Ministry of Economic Affairs

Strategic *Biomass* *Vision* for the Netherlands *towards* 2030

Strategic Biomass Vision for the Netherlands towards 2030

Summary

Biomass plays an important role in food supply and in the transition towards a bio-based and circular economy. Reducing our dependence on fossil energy and fossil resources, the optimal use of raw materials and the necessary associated reduction in CO_2 are at the heart of this transition. As 2030 approaches, biomass demand is expected to increase in the Netherlands due to the use of renewable raw materials, arising from energy and climate policy, the future scarcity of fossil resources and geopolitical considerations. Preventing adverse effects in the production and application of biomass is the topic of scientific and social discussion. It was therefore announced in the letter to the House of Representatives of the States-General on 'Added value from biomass through cascading' that the government would draw up a strategic vision for biomass use in 2030. This vision will look at biomass use as a whole and also address the related concerns. In 2016, further details will be provided in the umbrella programme on the circular economy that has been promised to the House of Representatives.

1. Key question
How can biomass use in the Netherlands best contribute towards achieving the policy objectives for 2030 in the areas of food, energy, climate, mobility and a bio-based and circular economy? And how can the Netherlands simultaneously develop an innovative and competitive economy? The precondition for this is that the biomass to be used in the Netherlands must be sustainably produced as far as possible.

2. Starting point
The starting point for Biomass Vision 2030 is the situation at the start of 2016, a situation that is characterised by:
- an increased urgency for climate reports and sustainability and the associated need for a transition to renewable resources and a circular economy;
- low global market prices for fossil sources such as petroleum and the associated sluggish demand for renewable alternatives;
- the creation of new potential applications for biomass in the chemical industry, including bio-based building blocks for the production of a wide range of chemicals and polymers;
- concerns about shortages, suppression or unwanted competition among the various applications of biomass, expressed by the paper, woodworking and chemical industries as a result of the subsidy on bioenergy;
- attention to sustainability in the various phases of the supply chain, such as production, processing, consumption, waste and recycling. Attention to co-production in the processing of agricultural crops and preventing the depletion of fertile soil and a shortage of soil carbon.

3. Message: In order to satisfy Dutch biomass demand for food, animal feed, energy, transport, chemicals and materials, adequate sustainable biomass could become available, provided that successful efforts are made to increase biomass supply and pursue optimal biomass use. The government will also continue to press for the sustainability of production and application of biomass. The contribution towards our policy objectives and economic growth can be increased by promoting innovative developments and the use of biochemistry and biomaterials through a comprehensive focus on CO_2reduction.

- <u>Biomass use can significantly contribute towards the above policy objectives.</u>
  Biomass can make a significant contribution towards replacing fossil resources with renewable ones, as well as the associated reduction in CO_2 emissions. In the long term, it is important to use biomass primarily for those applications for which there are hardly any alternative, cost-effective and sustainable resources. This includes at least the following applications: high-temperature heat for

industry, biofuels for aviation and shipping and raw materials for chemicals and materials. In the short and medium term, grants and investments in bioenergy ensure the start of sustainable woody biomass flows. A shift from combustion to value creation and combustion provides impetus to the bio-based economy in the Netherlands.

- The demand for biomass is expected to rise sharply over the next 15 years. The demand for food will at least keep pace with the growth of the world population and a change in diet is expected because of increased global prosperity. Global demand for traditional applications of biomass, such as building materials, paper and cardboard, will also increase. Many companies also see opportunities in switching to biomass as a renewable and sustainable raw material for materials and chemicals. As we approach 2030, and beyond, bioenergy is expected to form an important source of renewable energy.
- Sustainability is an essential starting point for the government. There are already many government-supported developments towards sustainable biomass. In addition to more efficient use of available agricultural and forestry land and countering supply chain losses, cascaded biomass use is crucial. Cascading extends over sectors and applications and therefore requires measures that encourage cross-sectoral cooperation. The development of an integrated sustainability framework for all raw materials is also important, because if we do not also preserve the raw materials for which biomass is an alternative, the application of renewable raw materials will be adversely affected. For this reason, it is wise to focus sustainability incentives on a single sustainability framework for all raw materials, including good quality assurance, combined with specific measures for raw material flows that require additional care in practice. This applies to Europe, but also to the indirect effects and social consequences for local populations in developing countries (coherence of the development policy).
- Adequate biomass could become available in order to satisfy Dutch demand for food, animal feed, energy, transport fuels, chemicals and materials. The figure obtained by converting the worldwide availability to potential availability for the Netherlands is 115-753 petajoules (PJ) for 2030. The expected biomass demand for energy, biofuels, chemicals and materials in 2030 totals 432-570 PJ. This means an adequate supply of sustainable biomass for non-food applications could be available. It should be noted, however, that the higher estimates for biomass availability will be achieved only if successful efforts are made to increase biomass supply and efficient biomass use.
- Biomass use creates economic opportunities for the country. The Netherlands is well-positioned for investments in the biobased economy: strategic connection to good seaports, strong agricultural, chemical and energy sectors and high-quality knowledge institutions. The Netherlands processes very large quantities of biomass for food and animal feed due to its strong agri-food sector. By increasing efforts in biorefining and co-production, additional biomass can become available for non-food applications through the current flows.
  The number of investments in the bio-based economy is increasing worldwide. There are concrete opportunities for the Netherlands for new investments in the areas of chemicals, materials and advanced transport fuels/bioenergy.

