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From biobased 0.0 to biobased 3.0: some propositions

The former Dutch Minister of Agriculture Gerda Verburg envisages the Netherlands to play an important role in the development of a biobased economy (Forum, 16 June 2010, p. 16). The use of biomass offers opportunities for countering climate change as well as stimulating economic development. In this respect, the Dutch biobased economy policy vision seems to stand a very good chance of success, as it is aiming at an efficient use of biomass.

Biomass is already being used in a variety of ways in our economy, but often by inefficient methods. The production of biofuels from food crops, for example, elicits much criticism. On the other hand, there is wide support for more efficient technologies, such as the so-called second generation biofuels, produced from inedible parts of plants, or the use of chemical building blocks of vegetable origin. Nevertheless, the Dutch and European policies do not, or only partly, endorse the efficient use of biomass. In some aspects, biomass policy even frustrates the creation of a biobased economy. Below we will discuss some biomass-related issues that are a factor in bringing a biobased economy a step closer. These issues ensue from a study of the biobased economy, which is to be published by the Rathenau Institute[1] early next year. This text is a first presentation of these issues. We will start with a brief explanation of the Dutch biobased economy policy vision.

Biobased economy: efficiency without waste

As described above, the core of the Dutch policy vision on the biobased economy aims at efficient and intelligent use of biomass. Even at present biomass is being used in various applications, in the Netherlands mostly for heating purposes and biofuels. The Dutch biobased economy policy vision sets two conditions for this: biomass must be used in the most efficient manner, both ecologically and economically, and not a single straw of biomass may go to waste: in other words, the chains must be closed.

Biomass can be used in numerous areas, for instance the chemical industry, energy supply and the production of medicines. Biomass may drastically reduce the use of fossil fuels, such as petroleum. Biomass-based products include bioplastics, biochemicals and biofuels.

[1] The Rathenau Institute investigates the dynamics of science and technology. It maps the significance of these developments for individuals and society. The institute also investigates the science system, and how it responds to scientific, societal and economic developments.

Biomass exists in all shapes and sizes. Basically it originates from living organisms, in contrast to fossil fuels, even if the latter are also organic. Biomass includes vegetable-based raw materials, such as plants, trees and algae, but also materials derived from animals, such as offal or frying fat, are often considered to be biomass.

