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GreenPremium Prices Along the Value Chain of Bio-based Products

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GreenPremium Prices Along the Value Chain of Bio-based Products

Authors: Michael Carus, Asta Eder, Janpeter Beckmann, nova-Institut GmbH

1 Initial questions

The GreenPremium is basically understood as the extra-price market actors are willing to pay for a product just for the fact that it is "green" or, in our specific case, "bio-based" (= derived from biomass). Several questions arise when analyzing the GreenPremium effect and attempting to understand the reasons for market actors to pay a higher price.

How exactly is GreenPremium to be defined and understood? Are GreenPremium prices really paid by the market? Which markets fetch which levels of GreenPremium prices? What are the relevant motivations and drivers? Do differences concerning the GreenPremium level depend on the position in the value chain? Who pays the extra prices? Will market actors only pay the GreenPremium for a limited time? Do special GreenPremium prices depend on single value-adding factors, such as bio-based, biodegradable, non-food and/or GM-free?

This paper summarises the results of several expert interviews, online surveys, market observations and literature research in 2012 and 2013, undertaken by experts of nova-Institute.

The work was funded by two European projects, BIOCORE ("BIOCOmmodity REfining", a biorefinery concept for the transformation of biomass into 2nd-generation fuels and polymers, n°FP7-241566) and MouldPulp (New biocomposites from bioplastics and pulp fibres, ERA-NET WoodWisdom-Net 2, project number 033R061B) in the framework of two comprehensive techno-economic evaluations including market research on volumes and prices.

2 Methodology

Our surveys and analyses cover cases of GreenPremium prices for 35 bio-based chemicals, polymers and plastics (drop-in and new biopolymers), and compounds – and additional background information from market insiders for the GreenPremium prices. Expert interviews by phone, skype, LinkedIn and face to face, as well as a literature analyses, were conducted in late 2012 and 2013. The following experts from leading companies, researchers and consultants were interviewed:

- **Representatives of leading companies in the field of bio-based intermediates/building blocks, polymers, plastics and compounds:** Arkema (Dubois 2013), BioAmber (Pettersen 2012), BIOTEC (Beythien 2013, Mathar 2012), Braskem (Cassinelli 2012, Pesce 2013), CocaCola (Stadler 2012), Dupont (Hausmann), Evonik (Häger 2012), Fischerwerke (Schätzle 2013), FKuR (Michels 2012), Ford (Magnani 2012), Futerro (Luijkx 2012), Linotech (Grashorn 2012), Purac (de Bie 2012), Synbra (de Loose 2012) and Tate & Lyle (Capitain 2012).
- **Market researchers and consultants in the research field:** Baltus 2012, Carrez 2103, Heine 2013, Kaeb 2012, Morel 2013 and Ravenstijn 2012.
- **In addition to the interviews, publications and blogs (LinkedIn) from leading experts in the research field:** Caesar 2008, de Guzman 2011, Farminer 2012, Hasson & Mestanza 2011, Levine 2012, Lunt 2012, Meller 2012, nova-Institute 2013, NRF 2010, Perriman 2013, Poynter 2012, Prestilio 2012, Tetra Pak 2009 and Toyota 2011.

3 Definition of "GreenPremium" prices

The GreenPremium is commonly understood as the additional price market actors are willing to pay for a product just for the fact that it is "green" or, in our specific case, "bio-based" (i.e. derived from biomass). For the first time, nova-Institute is putting forward a clear definition of GreenPremium which will be used in this study:

GreenPremium price is the additional price a market actor is willing to pay for the additional emotional performance and/or the strategic performance of the intermediate or end product the buyer expects to get when choosing the bio-based alternative compared to the price of the conventional counterpart with the same technical performance.

Technical performance: Technical performance is based on mechanical, rheological, thermal, optical and chemical properties. The properties are of relevance in regard to processability, waste management (e.g. aspect of biodegradation) and health-related compatibility or application specific characteristics like barrier properties. The properties can be valued differently from one application to the next and depending on the underlying process. In the case of a bio-based drop-in solution, the technical performance is precisely the same as its substitute (it can be assumed that the carbon footprint would differ, but that is not part of technical performance). Although specific technical performance could be an important reason for companies to choose or not choose a bio-based alternative, this is not part of the GreenPremium price.

Emotional performance of the product: The possibility of assigning a value to the product just because of its nature e.g. the perception of its nature by the customer. Being seen as green, bio-based, sustainable, and/or having a lower carbon and environmental footprint can create a specific emotional performance. The emotional performance can give the customer the feeling that he/she is doing something good by buying the product. The emotional performance increases towards the end of the value chain as end-consumers pay more attention to the "Green Touch" of an application than companies do (Grashorn 2012, Pettersen 2012).

The increased emotional performance of a product enables the producer and distributor to obtain higher prices for their products and higher selling volumes on the market.

Strategic performance of the product: This expresses the possibility of positioning the company via the product in the market as a green, sustainable, low-carbon and innovative company, as a forerunner with exclusive access to a new material, or in terms of supply chain diversification, an opportunity to gain a mid-term/long-term market advantage, to hedge the oil price or other price volatilities, and to comply with regulations or expected regulations before the competition does. The strategic performance of a bio-based product is strongly dependent on the specific market actor's position in the value chain.

An increased strategic performance enables the producer or distributor to get a better position and reception of the company on the market – via the product placement.