4. Approach: what measures are necessary?

In order to realise the sustainability and opportunities of biomass and its applications, the following measures are implemented alongside the pillars of Green Growth: Smart market incentives; Stimulating laws and regulations, Innovation, Government as a network partner and Greening through trade and investment. Specifically, this means measures aimed at:

Efforts to increase sustainable biomass supply

- Stimulating commodity creation from agricultural and forestry waste flows because the abundance of small flows that vary in composition do not meet the demand for uniform flows from the energy and industrial sectors. Both technological aspects (such as conversion technology) and organisational

aspects (such as the relevant level of spatial scale, the establishment of consortia, and how costs and benefits are to be apportioned) are important in this regard.
- Measures aimed at further increasing productivity in agriculture and forestry, both in Europe and globally, including paying attention to the production of aquatic biomass and using degraded land for biomass production.
- The new Common Agricultural Policy 2015 (CAP) supports the transition to a bio-based economy far better than before. Efforts at EU level after 2020 for the further reinforcement of the bio-based economy by means of the CAP.

Efforts to develop the demand for sustainable biomass
- Promoting market development by developing a product policy at EU level aimed at:
  i) phasing out harmful substances if there are good bio-based alternatives (such as non-biodegradable microplastics in cosmetics);
  ii) encouraging the use of bio-based and biodegradable materials in applications that leak uncontrollably into the environment (such as lubricants, agricultural plastics and drilling fluids); and
  iii) encouraging the use of bio-based products that have a better sustainability and health rating than current alternatives (plasticisers, ingredients for cosmetics, and materials for construction, packaging and the automotive industry).

Efforts to make biomass production and use sustainable
- Exploring the possibilities of designing a single overarching basic sustainability framework for all raw materials, as well as encouraging the application of the UN 'Ruggie Principles'.
- Additional criteria, including quality assurance, can be formulated for biomass flows that are encouraged by the government and for biomass flows that have a high risk of causing negative sustainability effects.
- We are continuing to work on the development of a harmonised European sustainability system for these biomass flows. The sustainability criteria of the Dutch Energy Agreement, including the initial growth path for full area testing, are some of the most progressive and far-reaching criteria in the world.
- Intensified efforts to encourage cross-sectoral cooperation that facilitates biomass cascading. This can be achieved through commitment to Green Deals, reinforcing national platforms and regional clusters and organising instruments so as to stimulate cascading.

Using the contribution of all biomass applications (including materials)
- The Netherlands strives for integration at EU level of policies aimed at renewable energy, climate and materials by focusing solely on one parameter, namely CO_2 reduction. The climate benefit from biomass use in chemicals and materials through CO_2 capture is only partially reflected in the renewable energy goals and emission reduction targets. In order to stimulate increased use, ways in which to reward this benefit further are being sought.

Efforts in relation to innovation and earning capacity in the Netherlands
- Encouraging investments in new production capacity in the Netherlands for advanced biofuels, chemicals and materials (flagship projects).
- Strengthening research and innovations in earlier technology readiness levels, such as the refining of wood and agricultural waste flows, alternative protein production and opportunities for negative climate emissions (Bio-Energy with Carbon Capture and Storage/usage). Implementing the agenda of the Top Consortium for Knowledge and Innovation in the Bio-based Economy (TKI-BBE) is a good starting point.

In 2016, further details will be provided in the umbrella programme on the circular economy that has been promised to the House of Representatives. This will be in conjunction with the activities relating to the Food Vision, the Energy Report, Green Growth and the implementation plan for the Sustainable Fuel Vision, as well as the dialogues scheduled in that regard.

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1. Introduction

1.1. Motivation and context

The Netherlands strives for green growth: an economy that grows, innovates and competes in a sustainable manner. Greening of our economy is essential. We must preserve our natural capital, curb our dependence on fossil and scarce resources and reduce greenhouse gases in the atmosphere. Sustainability is a source for economic growth. It is a driving force for innovation and can further boost the earning capacity of the Dutch economy. In this way, we also secure our prosperity for future generations.

Biomass plays an important role in this regard, both in food supply and in the transition towards a bio-based and circular economy. This is an economy that operates increasingly on biomass as a resource instead of fossil resources. The bio-based economy is one of the cornerstones of the circular economy, in which products and materials are recycled and raw materials retain their value.