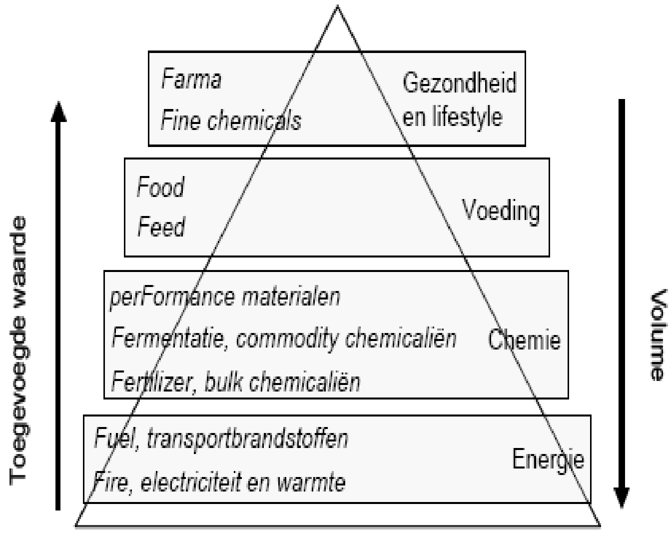
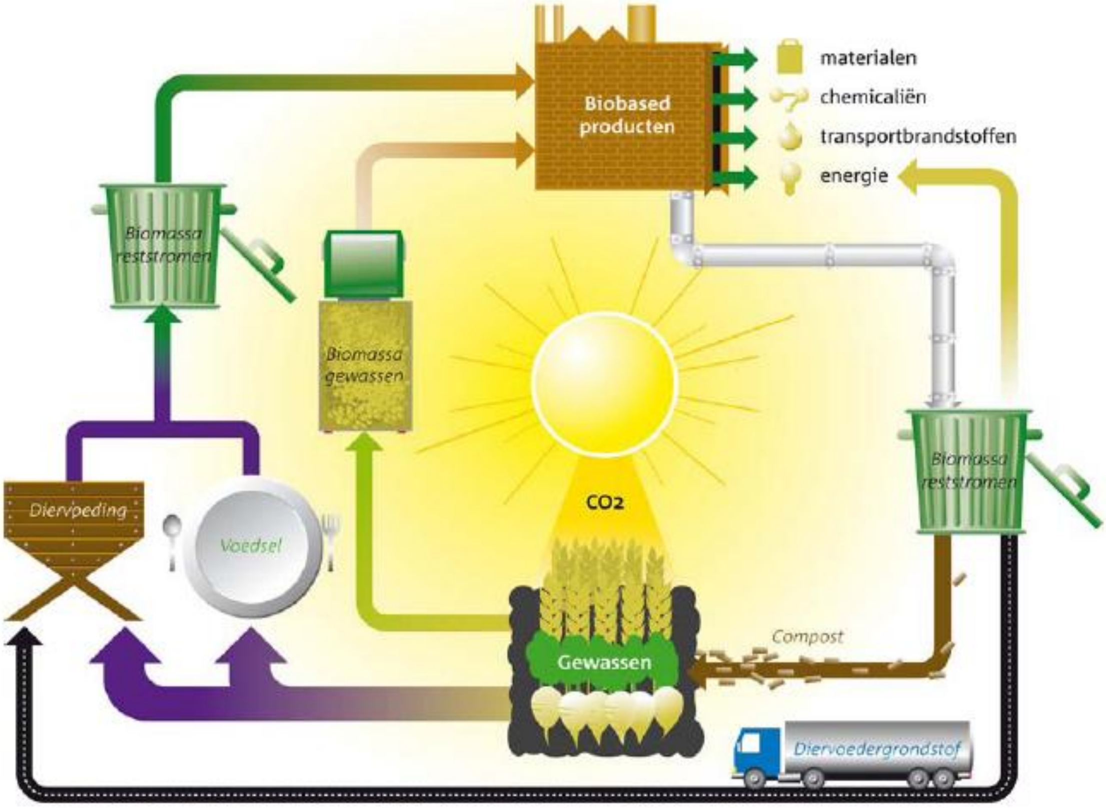


Figure A 'Value Pyramid' (source: LNV, 2007:19)

In various ways biomass can be converted into energy or into raw materials for products such as bioplastics, for instance with the aid of genetically modified enzymes or thermal processing. In the biobased economy policy the objective of achieving the highest added value is pivotal (Figure a).

This principle assumes that first of all, biomass is used for the economically most interesting applications, after which the residuals are used, to the greatest extent possible, for other applications, such as energy. Accordingly, the biobased economy policy does incorporate biofuels, but it comprises much more. In other words: it would be a waste to throw good plants into the incinerator or immediately convert them into ethanol. In both an economic and ecological sense, it is more interesting to extract other applications from plants, such as chemicals or drugs.

In addition, great value is attached to the above-mentioned realisation of closed chains (see figure B).



(Figure B: closing the chains, Source: LNV, 2007)

If this principle is adhered to, waste no longer exists. All residual flows can be introduced to the chain again with a new function, for instance as energy. In this way, no biomass and therefore no energy needs to be lost. This reintroduction of raw materials may also take place across different sectors, such as agriculture and the chemical industry.

A biorefinery is a biomass processing plant which, analogous to a petroleum refinery, integrates biomass conversion processes resulting in multiple products or semi-manufactures without waste production. In this way, a biorefinery is the technical realisation of the goal of perfect efficiency. It is also efficient to work with the chemical components already present in the biomass. Plants and algae often contain chemical compounds that the industry needs. The production of these compounds from raw materials is a very energy-consuming process. In other words, great energy savings can be realised by closely examining what the plant materials has to offer. This is currently being done at a large scale with hundreds of alga species in the Algeaparc in Wageningen, the Netherlands.

This policy vision is very promising, but will not become reality on its own accord. To provide insight into the complexity of this vision, a short outline is given below listing the principal objectives, the instruments, and the expected social effects related to the biobased economy.