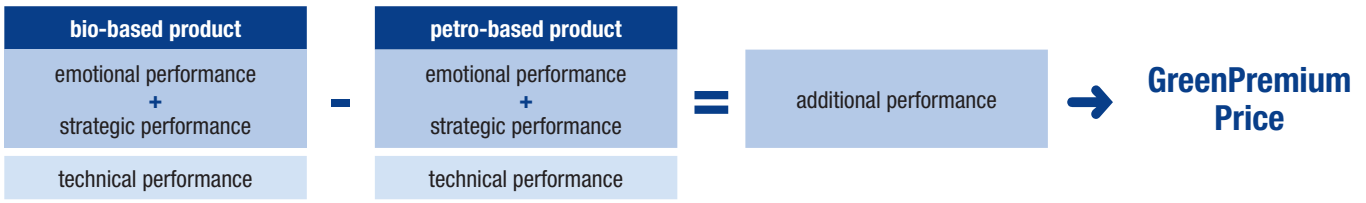

Figure 1: Definition of GreenPremium Price (nova 2014)

The GreenPremium paid for emotional and strategic performance is often associated or mixed with additional technical properties such as biodegradability, waste treatment or better barrier properties in food packaging. These technical aspects (see technical performance) are not part of emotional or strategic performance, even though this is not always clearly differentiated by the users.

4 GreenPremium prices do exist

The results of the surveys and analyses of 35 cases of bio-based chemicals, polymers and plastics clearly demonstrate that GreenPremium prices do indeed exist and are paid in the value chains of different bio-based chemicals, polymers and plastics – especially for new bio-based value chains and the European market. In line with the definition of GreenPremium, the motivation to pay additional prices is the bio-based product's expected increased emotional and strategic performance.

In the absence of any policy incentives, GreenPremium prices are very important for the market introduction of bio-based products, and many new bio-based polymers and plastics would not even exist without customers willing to pay GreenPremium prices. "The GreenPremium exists, and has enormous impact to get a project financed" (Baynes 2014).

Bio-based plastics are at present usually more expensive than their conventional counterparts and companies also face supply chain challenges when they switch from one raw material solution to another. Nevertheless, the bio-based plastics market continues to grow, and multinational brand-owners like Coca-Cola, PepsiCo, Nestlé, Danone, Ford, Toyota, Mazda, Procter & Gamble and AT&T as well as many other companies involved in all kinds of branches and applications already use bioplastics in their products or packaging (de Guzman 2011, nova-Institute 2013). "Companies that have set goals and objectives to become more sustainable and to leave a more sustainable impression on consumers have an interest in bio-based materials. If materials meet the necessary technical requirements, companies are willing to pay a "Green-Premium"" (de Bie 2013).

In regard to their bio-based products Braskem generally states: "Regardless of what each customers pays, the important fact is that a GreenPremium is necessary and accepted." (Pesce 2013).

5 Results of the LinkedIn survey in the bio-based community

Our survey on "LinkedIn" in 2013 also clearly showed the existence of GreenPremium prices as well as the ranges of GreenPremium and additional background information. The participants voted on the question put by nova-Institute: "GreenPremium for Bio-based Plastics: Which premium extra price would you or your customers be willing to pay?" that was addressed to the groups "Bioplastics" and "myBIO Community – Biotechnology connections", both of which are involved in the bio-based economy (LinkedIn 2013). The voting represents participants who were – or whose customers were – in principle willing to pay a GreenPremium. Participants could also make comments, i.e. give reasons and explanations.

The following figure shows the level of additional price that market actors would pay for bio-based plastics. The figure is based on 47 respondents, representing a random sample of bio-based plastics producers, traders and further experts (LinkedIn 2013).

The figure shows that 72% of all respondents estimate that customers (independent of their position in the value chain) would be willing to pay up to 20% more if plastics were bio-based instead of fossil-based. 17% would be willing to spend between 20% and 40% more compared to a fossil-based alternative, and 11% of all respondents would even pay a premium of more than 50%.

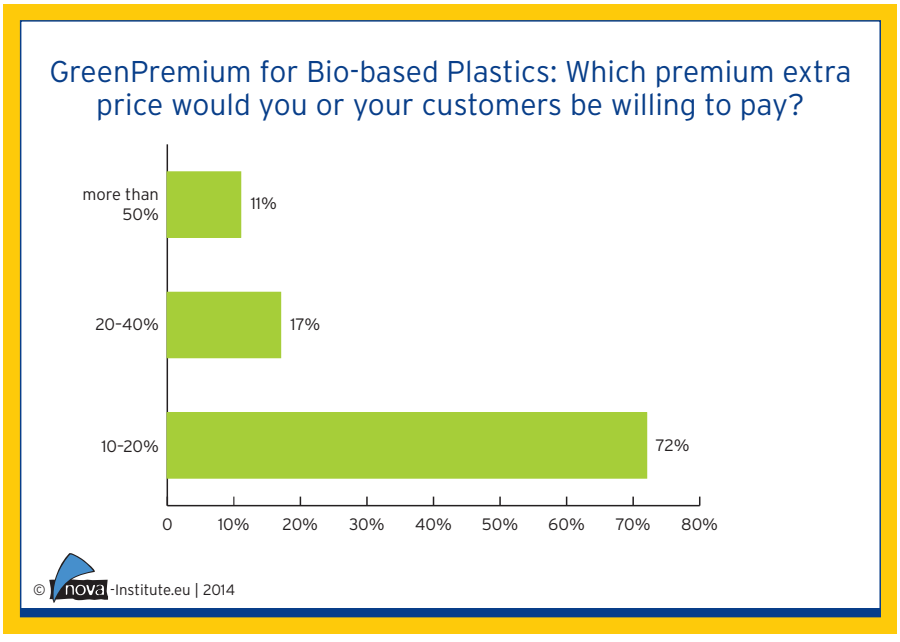

Figure 2: Level of GreenPremium (in percentage) that would be paid for bio-based plastics, n = 47 (Status: 20 August 2013)