A promise to draw up a strategic vision for biomass use towards 2030 was made in the letter to the House of Representatives of the States-General on 'Added value from biomass through cascading'. [1]. This 'Strategic Biomass Vision for the Netherlands towards 2030' provides clarity on the future use of biomass and what it can mean for the European climate and energy policy as we approach 2030. The 'Strategic Biomass Vision for the Netherlands towards 2030' also explains how biomass can contribute towards policy objectives for food security, renewable energy, biofuels and a bio-based and circular economy, combined with the strong economic development of the Netherlands.

Preventing adverse effects from biomass use is the topic of scientific and social discussion. The 'Strategic Biomass Vision for the Netherlands towards 2030' takes this into consideration. The vision 'Towards a sustainable bioeconomy' issued by the Dutch Sustainable Biomass Commission[2] has been used with gratitude. This document is a response by the government to the Commission's recommendations.

1.2.Policy objectives and key question

Biomass makes a significant contribution to a number of the government's policy objectives in the following areas, namely:

- **Food**

The transition towards a sustainable agriculture and food supply;

- **Energy**

The transition towards a sustainable, affordable and reliable energy supply with accompanying targets: 14% renewable (NL target, 2020), 16% renewable (NL target, 2023), 27% renewable (EU target, 2030);

- **Climate**

The transition towards a greenhouse gas-neutral society in the second half of this century with accompanying interim targets: 20% CO_2 reduction (NL target, 2020), at least 40% CO_2 reduction (EU target, 2030);

[1] Letter to the House of Representatives of the States-General on 'Added value from biomass through cascading 2014'

[2] Dutch Sustainable Biomass Commission 2015: Towards a sustainable bioeconomy

- **Bio-based and circular economy**

The transition towards a bio-based and circular economy, replacement of raw materials by biomass, optimal use and recycling of raw materials and products;

- **Mobility**

The transition towards a sustainable way of transport and transit with accompanying targets: 10% renewable energy in transport (Renewable Energy Directive, 2020), 6% fewer greenhouse gas emissions in 2020 compared to 2010 (Fuel Quality Directive), 17% CO_2 reduction in 2030 (fuel vision from the SER Energy Agreement) and 60% CO_2 reduction in 2050 compared to 1990 (SER Energy Agreement).

Through the above policy objectives, the Netherlands also contributes towards the UN's Sustainable Development Goals (SDGs).

Addressing the challenges

In order to be able to address the challenges of all these policy objectives and to contribute as much as possible to an economy that grows, innovates and competes in a sustainable manner (known as green growth), the Netherlands must make clear policy choices. An integrated approach to the optimal use of biomass is crucial for this purpose.

Accordingly, this Biomass Vision 2030 considers the following key question:

How can biomass use in the Netherlands best contribute towards achieving the policy objectives for 2030 in the areas of food, energy, climate, mobility and a bio-based and circular economy? And how can the Netherlands simultaneously develop an innovative and competitive economy? The precondition for this is that the biomass to be used in the Netherlands must be sustainably produced as far as possible.

Short and long-term solutions

Apart from the different policy challenges, the time horizon is also important. Due to the international consensus and ensuing urgency to act, the climate objective as agreed during the climate conference in Paris has been taken as the starting point. Global warming must be limited to 2 degrees Celsius, with 1.5 degrees Celsius as the target value. Viewed from this perspective, the challenge for 2030 is an interim step towards 2050 and beyond. This does not only mean cost-effective and socially supported choices for the short term, but also cost-effective and socially supported for the long term. As such, the reduction and sustainable development potential for the longer term is taken into account in the analysis and the choice of policy instruments in this vision.

1.3.Target scenario for 2030: well on track

The aforementioned policy objectives and ambitions of the government and the developments expected by experts produce the following target scenario for the Netherlands.

In 2030, the Netherlands is well on track towards a greenhouse gas-neutral, bio-based and circular economy. The guiding principles for the choices we make are sustainability and the benefits we gain from CO_2 reduction combined with the added value for our society. The policy focuses on an economy in which renewable energy and raw materials are given preference to fossil resources.

Bio-based and circular hotspot for the chemical and other industries
In 2012, 95% of the Dutch economy was still based on fossil fuels[3]. Due to the use of renewable energy and raw materials, this has been reduced to 70% in 2030. European targets for renewable energy and CO_2 emissions have also been met in 2030, thanks to the contribution of bioenergy and the climate benefit from bioproducts.

The chemical industry has had particular success in its gradual transition from fossil to bio-based. Some 20% of chemical production in the Netherlands is based on renewable raw materials. As a result of this, new investments have been generated and the Netherlands plays an important role as a bio-based and circular hotspot for the chemical and other industries in Europe and the rest of the world.

Effective use of waste flows
In 2030, biomass use for chemicals and materials has grown relatively stronger than for energy and fuels. Given the better business case for biomass use high in the value chain, the Netherlands makes effective use of waste flows that remain viable as long as possible through recycling and upcycling. In a bio-based economy, biomass is used with a minimal loss of quality for as high value applications as possible, using all components of biomass in the best way possible (also referred to as cascading). By cascading biomass, food crops are refined and used for food, animal feed and the production of chemicals and materials. Energy is generated from biomass at the end of the process and is the last phase of cascading.