Objectives	Instruments	Social effects
Sustainability	Biorefineries	Food security and biodiversity
Climate change	Closing of the chains	Poor international monitoring
Energy security	Opening up new potential	Public opposition
Self-sufficiency	Genetic modification	Vested economic interests
Economic opportunities	Open and innovative market	

On the basis of the above objectives, instruments and social effects we will discuss some propositions regarding policies for a biobased economy, in which both the economy and sustainability are key elements. In these propositions, we will consider the limitations of the production system, the policy context, the socio-economic infrastructure, and the various visions of the biobased economy.

Proposition 1

In the political and public debate greater emphasis should be put on the integrated approach of the biobased economy, so that the use of biomass can be assessed in that light. The debate on biomass for energy purposes obscures our view of more efficient applications.

The Dutch policy context around the possible uses of biomass makes it difficult to realise efficient use of biomass. As described in our study of the biomass policy, three lines of policy may be distinguished. One policy line focuses on the use of biomass for electricity and heat, while another focuses on biofuels. Together these two policy lines form the overall bio-energy policy. The third biomass policy line concerns the concept of the biobased economy. This policy line is an attempt to integrate the other policy lines into a broader vision of the use of biomass. As shown above in the ´Value Pyramid´, the application of biomass to generate bio-energy is part of the biobased economy concept.

This situation would not pose any serious problem, provided that the aims of the various policy lines would correspond, but this is not the case. For instance, the explicit goal of bio-energy is to use biomass for the generation of energy, whereas in the biobased economy this application represents a sub-optimal use of biomass. However, the divergence between these two policy lines is given little attention in the government vision.

There is need for an integrating, coordinating vision for two reasons:
First of all, the bio-energy policy is impeding the biobased economy policy. Converting biomass directly into biofuels is not the most efficient application. It is more efficient to extract other applications from biomass and then convert the residual flows into biofuels. Promoting biofuels as an aim in its own right without applying very stringent sustainability criteria, as is the current practice (as described in chapter 3 of our study), poses a real risk that other biomass applications are being overlooked.

Secondly, the current political and public debate on biomass mostly focuses on biofuels. The issues at hand here, such as the merit and necessity of certification and the possible adverse effects on the food supply, are obscuring the view of the possibilities to use biomass in a broader context. It would be better to discuss the contribution of biofuels to a sustainable economy from the perspective of the biobased economy, for this would allow for a much more efficient and thus sustainable use of biofuels.

Proposition 2:

New technologies alone will not suffice to break down the limitations of the current economy. Besides technological innovations, it will be necessary to change the underlying consumption pattern. This should be an integrated part of the policy for a sustainable biobased economy.

One of the most important motives for the transition to a biobased economy is that there is a limit to fossil fuels, currently the motor of our economy. Many forecasts say that the end of the petroleum reserves is near. In addition, the use of fossil fuels is being linked with climate change and implies undesired geopolitical dependencies.

Biomass is a renewable raw material that is CO2-neutral. In principle it can be produced anywhere, thereby reducing the risk of the concentration of power. It offers many possibilities for replacing petroleum in all sorts of products. As such, biomass appears to be able to overcome the limitations of fossil fuels.

Accordingly, the use of biomass can be considered as a new phase in making new raw materials available to overcome the limitations of the old production system. In the 19th century, the Dutch economy managed to overcome its natural limitations by bringing in raw materials from other parts of the world. This import of raw materials was the basis for the current prosperity in Western Europe, and for the current population density in the Netherlands.

As described in the historical chapter of our study, around 1850, before the arrival of fossil fuels, many self-sufficient Dutch farmers were barely able to survive from the resources their fields could offer. And this was in a period when far fewer people had to live of the Dutch land. As this historical chapter also describes, the eventual growth of the Dutch economy was partly the result of the import of raw materials from other countries. This started with the import of birds´ excrement, guano, from Peru, which allowed farmers to break out of the local cultivation cycles based on local manure and compost. The areas in Peru where guano was mined were scraped empty. Meanwhile, Dutch farming flourished thanks to the import of oversea raw materials. It was the first step towards the use of chemical fertilizers.