6 GreenPremium price ranges – the full picture

The following Figure 3 shows the results of all expert interviews and surveys undertaken and analysed in the context of this study (see Methodology). You will also find a table in the appendix containing detailed information on analysed cases of bio-based materials, products and companies.

The figure shows the identified GreenPremium levels depending on where they are paid in the value chain – for example, the polymer producer buys a building block from the chemical company and might pay a GreenPremium for it or the end consumer buys the final product and might pay a GreenPremium to the distributor.

The range of reported GreenPremium prices in the various branches and applications analysed lies between 10 and 300% above the conventional petrochemical product with the same technical performance. Most of the GreenPremium price findings are in the range of 10 to 20% for bio-based intermediates, polymers and compounds, followed by the range 20 to 40%. Higher GreenPremium prices could only be obtained in specific cases. For the end consumer, the range of GreenPremium prices for bio-based products goes from 0% (car, cosmetics, bottle) to 25% (wall plug, toy) with, in the middle, a 10% GreenPremium for organic food with bio-based packaging.

These are huge extra prices compared to biofuels. A recent US survey shows that even consumers involved in the biofuel sector only accept 1-3% higher prices for biofuels with the same technical performance as fossil fuels (details see below).

Some identified GreenPremium prices are part of the same value chain; they are shown by **coloured lines**. The empirical data shows that for all lines the GreenPremium price levels (in percentage terms) decrease along the supply chain towards the end consumer, the brown and green lines after an intermediate peak. Relatively high GreenPremiums are paid for (early) intermediate products, whereas the end consumer pays a much lower GreenPremium or even no extra price at all.

The reason for this is that intermediate products such as building-blocks, polymers or compounds only account for a minor fraction of overall product costs, with the effect that end product costs increase only slightly. The material costs share (including the GreenPremium) of the total product price decreases along the value chain.
The highest GreenPremium price (in percentage) is paid predominantly for the intermediates. And without this enhanced and confirmed willingness to pay high GreenPremium prices for intermediate products, many new bio-based value-chains would not have been implemented at all.