Green end products
Over the last fifteen years, the Netherlands has increasingly developed as a producer of green end products. We are strong in this area: some of Europe's largest biopolymer factories are based in the Netherlands. Sugar beet that is grown domestically and in our neighbouring countries is processed, while sugars are also produced from wood that arrives in the port of Rotterdam.

Besides wood, the Netherlands also imports other biomass flows and semi-finished products that are processed into advanced biofuels and chemicals. In this way, the port of Rotterdam manages to compensate for the reduced supply of fossil resources.

Front runner in sustainably produced biomass
In 2030, the Netherlands is the front runner in the application of demonstrable sustainably produced biomass. Dutch businesses are leading the way in the use of sustainably produced biomass. Our agriculture is still a world leader as a food producer and efficient producer of raw materials. The cultivation and processing of sugar beet is flourishing as never before, and other farming benefits from this because it can now produce more raw materials for non-food applications.

As a result, agriculture has been able to invest further in sustainable agriculture and food supply. The woodworking industry has experienced strong growth through recycling and the long preservation of materials in the supply chain. The production of biomass has created a stronger financial basis for the management of nature and the landscape. As 2030 approached, algae and seaweed also became increasingly prevalent as valuable biomass resources. As much of the biomass used is produced in a demonstrably sustainable way, social acceptance for biomass has increased.

In order to make this target scenario a reality in 2030, the Netherlands is faced with various major challenges. The main ones are set out below.

[3] Ministry of Economic Affairs 2014: Progress report – Energy from renewable sources in the Netherlands 2011-2012

1.4. Policy challenges

The 'Strategic Biomass Vision for the Netherlands towards 2030'takes 2016 as its starting point. We are dealing with a situation that is characterised by the following aspects:

- an increased urgency for climate change and sustainability and the associated need for a transition to renewable resources and a circular economy;
- low global market prices for fossil sources such as petroleum and the associated sluggish demand for renewable alternatives;
- the creation of new potential applications for biomass in the chemical industry, including bio-based building blocks for the production of a wide range of chemicals and polymers;
- concerns about shortages, suppression or unwanted competition among the various applications of biomass, in particular, concerns expressed by the paper, woodworking and chemical industries about the subsidy on bioenergy;
- attention to sustainability in the various phases of the supply chain, such as production, processing, consumption, waste and recycling;
- the sustainability of biomass also relates to the social and public effects in developing countries with regard to land rights, human rights, migration and the growing demand for water.

1.5.Document outline

On the basis of existing research material, Chapter 2 sheds light on the expected trends in supply and demand for sustainable biomass. Chapter 3 identifies the opportunities for the Netherlands. Lastly, Chapter 4 formulates the policy options towards 2030 on the basis of the 'no regret' analysis.

2. Is there enough biomass and can its sustainability be adequately achieved?

On the basis of existing research material, Chapter 2 sheds light on the expected trends in supply and demand for sustainable biomass.
In order to satisfy Dutch demand for food, animal feed, energy, transport, chemicals and materials, adequate sustainable biomass could become available, provided that successful efforts are made to increase the supply of sustainably produced biomass and pursue optimal biomass use. To achieve this:

- **a targeted policy must be pursued in order to increase productivity in agriculture and forestry in the Netherlands, within the EU and in other countries;**
- **there must be an active drive towards cascading and technological development in order to reach higher conversion yields and to facilitate co-production and the high quality use of waste flows;**
- **a targeted policy must be implemented to guarantee the sustainability of biomass production and the use of biomass in production chains;**
- **the options for arriving at a single overarching basic sustainability framework for all raw materials must be explored; additional criteria, including quality assurance, can be formulated for biomass flows that are encouraged by the government and for high-risk flows.**

From fossil to renewable
Biomass has been used for energy and materials since the dawn of time. Nature has provided the required raw materials for a long period of time. However, population growth, increased prosperity and the emergence of fossil resources for energy (coal, gas and oil) and later materials (petrochemicals) brought about enormous change in this area. Agriculture was able to focus increasingly on food production – until now.
Because of the need to combat climate change and deal with the growing scarcity of fossil resources, a new phase has started in which biomass – just as in the past – is being used on an increasing scale for production in non-food applications. Considerable CO_2 savings can be achieved by using renewable resources.

Is there enough biomass worldwide?
An important question in this necessary transition to biomass for non-food applications is whether there is enough biomass worldwide to meet all needs. The concern is that the large-scale use of biomass for non-food applications may jeopardise food supply. Conversely, there are those who contend that the production of biomass can support food production. The growing demand for water is also a factor in this regard. Agriculture is the largest consumer of water (70%) and a strong increase in competition for water supplies may also have geopolitical consequences. This can also be amplified by climate change.

