass in Flanders. If both the streams from the waste sector and the agricultural sector (forestry sector excluded) are taken into account, then 23 PJ was available in 2008 (or 45% of 51 PJ). In 2020, an estimated 53 PJ will be available (or 44% of 120 PJ) if the necessary strategies and policy measures to valorise these potentials are elaborated. Nevertheless, sustainable import of biomass for energy purposes will always play an important role in Flanders.

Figure 2 and Figure 3 show the share of renewable electricity and heat in 2010 and predicted for 2020.

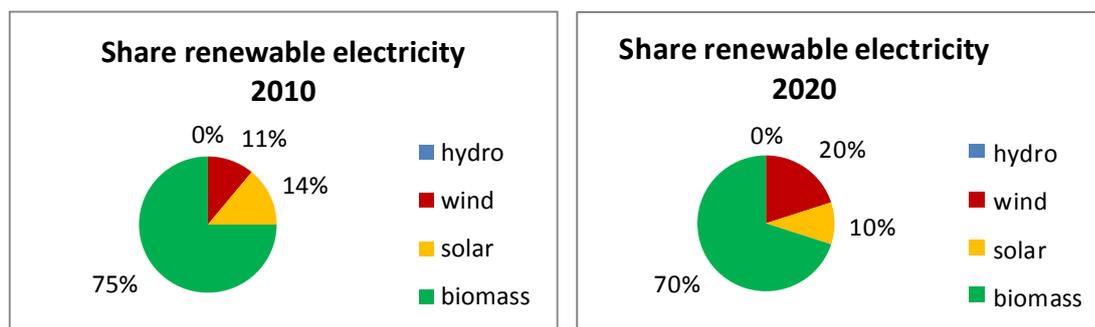


Figure 2 : Share of renewable electricity in 2010 and 2020

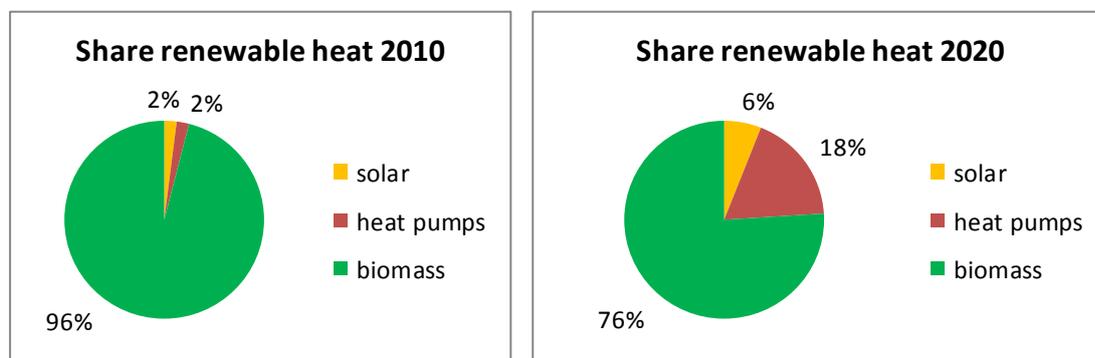


Figure 3 : Share of renewable heat in 2010 and 2020

3.3. Economic impact

Biobased economy can be broken down into biobased energy (biopower, bioheat and biofuels) on the one hand and biomaterials (bioplastics, paper, wood pulp, chipboard sheets, and biochemicals) on the other. The economic impact of these sectors is very different. Biobased products are mostly products with a high added value. Bioenergy is produced with little added value. Furthermore, the type of agricultural products for subsectors also differs. Biochemicals are produced from specific raw materials, while bioenergy needs bulk goods.

Biopolymers, bioplastics and biobased fine chemicals are based on the so-called 'building blocks'. Many sources and sectoral federations point out that these sectors are characterised by strong dynamics, growth and innovation.

When translating this into economic impact (gross margin) and employment, it appeared that 1.5 % of the total Flemish gross margin and 0.8% of all Flemish employment is generated by the biobased economy (see table). It should also be noted that the primary production of (agricultural) raw materials is not included here. The further processing of, for example, bioplastics into finished products in furniture, car industry or construction is not included either.

If we only make a comparison with the industrial sectors, the biobased economy accounts for up to 9% of the gross margin of Flemish industry and 5.7% of employment in Flemish industry. Almost half of the gross margin from the biobased economy is attributed to the chemical and packing industry. In absolute value the economic value of bioproducts is approximately five times as big as the value of energy. Employment is almost ten times higher for bioproducts than for bioenergy.