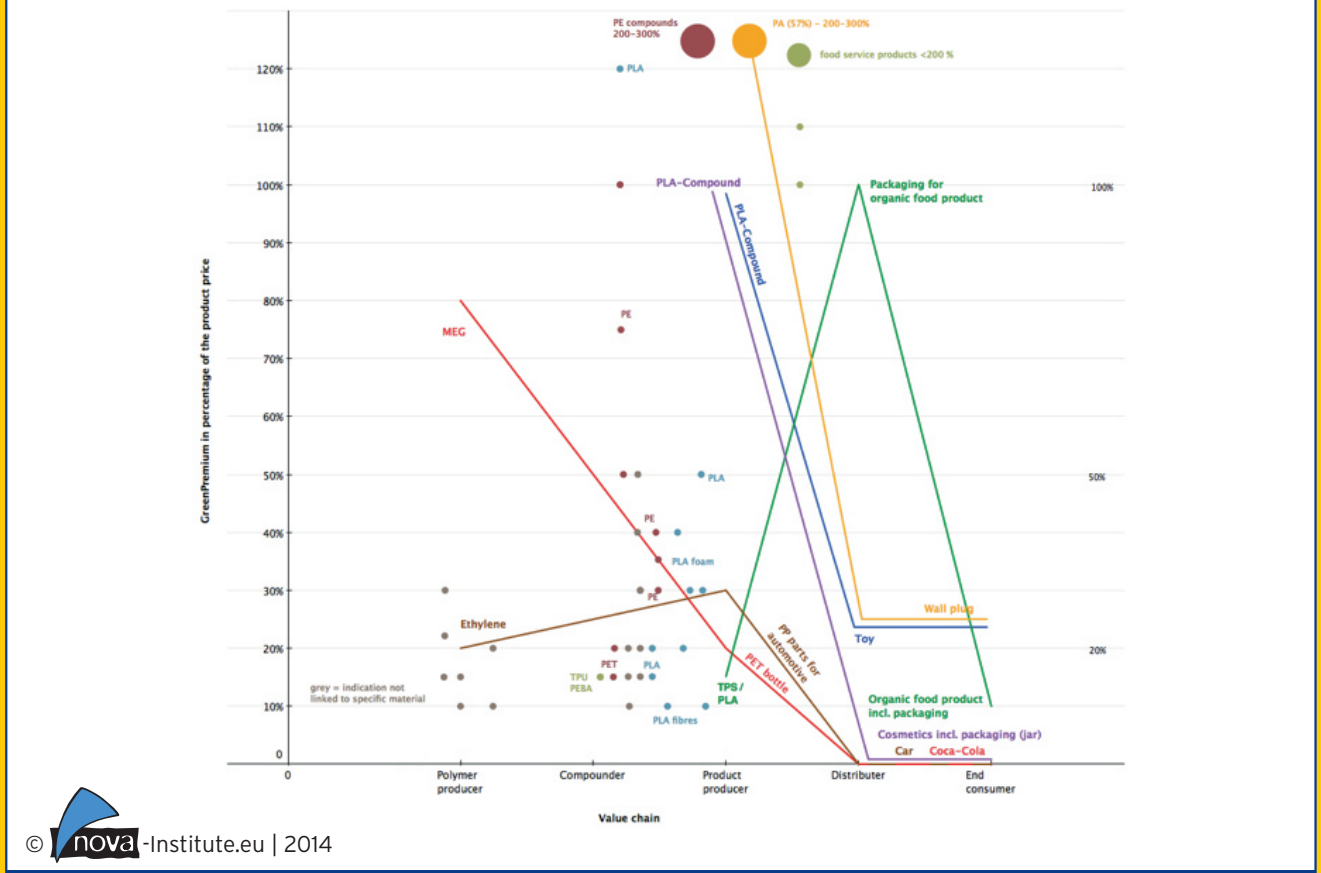

Figure 3: Analysis of GreenPremium prices along the value chain of different bio-based chemicals, plastics and end products. Coloured lines represent one value chain, single dots represent single findings.

Nobody would risk an investment to produce the bio-based building-block MEG, for example, if no large B2B customer guarantees a GreenPremium price for this intermediary to produce bio-based PET with an expected increased emotional and strategic performance. This example also shows three additional aspects, often discussed in the context of GreenPremium:

- The commitment to pay GreenPremium prices for bio-based intermediates or polymers has to last for several years, otherwise the upstream investment is not profitable – and such long-term commitments are indeed being made.
- The highest GreenPremium levels are mainly located in the beginning or middle of the value chain, since the end consumer pays the lowest (or even no) GreenPremium price.
- The main reason behind GreenPremium is an expected increased emotional and strategic performance of the product for the product's producer and/or distributor.

In some cases, the end consumer pays a certain GreenPremium price – they are willing to pay for the "Green Touch" (emotional performance) as the wall plug example shows; in other cases, the producers are willing to bear the extra costs themselves as there is a strategic benefit to them – e.g. a bio-based Coca Cola bottle contributes to a greening of the company's image (strategic performance).

The green line rises towards the middle of the supply chain, which means that the highest GreenPremium levels are paid by the distributor for the green packaging. This situation can occur when a product is subject to very high emotional performance that would allow producers and distributors to pass on their extra costs to the end consumer. Bio-based packaging for organic food can serve as an example, with a small fraction of packaging costs and high emotional performance through "green packaging" making a perfect fit with the consequent "green image" of the organic food product. The distributor can pass his extra costs of the "green packaging" (+100%) on to the end consumer, who only has to pay 10% GreenPremium for the final organic food product since the packaging makes up only a small share of the bought product. (The high GreenPremium price for the "green packaging" can be explained by a small production volume.)

These **unconnected dots** represent other empirically proven GreenPremium levels in the market, which could not be allocated to specific supply chains. The distribution indicates above-average GreenPremium levels for compounds and polymers compared to chemicals or end products.

Some of the dots represent specific materials and are coloured (e.g. PLA in blue), others represent more general findings and are marked in grey (e.g. bio-based chemicals in general).

7 Examples of GreenPremium prices

Some companies pay more than double the conventional price, for example for compounds based on PE made from biomass. One reason for FKuR customers to pay this premium is that the product fits their corporate identity, since they pursue sustainability targets and pay attention to their products' carbon footprints. Some of the buyers actively communicate this attitude to the public for marketing purposes, whereas other customers do not (Michels 2012). The company fischer brought a "green" wall plug made from 57% bio-based polyamide to market in order to strengthen their green company image. The bio-based version, which is 20% more expensive than the conventional one, is mainly aimed at environmentally minded do-it-yourselfers (Schätzle 2013).

Talking about the end consumer industry, Coca-Cola is willing to pay up to 25% extra for bio-based PET to be used in drinking bottles. This includes higher production costs caused by retooling and transport (Stadler 2012). Based on increasing economies of scale, Coca-Cola expects equal prices to petro-based PET by 2015 for the Brazilian production chain, whereas the European way will require further GreenPremium shares due to higher logistics costs (Stadler 2012). Generally, it is estimated that major companies like Coca-Cola and Danone pay 15-20% and even up to 25% more for Bio-PET or PLA used in packaging.

The main reason for this is to benefit from marketing effects due to environmentally friendly products, but supply chain diversification is also an aspect, specifically to create a second raw material pillar and to make the company less dependent on price volatilities for crude oil (Stadler 2012, Käb 2012, de Bie 2012). However, GreenPremium extra prices only make up a small share of overall product costs and are in any case overshadowed by advertising costs (Dubois 2013).

However, as examples such as Toyota, Coca-Cola and Braskem show, these GreenPremiums are paid for relatively new products such as bio-based PE or PET. Strictly speaking, respective investments in the necessary plants were dependent on the B2B customers' willingness to pay a GreenPremium.

A producer of plastic toys pays a GreenPremium of nearly 100% for a 68% bio-based version that has similar technical properties to ABS in order to take advantage of marketing effects. The final toy product prices are 20-30% higher than competing products (Grashorn 2012).