Other renewable resources
The existence of other renewable resources, such as solar and wind-generated electricity, is also important. For energy applications that need a compact energy carrier, technological alternatives are often still lacking.
In order to interpret the questions at play here, this chapter looks at the quantities of available biomass and the predicted demand for different biomass applications, sustainability and how to achieve this. The 'Strategic Biomass Vision for the Netherlands towards 2030'draws conclusions on the basis of this.

2.1. Comparison of biomass supply and demand in 2030

An analysis based on a large number of studies has been carried out to determine whether sufficient biomass can become available to meet demand in 2030. See Appendix 1 for a description of this analysis.

Developments in biomass supply towards 2030

A number of leading studies were analysed for *'A vision on sustainable fuels for transport'*, which was drawn up as part of the Energy Agreement of the Social and Economic Council of the Netherlands (SER) in 2014[4]. Based on research of the Netherlands Environmental Assessment Agency (PBL)[5] a range has been determined for global non-food biomass supply of 50-150 exajoules (EJ) in 2030 (including waste flows from agriculture and forestry). Based on this global supply, the availability of biomass for the Netherlands has been fixed at 115-753 petajoules (PJ). The bottom of the range is based on a per-capita allocation of the low prediction of 50 EJ[6] and the top of the range on an allocation according to the share in primary energy consumption of the high prediction of 150 EJ. With an average biomass energy content of 17 GJ/tonne, the range applied for the Netherlands amounts to 7 MT of biomass (dry matter) for the bottom of the range and 45 MT for the top of the range. This supply relates to biomass that is available for non-food applications, such as electricity, heating, transport fuels and raw materials for chemicals and materials.

Uncertainties in the predictions

It is unlikely that biomass supply will be at the bottom or top of the range in practice, as these represent the most extreme approaches: from very cautious and averse to risk, to very hopeful and with full confidence in technological developments and international cooperation.

The low estimates are based on strict sustainability requirements for the production of biomass and are very conservative in their evaluation of the possibilities for increasing biomass supply in future. The high estimates are based on what is possible from a biophysical perspective and assume that there will be international agreements and standards on sustainability. Achieving a biomass supply in the vicinity of these high estimates will be possible only with concerted policy efforts.

Important factors that affect the availability of biomass for non-food applications include:

- The efficiency of food production. Some 1.3 billion tonnes of food are presently wasted worldwide, a third of total production[7];
- The development of the global diet. Land requirements for meat are generally greater than for fish or a vegetarian diet. More than half of the global biomass demand is currently related to the production of animal feed;
- Local agricultural productivity, particularly outside Western Europe. Bottlenecks in global food supply are to be expected if global productivity remains the same. If productivity in developing countries and emerging economies can develop to sustainable Western levels, there will be adequate biomass to meet demand for all applications;
- The cost level of producing, transporting and processing biomass. It will often be too expensive to ship agricultural waste to the Netherlands;
- The development of biorefinery technology for the optimal use and processing of biomass (known as cascading in function).

[4] Social and Economic Council of the Netherlands (SER) 2014: A vision on sustainable fuels for transport
[5] Netherlands Environmental Assessment Agency (PBL) 2013: Biomassa: wensen en grenzen
[6] This approach is based on each inhabitant in the world being allocated the same quantity of biomass.
[7] Food and Agriculture Organization of the United Nations (FAO) 2011: Global food losses and waste

Without a targeted policy for increasing the biomass supply, this supply will be at the bottom of the range by 2030.

Developments in biomass demand

The trend in biomass demand for each application is shown in Figure 1.

- For electricity and heating, the current policy of National Energy Outlook 2015 (NEO) (National Energie Verkenning [NEV])[8] (without the additional policy after 2020/2023) has been extrapolated for 2030. The implementation of the Van Weyenberg/Van Veldhoven motion (Parliamentary Document 34302, no. 99) for drawing up a plan to phase out coal power plants could have an effect on biomass use in the Netherlands for renewable energy as we approach 2030. This aspect will be included in the project that the government starts to implement this motion (Parliamentary Document 30196, no. 380).
- In relation to transport, the low curve shows the final biomass consumption for transport based on an extrapolation of the current policy (NEV). The high curve shows the Dutch transport sector's level of ambition in 2030 (A vision on sustainable fuels for transport).
- Two levels of ambitions are also shown for the avoided use of fossil resources for chemicals: the ambition of the Association of the Dutch Chemical Industry (VNCI) to replace 15% of fossil resources in chemicals (VNCI, low curve) and the ambition of the European Biobased Industries Consortium, which is based on 30% replacement (BIC, high curve) [9].

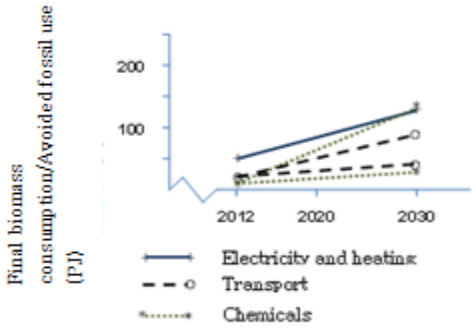

Figure 1. Development of biomass consumption in the Netherlands for each sector, shown in final consumption for electricity, heat and biofuels and in avoided fossil resources for chemicals.