Compared to 2008, Flemish biobased economy increased with regard to gross margin by 2% while Flemish industry declined by 6%. Employment in Flemish biobased economy dropped by 1% in the 2008-2010 period, but employment in Flemish industry shrank by 10%. Thus, we can conclude that BBE is a growing market which remained untouched by the crisis, whilst the total Flemish industry clearly had to cope with it.

Table 2 : Estimate of Gross Margin and Employment (FTEs, full-time equivalents) of biobased economy in Flanders

| Use | 2008 | | 2010 | |
|--------------------------|-----------------------------|----------------------|-----------------------------|----------------------|
| | Gross margin (million €) | Employment (FTEs) | Gross margin (million €) | Employment (FTEs) |
| ENERGY | | | | |
| Biobased power (1) | 158 | 683 | 199 | 760 |
| Biobased heat | | | | |
| -Pellets (2) | 3 | 46 | 3 | 46 |
| Biofuels (3) | 25 | 146 | 54 | 165 |
| SUM OF BIOENERGY | 186 | 875 | 256 | 971 |
| BIOPRODUCTS | | | | |
| Paper | 215 | 1,546 | 187 | 1,666 |
| Wood-fibre boards | 256 | 1,991 | 238 | 1,808 |
| Bioplastics (4) | 66 | 980 | 62 | 868 |
| Chemistry (biobased) (5) | 653 | 3,930 | 829 | 3,903 |
| SUM OF PRODUCTS | 1,191 | 8,447 | 1,315 | 8,245 |

| | | | | |
|--|--------------|--------------|--------------|--------------|
| TOTAL BIOBASED ECONOMY | 1,376 | 9,322 | 1,571 | 9,215 |
| TOTAL FLEMISH ECONOMY | 102,560 | 1,113,903 | 103,599 | 1,103,438 |
| Percentage biobased | 1.34% | 0.84% | 1.52% | 0.84% |
| INDUSTRY in Flanders | 18,547 | 178,549 | 17,467 | 161,634 |
| Percentage biobased in Flemish industry | 7.42% | 5.22% | 8.99% | 5.70% |

Source: own calculations on the basis of annual accounts (NBB, 2011)

- (1) estimate on the basis of the number of companies
- (2) pellets = 100%; these are pellets manufacturers; (imported) pellets consumption has indeed risen, which can be derived from the increase of bioenergy from biomass from agriculture or forestry
- (3) only the share of biobased of the companies was included (e.g. proviron =10%)
- (4) estimate: 5% of all plastics (PU2301) is biobased
- (5) estimate: 8% of all chemistry (PU2301) is biobased
- (6) paper and wood-fibre boards production = 100% biobased

3.4. Research and innovation in the field of biobased economy

In Flanders, IWT Vlaanderen, the Agency for Innovation through Science and Technology is the body supporting applied research. There are programmes for research institutions as well as for companies. In addition, the Flemish Government also supports sustainable development via the DTO regulation (Sustainable Technological Development). In the framework of the targeted Flemish innovation policy and the New Industrial Policy of the Government of Flanders, the non-profit organisation FISCH was created as a tool for facilitating the transition of Flemish chemical industry towards (more) sustainability. FISCH stands for “Flanders Innovation hub for Sustainable CHemistry”.

In addition, there are also private initiatives. Among them is the initiative of Ghent University which launched the “Ghent Bio-Economy” spearhead in 2010, a multidisciplinary partnership involving 13 promoters from 5 faculties.

Different research projects with one or more Flemish partners are financed by European research programs and funds as for example FP7, Interreg, Eco-Innovation, ERA-Net, LIFE+.

Many of the above-mentioned European and Flemish financial resources are used by a number or a cluster of Flemish companies and research institutions. Therefore, it may be said that (fundamental) research which is conducted in Flanders in the field of biobased economy is of a very high quality and is certainly an asset for Flanders.

What strikes is that the greater part of those financial resources is aimed at fundamental research. In order to take the big leap from fundamental research to technology usable in the industry, demonstration projects are necessary. Therefore Flanders has invested in setting up some common research infrastructure for demonstration projects although a specific financing channel for that kind of demonstration projects is still missing.

An example of such infrastructure is the Bio Base Europe Pilot Plant. This plant works according to the "open innovation" principle, which allows companies to use the infrastructure in order to step up the pace of progress of their innovation projects as well as to complete them at a lower cost. It is essential now to provide sufficient demonstration projects in these installations.