Tetra Pak strived for a 100% bio-based packaging (with the exception of the metal films) which meant several materials had to be replaced. It was willing to pay a GreenPremium of over 30% for Braskem's HDPE as the remaining coating needed to reach the 100% bio-based share. In Tetra Pak's view this approach was justified, since their product was the only 100% bio-based solution in the market segment and stood out from the competition (Tetra Pak 2009, Cassinelli 2012).

For organic food in particular, bio-based (and compostable) packaging must be seen as part of the product and its image. As extra costs for packaging are negligible in relation to the extra price for 'organic', supermarkets can simply pass on even major GreenPremium prices (from about 100% for the distributor to about 10% for the final product) (Ravenstijn 2012, de Bie 2013).

Industry insiders confirm that companies in the bio-chemicals sector are willing to pay a general GreenPremium of 10-30%, at least for a certain time (Capitain 2012, Cooper 2013).

Within the automotive sector, Toyota has covered 80% of the interior surfaces of one of its hybrid cars with Bio-PET-based plastic. The material, which is used in the seat trim, floor carpets and other interior surfaces, is estimated to raise raw material costs by 15% (Toyota 2011, Ravenstijn 2012). One reason for this development is to meet internal sustainability targets, e.g. concerning the product's carbon footprint (Carrez 2013).

Ford, Toyota and Volkswagen are also interested in purchasing Bio-PP from Braskem in order to benefit from marketing and supply chain effects. They are expected to pay around 30% extra compared to the current petro-based counterpart, at least for a limited period of time (Ravenstijn 2012).

Unlike Braskem's PE production, its bio-based PP plant is still pending, and production will depend on demand from Ford, Toyota and Volkswagen. Only upon necessary demand, which has to include a GreenPremium, production will be possible and profitable (Pesce 2013). Suppliers are able to enforce GreenPremium prices in case of

exclusivity contracts to their customers (Morel 2013).

8 Main drivers for emotional and strategic performance

The analysis shows that the willingness of market actors to pay GreenPremium prices is dependent on two factors:

- The additional emotional performance compared to the conventional counterpart
- The additional strategic performance compared to the conventional counterpart

The emotional performance is subjectively valued and mainly due to the end consumer's preference. The GreenPremium effect is passed on through the value chain as a result of an expected consumer pull.

The value of a product's strategic performance that leads to GreenPremium depends on the company's and the branch's general market circumstances and framework. Often, the improved strategic performance for the company is directly linked to the product's increased emotional performance for the end consumer. In some other cases, the strategic performance is to a certain extent independent from the product's emotional performance. Depending on the market position and targets, some players in the bio-based industry focus more intensively on the emotional or more on the strategic performance.

Most commonly mentioned aspects in the context of the emotional performance of a bio-based product

- Benefits in marketing due to
  - Green or environmental friendly image
  - Reduced carbon footprint
  - Access to "eco-labels"
- Additional benefits and public attention from exclusive access to scarce, new materials
- Cost efficient image effects are possible if the material costs account for only a small share of overall production costs[1] or the GreenPremium expenses can be fully and directly passed on along the value-added chain
- Niche markets can be very sensitive to emotional performance.
- The emotional performance can give the customer the feeling of doing something good by buying the product

Additional product properties such as the feedstock used for the polymer production could have an impact on the GreenPremium level. Feedstock from GM (genetically modified) crops or food crops will achieve lower GreenPremium prices compared to non-GM and non-food. The level depends mainly on their emotional performance in individual cases. For non-GM derived bio-based plastics the extra premium price can range from 0% to over 100%, mainly depending on specific markets and regions. In regard to the emotional performance behind the mentioned product properties, the respective GreenPremium level is strongly dependent on end-consumer preferences.

Non-GM crops or ones "not in competition with food" play a more important role the closer the position in the value chain to the end consumer (Grashorn 2012).

The data within the study is largely based on estimations of the European market. It should also be mentioned that the willingness to pay a GreenPremium price is relatively high in Europe, whereas in China it is relatively low and North America somewhere in between (Ravenstijn 2012).

Additional findings from surveys and literature

Experience shows that consumers tend to pay GreenPremium prices (and hence pass on the difference to other actors in the supply chain) when the environmental or social benefits are explained to them (Levine 2012).

"The consumers are the driving force. Some consumers already pay a premium for less polluting cars, for organic food and for green plastics, and they are constantly growing in number. 'Being green' is the premium, and the consumer shall pay for it. Local regulation can be helpful, but it is definitely the demand that makes the difference. And the current trend is going green, worldwide." (Prestileo 2012).

The examples of Coca-Cola and Toyota confirm this assessment, as the image of a product and the emotions customers associate with it become more and more important in certain markets (Stadler 2012, Ravenstijn 2012).

GreenPremium prices can even be achieved for bio-based products that can be controversial from an environmental point of view, as shown by bio-based PVCs. Prerequisites are, however, exclusive contracts for the customer and that the target markets are susceptible to emotional performance, e.g. flooring and pharmaceutical films (Morel 2013).

An evaluation of the US market conducted by P&G largely confirms this trend. "Roughly 80% of consumers are either highly engaged with environmental sustainability (they will accept some performance trade-offs for products with better environmental footprints), or are 'eco-aware' but will not accept trade-offs. The latter group (70%) are considered the mainstream and are an important target group for bio-based products. The remaining 20% are indifferent; in the US, half of this 20% self-classify as never greens" (Meller 2009). Similar results have been revealed by the National Retail Federation, showing that 70% would be willing to pay a premium of at least 5% (NRF 2010). Other analyses confirm more generally that "consumers are willing to pay slightly more, but not huge amounts more" (Cooper 2013).