Comparison of supply and demand

In order to be able to meet the expected demand in 2030, 432-596 PJ (25-35 MT) of biomass is needed. This demand lies somewhat above the middle of the supply range. Although this may seem reassuring, achieving a sustainable, mid-range biomass supply will still require significant policy efforts at national, European and global level. If we compare the expected demand in 2030 (25-35 MT of biomass) with current biomass use for energy and materials (14.5 MT in 2012), it is clear that biomass use is still going to increase sharply in the Netherlands.

Available biomass for non-food applications

The first challenge, through the cascaded use of the biomass that is already processed in the

[8] Energy research Centre of the Netherlands (ECN), Netherlands Environmental Assessment Agency (PBL), Statistics Netherlands (CBS), Netherlands Enterprise Agency (RVO) 2015: National Energy Outlook (NEV) 2015

[9] Biomass use for materials (paper, cardboard and wood) is included in the estimate of how much biomass is needed for non-food purposes. It is not included as avoided fossil use in petajoules (PJ) because these materials are already bio-based.

Netherlands, is to harness the potential to generate more energy/product from the same biomass. In addition, biomass can also be imported:

- agricultural raw materials and waste streams of agricultural crops, particularly for applications in chemicals and transport fuels. Most of these raw materials can be sourced from Europe;
- wood and waste flows from forestry, particularly for applications in materials (paper and building materials), electricity, heating and biogas. Wood may also emerge as a raw material for chemicals in due course. Most of these raw materials can also be sourced from Europe.

2.2.Sustainability

Sustainability is an important premise in the application of raw materials. The basic idea is that biomass production and use may not prejudice the quality of the environment or social welfare, but must be able to contribute to the protection of our natural capital and well-being. Preventing adverse effects in the production and application of biomass is the topic of scientific and social discussion.

Current situation with certification systems for sustainable biomass

There are currently a host of certification systems that aim, with the help of sustainability criteria, to reduce or prevent adverse effects of sustainability. These certification systems differ from each other. Some are enshrined in law; others are set up voluntarily by NGOs, market players, governments or have arisen from joint initiatives. The criteria applied by these systems differ in relation to application, content, ambition level, geographical coverage and guarantees.

Because crops can be used for various applications, different certification systems, sometimes with different sustainability criteria, can apply to a particular crop. This leads to uncertainty and a situation in which high costs have to be incurred in order to satisfy the requirements of the different systems. There is thus a growing need among both producers and buyers of biomass for a clear-cut sustainability framework with harmonised sustainability criteria.

One sustainability framework for all raw materials

The main focus for guaranteeing the sustainability of biomass production needs to be on biomass that is imported from outside Europe. In the letter to the House of Representatives of the States-General on ‘Added value from biomass through cascading’, the government indicated that it wished to work towards an international system of cohesive agreements on sustainability criteria that cover the entire supply chain, from the production to the application of biomass. Such a system must be socially accepted and provide a stable framework for trade and industry. Since biomass is generally applied as an alternative to fossil resources or materials, and because harvesting or extracting these raw materials gives rise to sustainability issues, it is desirable that sustainability be guaranteed for all raw materials, both renewable and fossil. Aspects to be taken into account are, for example, environmental effects on soil, water and air, the effects on biodiversity, the nutrient balance in the soil, greenhouse gas reduction and social aspects.

It is also essential to agree on initial growth paths (these are agreements between government and the business sector to comply with sustainability criteria over time), in order to guarantee sustainability for specific types of biomass or specific applications, for both biomass and other raw materials. Our competitiveness is a point to consider in this regard.

Additional criteria for high-risk or large-scale applications
Additional, specific criteria can be formulated for high-risk or large-scale applications[10]. There is also room for a customised approach in order to be able to respond effectively to specific developments and issues that are typical of a sector and/or region. We are continuing to work on the development of a harmonised European sustainability system for these biomass flows.

The development, harmonisation and application of sustainability criteria are not the government's sole responsibility, but also require efforts by and commitment from private parties. If public funding is used to promote biomass, strict sustainability criteria can be applied that are tested and enforced with public funding. In other cases, the greening of biomass sectors largely depends on the private sector, in conjunction with public organisations and government support.

Improving biomass application
While sustainability systems and criteria monitor the effects on production and supply, the sustainability of biomass application can also be improved. This obviously starts with economical use, savings and prevention of waste.

As far as possible, biomass use should involve cascading: using all parts of biomass, and recycling waste flows in a way that nutrients (phosphate and nitrogen) are preserved, the soil carbon content remains constant and biomass can be used for as long as possible.

Looking more closely at external effects
It is moreover wise reflect on the external effects that can arise with specific applications. One example is air pollution and CO_2 emissions during combustion. While it is true that CO_2 is also absorbed during the growth of biomass, the aim is reduce total emissions, which is possible in the case of biomass through alternative use or ensuring that the carbon can be captured over time. The government will take the prevalence of such effects into account when weighing up its policy options.