3.5. Sustainability of Flemish biobased economy

An economy based on biomass is not, by definition, green or sustainable. The availability of land and biomass is and remains limited, both at home and worldwide, and that is why a judicious ("sustainable") use must be made of it. Sustainable development implies a balance between ecological, economic and social interests. The different aspects of sustainability must be monitored by indicators, allowing the authorities to impose sustainability criteria. While in the past, sustainability principles were primarily linked with voluntary labels, the legislator now imposes a wider set of conditions. Biofuels and bioenergy are pioneers in this. Due to the strongly increased relations between biomass markets (agriculture, forestry, energy, food, biomaterials, chemistry) consistent sustainability conditions must be applied on all fields in order to avoid shifts between markets.

Sustainability criteria

A recent study for OVAM proposed a set of sustainability criteria applicable to different biomass uses. The criteria are listed in the table below:

- | |
|--|
| <ol style="list-style-type: none">1. greenhouse gas savings (carbon footprint),2. damage to human health,3. damage to ecosystems,4. impact on fertility of the soil,5. land use,6. depletion of pure water resources,7. exhaustion of fossil fuel reserves,8. exhaustion of mineral sources,9. dependence on import/ degree of self-sufficiency,10. diversification/impact on the resilience of a sector,11. creation of added value,12. employment,13. social sustainability, including the impact on food prices and availability. |
|--|

The allocation of weights to the different indicators is based on political choices and priorities and may be dependent on time. Determining threshold values for certain indicators ('stop lamps criteria') could be a possible practical approach, as is also adopted by the European Renewable Energy Directive, while only a limited number of 'key criteria' are used for balancing the different uses.

Concerns

If we examine the issues of sustainability, we must distinguish between the type of biomass, its origins and processing and end-use. As regards biomass, the distinction between main and co-

products on the one hand, and residues and waste products on the other is important. If agricultural products are concerned, the agricultural process to grow the crop plays a crucial role in the sustainability analysis; attention must also be paid to the competition with food. For forestry or forestry management, it is being discussed which wood fractions are advisable for which sector, and to what extent wood may be extracted from woods in the framework of sustainable forestry management. An important concern stems from the fact that sustainability risks are often generated by materials from outside Europe, where our legislation can indeed exert little influence. Apart from the production and origins of biomass, 'Resource efficiency' is a key concept for all materials, both exhaustible and renewable materials. Raw materials must be manufactured, traded and transported, processed and used in an efficient way, taking also into account the end-of-life. Closing the cycle is an important concept here. For biomass, in particular, the carbon cycle, partly via the atmosphere, and the nutrients cycle are concerned.

Extrapolation to the current biobased economy in Flanders

The study estimated the associated greenhouse gas emissions savings compared to fossil alternatives for the current biobased economy in Flanders. Greenhouse gas emissions savings associated with biofuels in Flanders are an estimated 350 kilotonnes in 2010, and may rise to more than 800 kilotonnes in 2020. Stationary bioenergy (electricity and heat) savings for 2010 are estimated at over 2 million tonnes of CO₂. In this context, an increase of stationary bioenergy of more than 200% is announced within the Belgian Renewable Energy Action Plan.

With regard to biomaterials, we can state that the paper and chipboard sectors are important sectors in Flemish economy, still leaving space for further reduction of raw material and energy use through new technologies. Recycling is an important focus for which many efforts are being made. For building materials, an increased use is made of renewable raw materials, and in this way carbon is locked up in these products for a long period of time.

Furthermore, the chemical sector also makes use of bioplastics, biolubricants, biosolvents, detergents and biosurfactants (soaps).

The production of biochemicals in Belgium is primarily based on starch (wheat and maize) and vegetable & animal oils and fats. The advantages of these biobased products mainly arise from the reduction of fossil fuel use, of greenhouse gas emissions and their biodegradability/compostability. On the other hand, these products are often made from known agricultural crops such as corn, sugar beet or maize. The agricultural process here (see also first generation biofuels) meets with the same problems of fertilisation, pesticides, land use and competition with food.

Figure 4 shows that there is a very large spread in the field of greenhouse gas emissions and fossil energy use of bioplastics, but that there is a clear advantage compared to their fossil counterparts.