Most mentioned aspects in the context of the strategic performance of a bio-based product – strategic benefits for the company

- Creating a positive public awareness and improving corporate identity of the company by:
  - Meeting sustainability targets
  - Reducing the product carbon footprint, covering CO_2 reduction targets
  - Strengthening the green company image
- Forerunner in technology, public perception as an innovative company, early experiences with potentially long-term cost efficient materials, pathways and products
- Meeting public regulations or expected regulations in advance
- Increased feedstock diversity and security. Supply chain diversification and independency of price volatilities
- Benefitting from potential subsidies or public incentives (Michels 2012, de Bie 2013, Schätzle 2013)

1 Given the case that a bottle weighs 50 g, the petro-based material is at € 1.50 per kg and the bio-based alternative is at € 2.25 per kg. The GreenPremium on the material is therefore € 0.75 per kg or 50%. If the bottles were sold at 2.50 (filled), material costs per bottle would be € 0.075 or € 0.1125, respectively. The difference of € 0.0375 represents only 1.5% of the total bottle price.

According to a survey by Genomatica and ICIS, 72% of the chemical producers said they their customers are expressing interest in sustainable products. This market-based pull has grown much stronger over the last five years. As a result almost half of the companies (45%) reported to have investments in research and development for using renewable feedstocks (Perriman 2013).

Leaving aside public regulations, from a market point of view "gaining market potential" (Caesar 2008) as well as "supply chain diversification" and "a direct/short-term increase of return on investment" are the predominant factors when it comes to strategic intentions.

9 GreenPremium in the automotive sector

A 2011 study by Hasson and Mestanza covering OEMs' and Tier X suppliers' willingness to buy bio-based materials in the automotive sector identified the following reasons (see Table 1), which mainly show strategic aspects.

Image of the company or of the brands	30%
Growing pressure from the consumer	19%
Anticipation of future regulations or "carbon taxes"	14%
Anticipation of oil price increase (and then costs)	13%
Get "Eco labels"	10%
Company/corporate policies	9%
Existing regulations	4%

Table 1: "What is the main reason why OEMs or tiers have or feel pressure for using more bio-based polymers?" (Hasson and Mestanza 2011)

Hasson and Mestanza identified the following ranges of willingness to pay an extra price for bio-based materials. The results show that the GreenPremium prices are lower in the automotive sector than in other branches.

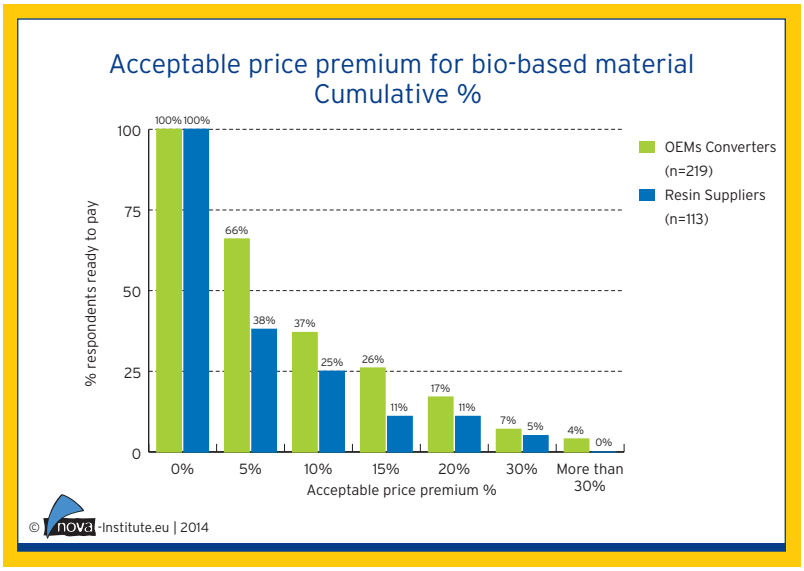

Figure 4: Acceptable price premium for bio-based materials in the automotive industry (in percentage). (Hasson and Mestanza 2011)

10 Some actors fail to receive a GreenPremium

Some experts are sceptical about GreenPremium prices. "Very few users are willing to pay a premium for a bio-based product. Such products must be equivalent or better in performance and equivalent, or lower, in price to be successful – a typical marketing situation. This market segment will be driven mainly by legislation long-term." (Farminer 2012). Another expert confirms this: "There is no broad willingness to pay a premium, but there are signs of change." (Poynter 2012)

This is in clear contrast to our findings. In practice, however, some companies genuinely do not succeed in achieving a GreenPremium price. In particular, it is nearly impossible in long-term existing supply chains in established markets, according to Arkema, Arizona Chemical and Borealis, to force a GreenPremium on customers (Dubois 2013). A crucial factor is that these companies had been producing and selling bio-based products for years without receiving any GreenPremium. When they noticed that customers were willing to pay a GreenPremium for recently launched bio-based products, they tried to charge more, but buyers – of course – refused.

So GreenPremium prices are mostly linked to new investments in bio-based chemicals and plastics, which have been realized upon expected or confirmed demand, which includes often a confirmed willingness to pay GreenPremium prices for intermediates over a longer period.