The breaking down of boundaries in the worldwide economy, which was partly realised thanks to fossil energy resources, will continue in a biobased economy. But biomass also has its limitations, just as petroleum and guano. The production of biomass requires land, water and fossil raw materials. Fossil raw materials are needed, among other reasons, for the production of chemical fertilizers: an important condition for productive agriculture. In this respect, the production of biomass is confronted with existing limitations. The use of biomass leads to deforestation, loss of biodiversity and it may be competing with the supply of food.
However, there appear to be possibilities to overcome these limitations. As described in the technology chapter of our study, new technologies enable us to use raw materials that previously were not part of our raw-material cycle, such as trees, algae, non-edible parts of plants, marginal land and the sea surface. In addition, more radical solutions are available that bypass the use of biomass and directly convert photosynthetic energy into fluid energy carriers. An example of such solutions are biosolar cells. These new technologies embody the biobased ideal to utilise biomass intelligently and efficiently. At present these technologies only represent a minor or non-existent portion of the biomass used.

These attractive prospects and the green aura of biomass often threaten to legitimize the negative effects of current applications. The fact that raw materials are renewable does not make them automatically sustainable. The green aura of the biobased economy should not lead to a continuation of non-sustainable economic patterns, but should do justice to the ideal of waste-free efficiency. This means that the economy as a whole must become more sustainable and less wasteful.

Proposition 3

Sustainability is an ideal that is difficult to put into practice, but for a sustainable global economy it must be implemented as concretely as possible, so that international monitoring becomes possible.

One of the most important advantages of biomass is that it has the capacity of being sustainable. However, biomass cannot automatically be put on a par with sustainability, because of negative effects such as deforestation and loss of biodiversity. As there is no crystal-clear definition of sustainability, it is not so easy to determine which forms of biomass and which applications are sustainable or not. On the one hand, not all sustainability criteria can be measured. For instance, the social impact of biomass production is difficult to establish. On the other hand, there is often disagreement or lack of clarity as to what sustainability exactly means.

Internationally, sustainability proves to be a controversial issue. Some countries (e.g. Brazil and Malaysia) regard the European sustainability requirements as disguised trade policy: a way to prevent foreign producers to access European markets. At the same time, from a European perspective it is untenable to import supposedly ‘green products’, which cause non-sustainable effects in other parts of the world, such as competition with food supplies and production methods with high CO2 emissions. Consequently there is a need for an internationally tuned monitoring system to control the negative effects of the use of biomass that enjoys international support.

Applications such as biofuels have firmly anchored awareness of negative aspects of the use of biomass in the public debate and policies. The Dutch Cramer Committee has put the sustainability criteria for biofuels on the European policy agenda, and the Dutch Corbey Committee is currently elaborating these criteria. These criteria are an important basis for realising the sustainability of the biobased economy, but many find that they are still falling short. For example, the European sustainability criteria do not consider Indirect Land Use Change (ILUC). This relates to effects that occur when land is cleared for biomass production, for instance when logging a forest.

Proposition 4

The first generation of biofuels can be seen as a trailblazer for more efficient solutions: these can be achieved by preparing the existing socio-economic infrastructure as much as possible for use of alternative raw materials, by providing insight into the properties of biomass, and by stimulating experiments with sustainable farming.

The economic transition from fossil fuels to biomass as raw material poses a great challenge. It may have far-reaching social effects. An important question in this respect is whether the existing socio-economic infrastructure is a springboard or, conversely, an obstacle for a biobased economy. In our study we describe two divergent positions on this issue. According to some (mostly businesses) the existing economic structures provide a first step towards a different, more sustainable economy where biomass is used on a large scale. In this vision, we should start with a biobased raw material which can draw on a large corpus of existing knowledge: sugars from food crops. We can use these to make the existing structures more sustainable. This gradual transition will open our eyes to the possibilities that green raw materials can offer us. To illustrate, a number of chemical applications of biomass result from the knowledge gained in the production of first-generation biofuels. By applying sustainability criteria, the production of this biomass will become increasingly sustainable, for instance by reducing the use of chemical fertilizers.

An important argument in this vision is that we cannot change the existing economy overnight. We need existing economic resources and structures for the development of new technologies. Fuel producers that are currently refining petroleum and distributing fuel can deploy their knowledge and technical network for the development and distribution of biofuels. The same applies to the chemical industry.