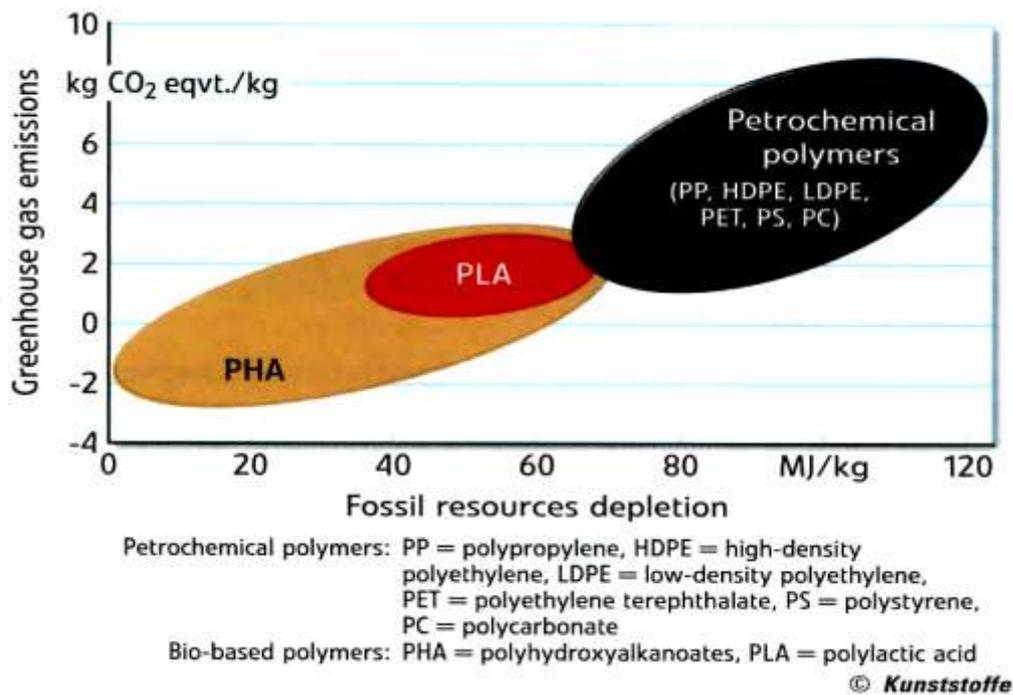


Figure 4 :Greenhouse gas savings from bioplastics (PLA and PHA) in relation to petrochemical plastics (source: Essel, 2012)

A rough estimate was made of the total greenhouse gas savings in the chemical industry based on starch and vegetable/animal oils. For Belgium, this would amount to an order of magnitude of between 1 and 1.5 million tonnes CO_{2-eq} in 2010. Please note that there exists great uncertainty about this figure. For more specific figures illustrating the Flemish situation, more in-depth market studies and LCA studies are needed.

3.6. Impact of policy on the development of the Flemish BBE

There are important reasons why an appropriate policy is necessary for the further development of a biobased economy:

- A biobased economy requires the development of new technologies, which at first will be more expensive than existing alternatives already developed and proven to be cost efficient. Over the course of time, it is to be expected that biobased technologies will also become economically viable, thereby allowing government support to be cut back.
- However, some aspects of biobased economy are not expected to be or to become competitive, as several external profits cannot be internalised (such as environmental benefits).

An overview of a typical biobased product moving along the chain and the relevant policy areas is illustrated by the following figure.