2.3.Conclusions

It is clear from the comparison of supply and demand that adequate sustainable biomass could become available to satisfy Dutch needs for food, animal feed, energy, transport, chemicals and materials, provided that a number of conditions are fulfilled.
These conditions relate to:

- responsibly increasing sustainable biomass supply on a national, European and global level;
- the optimal and more efficient use of the total available biomass;
- cascading and technological development in order to reach higher conversion yields and to facilitate co-production and the high quality use of waste flows.

Not simply assuming adequate supply
Tension can arise between the supply and demand of specific biomass flows. Studies into future biomass supply vary widely. It is therefore important to be receptive to signs of biomass use perhaps leading to an undesired suppression of biomass for food supply or to other adverse effects.

[10] The UN's 'Guiding Principles on Business and Human Rights' (known as the Ruggie Principles) and the 'Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries, and Forests', as agreed in the 'Committee on Food Security' (FAO), which both try to guarantee human rights and the public consultation of local communities in the case of large-scale agricultural investments, particularly in developing countries, can also be followed.

Focus on the sustainability of biomass production

In order to guarantee the sustainability of biomass production, it is necessary to work both on the harmonisation of sustainability criteria and the overall sustainability of production (including social and possible geopolitical effects).

Because biomass competes in the market with fossil and mineral resources, the unilateral introduction of sustainability requirements for biomass may hamper market entry. There is accordingly a need for a single sustainability framework for all raw materials. Additional criteria, including quality assurance, can be formulated for biomass flows that are encouraged by the government and for high-risk flows. We are continuing to work on the development of a harmonised European sustainability system for these biomass flows.

3. Where are the opportunities for the Netherlands?

In Chapter 2, the 'Strategic Biomass Vision for the Netherlands towards 2030' analyses the expected trends in the supply of and demand for sustainable biomass based on existing research material. Chapter 3 looks at the opportunities for the Netherlands in more detail. What are the implications of an integrated approach to biomass for the Netherlands?

- **A reduction in CO_2 emissions in the chemicals and materials sector (both savings in fossil resources and savings in process energy)**
- **As we approach 2030, biomass use must be given preference for certain priority applications, such as the use of high-temperature heating for industry, the use of biofuels for aviation and shipping and the use of raw materials for chemicals and materials. There are hardly any alternative renewable sources for these applications.**
- **In the short and medium term, the co-firing of biomass in coal power plants is a cost-effective option to make energy supply sustainable.**
- **Investments in production capacity and employment in chemicals and materials and for advanced transport fuels/bioenergy in the Netherlands.**
- **It has proved necessary in many international scenario studies to adopt measures that lead to negative CO_2 emissions in order to remain within the climate objective. Bioenergy carbon capture storage (BECCS) is one of the few options to achieve negative CO_2 emissions.**

3.1. Towards an integrated approach to biomass

Biomass use in the Netherlands

Fossil resources are not used only for energy applications such as electricity, heating and transport fuel. Around 20% of the current fossil resources in the Netherlands are used as raw materials for the production of chemicals and plastics (Figure 2, Statistics Netherlands [CBS]). Biomass use for chemicals and materials in the Netherlands can thus significantly contribute towards the replacement of fossil resources and the concurrent reduction of CO_2 emissions.

Important instruments in the current renewable energy and climate policy include the Renewable Energy Directive (RED), the Emission Trading System (ETS) and, in the Netherlands, the Stimulation of Sustainable Energy Production (SDE) scheme. These instruments stimulate biomass use for energy and mobility, but do not do the same for chemicals and materials. The additional reduction potential of using biomass for chemicals and materials in 2030 amounts to around 3-6 MT CO_{2eq}[11].

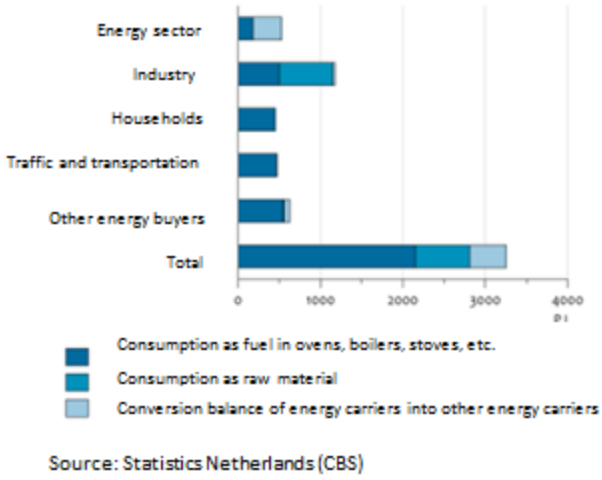

Figure 2 Fossil resources consumption by sector and use, 2013

[11] Based on the ambitions of VNCI and the JTI Biobased Industries Consortium

Alternative sustainable options for each application

If fossil resources consumption is broken down further into applications, it is possible to see the extent to which there are alternatives for making a specific application sustainable, see Table 1.