According to others (mostly environmental organizations) the first-generation biofuels are an obstacle for arriving at a truly sustainable economy. The risk exists that this form of biobased economy becomes such a success, that it can no longer be changed. Because there would be a mature, independent biomass market, governments would lack instruments to promote further sustainability, for instance by requiring that fossil fuels are mixed with sustainable biofuels. Once the producers of first-generation biofuels have established their market share, they will not be willing to give it up again. Already Malaysia, a large palm oil producer, is opposing the strict climate requirements that are being set for biofuels (MPOC, 2010).

In addition, there is no guarantee that the technology developed for the first generation of biofuels will automatically result in technology for the second or third generation of biofuels or for integrated biorefineries. For instance, the production of biodiesel from palm oil requires a completely different process than the production of biodiesel from wood chips. Moreover, the first biofuels are not making the existing infrastructure any greener at all, because they often score even worse on CO2 emissions than fossil fuels. This effect is mostly due to deforestation to free up space for new arable land (CEDelft, 2010).

As our guano example shows, the introduction of a new raw material may blaze the trail for another raw material (in this case petroleum), simply by pointing the way to unprecedented possibilities. In this way, a technology can function as a ‘cultural battering ram’ for better applications, even if the technology itself is imperfect. The first generation of biofuels seems to fulfil this function. Many agree that these biofuels are anything but perfect, but before we discard them completely, it is worthwhile to see what we can learn from them. To ensure that first-generation biofuels indeed become as sustainable as possible, the sustainability criteria will have to be stepped up, for instance by including the factor of ILUC (Indirect Land Use Change). Actually at present (autumn 2010), the European Committee is considering to implement a policy that addresses ILUC. Aside from such measures, a lock-in effect must be prevented, and this is the subject of the next proposition.

Proposition 5

Sustainability criteria alone will not bring an efficient biobased economy any closer. For second-generation biofuels and other efficient technologies to be successful, investments in the supporting socio-economic infrastructure are required.

The ideal of a biobased economy cannot be achieved without changes to the existing economic infrastructure. The most promising technologies and production systems in terms of sustainability and efficiency require modifications to the existing socio-economic infrastructure. For example, biomass takes up the smallest portion of the available land if it is blended in with existing uses. Examples of this approach are genetically modified poplars that are suitable as a source for second-generation biofuels. In Belgium, these poplars are being planted alongside roads. And with Jatropha the best results are obtained in terms of sustainability if it is planted around the edges of the fields of small farms, instead of in plantations. This approach to biomass production requires a more diversified collective infrastructure and therefore different logistics than the production of food crops. In addition, the efficient use of waste flows requires new forms of collaboration and logistics. This often involves sectors which currently have very little to do with each other, such as agriculture and the chemical industry. And there are even more radical changes to the infrastructure imaginable, if it becomes possible to make cars drive on household waste or human excrement, or if synthetic trees can supply us directly with fluid fuels.

As the historical chapter demonstrates, the economic infrastructure is an important aspect in a technological transition: if the social context is not ready for a new technology, this will prevent or delay its introduction. In the historical chapter the transition to an economy based on fossil fuels only took place after the land ownership relations were favourably arranged and specific scientific knowledge was transferred to farmers.

The aim of integrating economy and sustainability in a biobased economy cannot succeed by only monitoring negative effects. Efforts must be made to embed smarter biomass applications into the socio-economic infrastructure. On the one hand, this implies fundamental forms of change, such as radical energy savings, a different organization of existing petrochemical and agricultural production lines to make better use of residual flows, investments in desired infrastructure in biomass-producing areas such as developing countries, and proper legislation in respect of the processing of waste. Other options are financial support of smart, integrated forms of biomass, such as biorefineries for multiple applications, and so-called second and third-generation applications, for instance in the form of tax benefits. In other words, there must be enough room and support for fundamental forms of transition. The government plays a leading role in this, as these forms of transition usually cannot be borne by individual actors. Still, these actors are indispensible for making such a transition a success.

Proposition 6
Different notions about naturalness are playing a role in the debate on a biobased economy. These notions themselves should be made part of the debate, otherwise the debate will become deadlocked.

The biobased economy invokes a range of associations about nature and agriculture. These associations may play a role in the public acceptance of the biobased economy. Below some extremes in a continuum are briefly presented. Important aspects of these positions are for instance a romantic view of nature versus a utilitarian view of nature, a trusting or distrusting attitude towards industry, scientific developments, and man´s ability to control nature. Similar positions can be discerned in the debate about genetic modification. The various positions in the biobased economy may become further polarized if the genetic modification of plants starts playing an important role in the biobased economy.