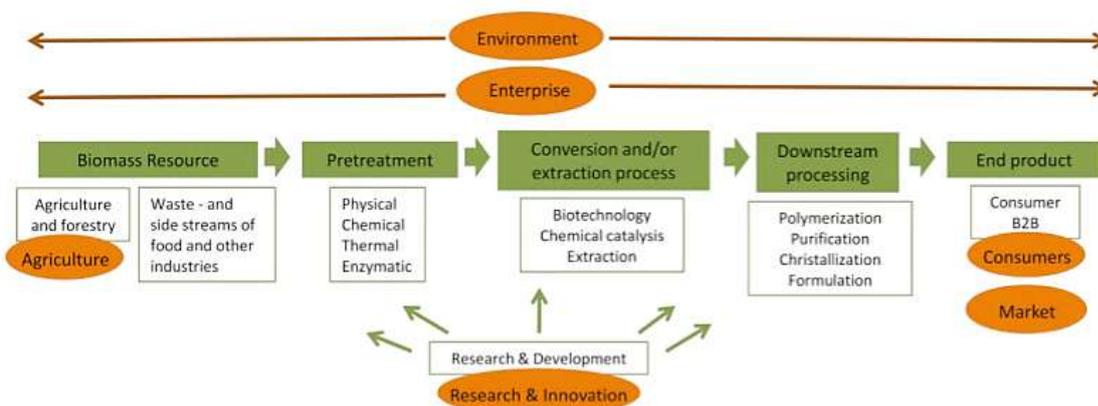


Figure 5 : The different policy areas having an impact on biobased economy

Apart from European initiatives such as the “Lead Market Initiative for biobased products” and the more recently published “European strategy for a sustainable Bioeconomy”, current policy - both European and Flemish - is specifically aimed at the production of bioenergy and biofuels. Mainly under pressure from Europe, Flanders gives support to bioenergy and biofuels today.

A similar supporting policy for biobased products is lacking at present. As different policy areas (agriculture, economy, innovation, environment, energy...) should work together in this, matters are complicated. However, regulations having an indirect impact on the further development of the sector or parts thereof do exist: for instance, the “Directive on packaging and packaging waste” and the Ecolabel initiative are of importance to the bioplastics sector, whilst the Common Agricultural Policy is important for the availability and the price of the available biomass.

A positive note is that biobased economy has become a component of several recent policy initiatives in Flanders. Examples include the initiative with regard to "Sustainable Materials Management" and the FISCH³ project.

Thus, there is obviously a need for a clear vision and a specific integrated policy in support of biobased economy as a whole. Here, the interdepartmental working group for biobased economy (IWG BBE) will play an essential role, as the group is indeed charged with the development of a vision and strategy for a Flemish BBE.

³ <http://www.fi-sch.be>

4. Recommendations

Subsequently, a detailed **SWOT analysis** was developed for this study, based on existing literature, the input and experience of the various experts, and interviews with stakeholders from industry, research institutes, the authorities, the agricultural sector, and non-governmental organisations. The results of this SWOT analysis, together with previous conclusions, were used to draft a series of **recommendations**:

- Firstly, there is a clear need for an integrated approach, in which policy areas such as research and innovation, economy, agriculture, energy, environment and education are important, and it is also vital that all stakeholders are involved (agricultural organisations, the research community, industry, NGOs, etc.). In order to achieve all this, it is proposed that a **“Vlaamse Raad voor de Bio-economie”** (Flemish Council for the Bioeconomy) be established.
- **Research and innovation**, across the entire value chain (from feedstock to application), is one of the most important resources for building a competitive and sustainable BBE in Flanders. Although Flanders already possesses many assets in this respect, they are too fragmented and there is little cooperation between the various industrial sectors. By analogy with our neighbouring countries, it is necessary to increase visibility and efficiency by setting up a clearly visible - inside and outside of Flanders - Flemish public-private partnership for the BBE and to support it financially as well. In the longer term, it must also be possible to establish cooperation partnerships with other regions (such as the Netherlands, Germany, France and Wallonia) and to attract research projects and investors. In addition, Flanders needs a bio-incubator and a new financing instrument for valorisation and demonstration projects for the biobased economy. It is also recommended to bring possible partners and stakeholders from different sectors together in new innovative value chains. Finally, due to its high industrialisation and CO₂ emissions, Flanders has to analyse the possibility to transform CO₂ into fuel or chemical building blocks.
- It is also necessary to promote the optimal utilisation of **biomass**. In the future, Flanders must focus more effectively on the valorisation of secondary streams from biomass-related industries such as food, animal fodder, wood, and paper before transforming them to energy at the end of the life cycle; maximum use must be made of existing and new waste streams. Agricultural research must also be encouraged, for example, to increase yields of existing crops, cultivate new crops in line with the BBE, develop efficient biorefinery techniques, etc.
- In terms of **logistics**, Flanders has a number of assets that must be developed as extensively as possible, such as two major ports whereby Ghent could be further developed as a “bio-port” and Antwerp as a “CO₂ conversion platform”.
- There is certainly a need for a regulatory framework to **promote the use of renewable feedstocks in materials** and the promotion of biobased products following on from this. In this way biobased products could be supported just like bioenergy, for example, on the basis of their greenhouse gas emission benefits, or could be included in a “sustainable public procurement” programme.

Lastly, it is necessary to make the **opportunities and benefits of the bio-based economy** more visible to both policymakers and consumers and within the industry itself. Flanders Investment and Trade could promote Flanders as a “centre of expertise for the biobased economy”, and organise specific missions to other regions in order to attract research projects and foreign investors.



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