11 GreenPremium for Biofuels?

Early January 2014, the US BiofuelsDigest – "The world's most widely read biofuels daily" (www.biofuelsdigest.com) made a survey of 482 readers (277 responded to the following question), most of them living in the USA and involved in the biofuel industry. The question was: "For fuels like drop-in renewable gasoline, diesel, there are exactly the same fuel properties – and, up to 60 percent reduction in CO_2 emissions, plus domestic green jobs and improved energy security. Given all those benefits – for a fuel like drop-in renewable gasoline, diesel or jet fuel that would have exactly the same performance in mileage and in the engine – how much more would you expect to pay at the pump and still choose renewable fuels over regular fuels?"

In early January, a gallon of gasoline costs about $ 3.30 per gallon.

Answer	in percent
Only if they cost less	5.4%
Only if they cost the same	30.3%
3 cent per gallon more (= 0.9%)	13.7%
5 cent per gallon more (= 1.5%)	18.0%
10 cent per gallon more (= 3%)	15.2%
20 cent per gallon more (= 6%)	6.1%
25 cent per gallon more (= 7.6%)	9.4%
Other	1.9%

Table 2: "How much more would you expect to pay at the pump and still choose renewable fuels over regular fuels?" (Survey by US BiofuelsDigest 2014)

The result shows that nearly 83% of end consumers in USA involved in the biofuel sector are willing to pay an extra price of between 0 and 3% for bio-based fuels, and only 15% of those end consumers would accept 6 to 8% more. It is to be expected that the acceptance of the average consumer is even much lower.

12 Summary – GreenPremium prices along the value-added chain from bio-based chemicals to products

A GreenPremium price is the additional price a market actor is willing to pay for the additional emotional performance and/or strategic performance of the intermediate or end product the buyer expects to get when choosing the bio-based alternative compared to the price for the conventional counterpart with the same technical performance.

The results of the surveys and analyses of 35 cases of bio-based chemicals, polymers and plastics clearly demonstrate that GreenPremium prices do indeed exist and are paid in the value chains of different bio-based chemicals, polymers and plastics – especially for new bio-based value-added chains and on the European market. In line with the definition of GreenPremium, the motivation for paying additional prices is the bio-based product's expected increased emotional and strategic performance.

In the absence of any policy incentives, GreenPremium prices are very important for the market introduction of bio-based products and many new bio-based polymers and plastics would not even exist if there were no customers willing to pay GreenPremium prices.

The reported GreenPremium prices in the various analysed branches and applications range from a 10% to a 300% premium over the conventional petrochemical product with the same technical performance. Most of the GreenPremium prices found lie within 10–20% for bio-based intermediates, polymers and compounds, followed by the 20–40% range. Higher GreenPremium prices could only be obtained in specific cases.

For the end consumer the range of GreenPremium prices for bio-based products goes from 0% (car, cosmetics, bottle) to 25% (wall plug, toy) with, in the middle, a 10% GreenPremium for organic food with bio-based packaging.

The empirical data shows that in all cases the GreenPremium price levels (in percentage) decrease along the supply chain towards the end consumer, sometimes with an intermediate peak. The two main reasons are: the material costs share of the total product price decreases along the value chain; and the highest GreenPremium price is paid predominantly for the intermediates. Without this enhanced and confirmed willingness to pay GreenPremium prices for intermediates, many new bio-based value-chains would not have been implemented at all.

nova papers on bio-based economy

nova paper #1: Level Playing Field for Bio-based Chemistry and Materials. 2011-07.
nova paper #2: Food or non-food: Which agricultural feedstocks are best for industrial uses? 2013-07.
nova paper #3: GreenPremium prices along the value chain of bio-based products. 2014-05.
nova paper #4: Proposals for a Reform of the Renewable Energy Directive (RED) to a Renewable Energy and Materials Directive (REMD). 2014-05.

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List of acronyms

ABS	Acrylonitrile Butadiene Styrene polymer
BASF	Badische Anilin und Soda Fabrik
BDO	Butanediol
BMW	Bayerische Motoren Werke
B2B	Business to business
Drop-in	A bio-based polymer with a chemical structure identical to that of its petro-based counterpart
DSM	Dutch State Mines
EPS	Expandable Polystyrene
EU	European Union
HDPE	High Density Polyethylene
ISCC	System International Sustainability & Carbon Certification System *(www.iscc-system.org/en)*
ISO	International Organization for Standardization
LA	Lactic Acid
LCA	Life Cycle Analysis
LDPE	Low Density Polyethylene
L-LA	l-Lactic Acid
LLDPE	Linear Low Density Polyethylene
MEG	Monoethylene glycol
MSc	Master of Science
NGO	Non Governmental Organisation
OEM	Original Equipment Manufacturer
PA	Polyamide
PBAT	Polybutylene Adipate Terephtalate aliphatic aromatic copolyester
PBS	Polybutylenesuccinate
PBT	Polybutyleneterephtalate
PC	Polycarbonate
PE	Polyethylene
PEBA	PolyEtherBlockAmide
PET	PolyEthyleneTerephtalate
PETS	PolyEthyleneTerephtalate-co-Succinate
PLA	Polylactic acid
PP	Polypropylene
PS	Polystyrene
PU or PUR	Polyurethane
PVC	Polyvinylchloride
R&D	Research and Development
ROI	Return on investment
SA	Succinic acid
Tier X suppliers	Suppliers to OEMs independent of their position in the value chain
TPE	Thermoplastic elastomer
TPS	Thermoplastic starch
UK	United Kingdom
USA	United States of America