Biobased as in harmonious with nature
With respect to a romantic view of nature, the following quote of Mr Cees Veerman, at the time Minister of Agriculture, Nature and Food Quality, is striking:
"Ever since man began to grow food, herd cattle, build simple dwellings, his economy has been based on renewable natural resources. It has been like that for untold ages; let me remind you that the petroleum-based economy is a mere 140 years old and unlikely to survive into the next century. So let's not talk about the emergence of bio-based economy; let's call it a triumphant come-back." (Cees Veerman, Conference 'sustainability, rural development and rural tourism', 2005). As was evident in the historical chapter, the period before the petroleum-based economy was far from prosperous. Therefore it may be very much doubted whether everybody will find the comeback of this period ‘triumphant’.

Biobased as in alienation from nature
Other parties may also have a romantic view of nature and farming, but they do not consider the biobased economy to be a return to this romantic period, but more as an alienation from a romantic ideal of agriculture and/or nature. In their opinion, the quest for new raw materials must be seen as the ultimate mechanization of nature. In this view, every bit of natural material must be broken down into usable components and swallowed up by the relentless Western consumer society, thereby depriving people in developing countries and withdrawing it from the natural cycles.

The opposition against genetic modification partly ties in with this position. This ‘tinkering with plants’ arouses an uneasiness about our contact with nature, which now seems to be completely subjected to our needs and is no longer attributed any intrinsic value of its own. Such a position can be heard from some environmental and natural preservation organizations, including Greenpeace. In addition, there are concerns about the safety of genetically modified organisms and the ability to control these organisms. Genetic modification also arouses a lot of opposition, as it consolidates the power of large companies because of the possibility of obtaining patents on living matter. This corresponds with the fear described above in respect of the biobased economy: all living organisms are reduced to raw materials for the life science industry and are withdrawn from vulnerable groups, such as small farmers.

Biobased as in efficient green economy
The unlocking of new raw materials may also be viewed as making the consumer society greener, as fossil fuels are replaced by renewable, plant-based raw materials in a way that is not taxing the food chain or our room for living. The ideal of efficiency is an important condition for this. As a matter of fact, nature provides the basis for more efficiency. Plant-based materials contain many valuable substances that can be used industrially. Wherever necessary, nature can be incited to more efficiency by means of genetic modification. In this respect, the biobased economy and - in its wake - genetic modification offer superb opportunities for petty farmers and farming in general. Their market will grow and they will be able to increase production. This view is held among producers of biobased products, such as the chemical industry, producers of biofuels, and such organizations as the *Platform voor Groene Grondstoffen* (Biobased Raw Materials Platform).

Proposition 7

The support for a biobased economy will increase if innovations tie in with the different notions of naturalness that feature in the debate about a biobased economy.

The concept of the biobased economy seems to balance on a thin line between a transition towards a society that is closer to nature, and one that totally subjects nature. The biobased economy is often conceptualized as a green, harmonious economy, but it may also be understood as a mechanistic and soulless industrial complex.

In the communication with the wider public it is important to keep an open mind towards different interpretations of the biobased economy, to prevent the suspicion from arising that the green image is wrongly used to sell the industrial view. This might bring about the risk of a ´green rhetoric´, which lends a ´green aura´ to all sorts of activities because they are part of the biobased economy, without being necessarily sustainable in a broad sense. Such rhetoric will arouse much opposition from civil society organizations, as is already happening in respect of biofuels.

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Who was Rathenau?

The Rathenau Instituut is named after Professor G.W. Rathenau (1911-1989), who was successively professor of experimental physics at the University of Amsterdam, director of the Philips Physics Laboratory in Eindhoven, and a member of the Scientific Advisory Council on Government Policy. He achieved national fame as chairman of the commission formed in 1978 to investigate the societal implications of micro-electronics. One of the commission's recommendations was that there should be ongoing and systematic monitoring of the societal significance of all technological advances. Rathenau's activities led to the foundation of the Netherlands Organization for Technology Assessment (NOTA) in 1986. On 2 June 1994, this organization was renamed 'the Rathenau Instituut'.