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15 Appendix

Table 1: GreenPremium market overview – biochemicals and bioplastics in general

Position in the value chain, product	GreenPremium price level	End-use application	Comments	Reasons to pay the GP	Source
Biochemicals, drop-in bioplastics	10–20%	Consumer goods and others (big players)	Temporary willingness for 2–3 years; Non-GM no extra	Long-term price advantages, early technical expertise	Capitain 2012
Biochemicals, bio-plastics (no drop-in)	10–15% (equal perform.), 10% + x % for additional performance	Consumer goods and others (big players)	Temporary willingness for 2–3 years; Non-GM no extra	Long-term price advantages, early technical expertise	Capitain 2012
Biochemicals for drop-in bio-plastics	15–30%	Consumer goods			Cooper 2013
Chemicals, bioplastics	individual case: depending on the added value to the product		Biodegradability (technical performance); non-GM: depending on the added value to the product		Pettersen 2012
Bioplastics, biomaterials	10–20%	General	By early adopters, only in small market segments		Häger 2012, de Bie 2012
Bioplastics, biomaterials	0%	General			Häger 2012, de Bie 2012
Bio-based plastics	30–50%	Consumer goods, health care	Non-GM, food competition are soft criteria, especially occurring when close to the end consumer, GM can be k.o. criterion.		Grashorn 2012
Drop-in bio-plastics	15–20%	consumer products, packaging (brandowners)	Temporary willingness for approx. 3 years	mage, strategic aspects	Michels 2012, Ravenstijn 2012, de Bie 2012
Bioplastics, biocomposites	(low)	Automotive		Emotional performance of importance	Magnani 2012
Bioplastics	(low)	Automotive	Basically low, only for technical performance		Michels 2012, Ravenstijn 201
Supermarket, bioplastics	100% and more	Packaging	Material extra costs (minor part of total costs) are passed on to the customers	Add. technical performance (increased shelf life by PLA, waste management)	Ravenstijn 2012, de Bie 2013
Bio-based food service products	100–200 %	Packaging; bio-based food service products	+ 100% for biodegradability/compostability or other sustainability aspects	Environmental and social benefits, emotional value	Levine 2012

Table 2: GreenPremium market overview – Bio-PA, Bio-PE, Bio-PP, Bio-PET

Position in the value chain, product	GreenPremium price level	End-use application	Comments	Reasons to pay the GP	Source
Bio-PA (57%)	200–300%	Wall plug	End product 20% more expensive; GreenPremium for Bio-PA continuously decreasing due to increasing scale effects	Greening the corporate image	Schätzle 2013
Bio-PE	50–100%				Cassinelli 2012
Bio-PE	30%				Ravenstijn 2013
Bio-PE	30–40%				Hausmann 2013
Bio-PP	30% (expected)	Automotive (big players)	Temporary willingness to pay GreenPremium	Image, better carbon footprint, price stability	Ravenstijn 2012
Bio-PET	10–25%	Packaging; bottles (Coca-Cola Company)	GreenPremium related to delivery costs at the site; Exact level depending on supplier	Image as a forerunner, supply chain diversification	Stadler 2012
Bio-PET	15–20%	(Big players)		Image as a forerunner, supply chain diversification	Käb 2012

Table 3: GreenPremium market overview – Bio-PLA

Position in the value chain, product	GreenPremium extra charge	End-use application	Comments	Reasons to pay the GP	Source
PLA	15–20%	Consumer goods, packaging (big players, e.g. Danone)		Image, supply chain diversification	Käb 2012
PLA fibres, Bioplastics	10%				Luijkx 2012
PLA foams	20–40%	Moulded parts for consumer goods and miscellaneous applications		Trend to replace polystyrene in food applications/polystyrene bans, disposal options (techn. perf.), consumers value sustainability	Heine 2013
PLA	120%	Insulation, packaging		Non-GM	de Loose 2012
PLA	< 50%	(Big players)			Käb 2012
PLA	100%	Cups in stadiums		Add. technical performance (surface texture, hardness, biodegradability)	Käb 2012, Capitain 2012

Table 4 GreenPremium market overview – other bioplastics and compounds

Position in the value chain, product	GreenPremium price level	End-use application	Comments	Reasons to pay the GP	Source
TPU, PLA, PEBA (major part bio-based)	15%	Consumer goods; injection moulded parts, foams (big players)			Ravenstijn 2010
Bio-based (68%) compound with technical properties similar to ABS.	100% compared to ABS	Toys	GM soft criterion	Image very important	Grashorn 2012
Compounding, TPS	15%	Packaging and others	Biodegradability basically not important; exception: British market asks for non-GM (knock-out criterion)	Portfolio expansion, distinguishing from competitors/exclusivity, image, advantages when single supplier, higher throughput (technical performance), additional use in biogas plant, lower carbon gas emissions	Mathar 2012
Compounding, PLA	100%	Packaging (cosmetics jar)	Raw material costs are a minor fraction of end application costs	Bio-based packaging is part of the product marketing. Technical advantage: Due to PLA jar is not transparent (intended).	Beythien 2013
Compounding, Bio-PE compounds	200-300%	Blow moulding apps, tube apps, pouch apps, lid apps, WPC	Non-GM up to 10% extra in Germany. In England very strong criterion. Non-GM derived-PLA maximum + 30%	Image, corporate identity, sustainability targets, carbon footprint	Michels 2012