Application	Share (% of the total number of fossil energy carriers)	Bio-based solution	Other sustainable alternatives
Electricity generation/CHP	29%	Co-firing Bio-CHP Gasification	Sun Wind Water
Heat (to 120^{0}C) Households, horticulture	22%	Bio-CHP Biomass boiler	Geothermal heat, Heat pumps Solar boilers, Electrification
Industrial heat (especially steam)	15%	Biomass boiler Biogas	--
Passenger transport, light delivery vehicles	10%	Biofuels Biogas	Electrification Hydrogen gas
Road haulage	4%	Biofuels Biogas (LBG)	Partly over time: Fuel cell, electrification
Aviation • **Dutch consumption** • **Bunkers**	0.1% 5% (*)	Biofuels	Modal shift
Shipping • **Dutch consumption** • **Bunkers**	0.5% 17% (*)	Biofuels Biogas (LBG)	Modal shift, partly electrification
Chemicals and plastics	20%	Bio-based chemicals Bio-based plastics	CO_2 (initial stage)

Table 1 Energy carrier consumption by application[12]

(*) For the purpose of consumption, Statistics Netherlands (CBS) only takes domestic consumption into account for aviation and shipping, it counts tankers/aeroplanes with overseas destinations under exports. The 'including bunkering' percentage relates to the total fuel sales in the Netherlands in relation to the total Dutch energy supply.

Chemicals and plastics also need a continuous carbon source. CO_2 aside, biomass is the only alternative source to fossil carbon. The production of chemicals and materials from CO_2 is still in the research phase. Biomass is also the only non-fossil alternative for industrial, high-temperature heat. The vision on sustainable fuels for transport concludes that there are no sustainable alternatives for large-scale application in sight for 2030 to the use of biofuels for heavy transport, such as aviation, shipping and long-distance road haulage. Further savings may be possible by means of a modal shift (the replacement of some road haulage with transport by rail or sea). Short-haul passenger flights could also be replaced by rail transport.

Cost-effectiveness of the various options

The current costs of the different measures to reduce greenhouse gas emissions are presented in the cost curve below (Figure 3)[13]. These measures vary from reducing greenhouse gas emissions in

[12] Smedema 2015: Outlook on 2016, TKI-BBE
[13] Energy research Centre of the Netherlands (ECN), Londo 2015: Indicative cost curves

agriculture, renewable energy and energy savings, to CO_2 capture and storage. The latter is referred to as carbon capture storage (CCS). Some measures relate to biomass applications. The cost range of biomass applications in the chemical industry is also shown in the figure. This range corresponds with most of the other measures.

Most business cases for biochemicals and bioplastics currently have a cost-effectiveness of 0-100 € per tonne CO_2.

The use of biomass as a raw material for generating bioenergy is encouraged in the Netherlands in order to achieve renewable energy targets. Biomass use in chemicals does not contribute towards the increase in the renewable energy share, but it does contribute towards the reduction of CO_2 emissions.

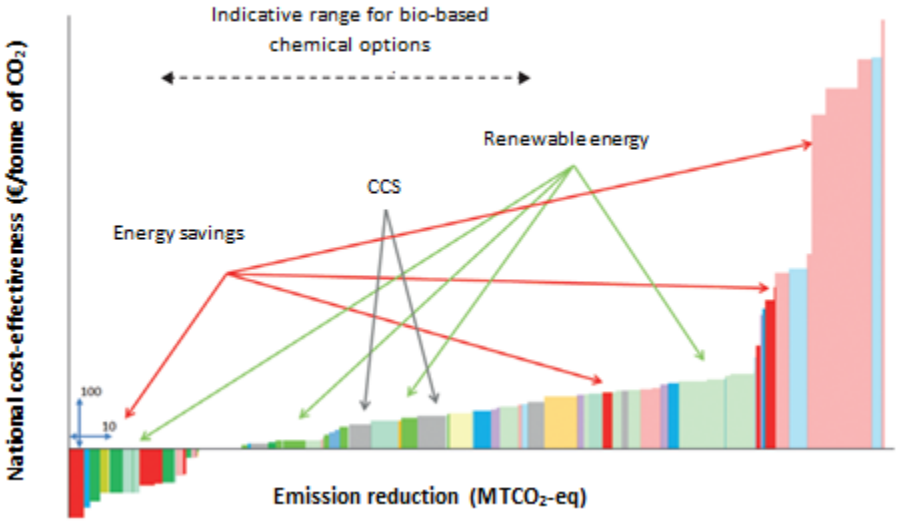

Figure 3 Indicative marginal cost curve for measures aimed at the reduction of CO_2 emissions

Various macro-economic studies indicate that by 2030, the production of advanced biofuels and chemicals will be competitive in comparison to their fossil counterparts, while the production of electricity and gas from biomass will not be competitive[14]. From a cost-effectiveness perspective, it is therefore more favourable to use biomass for the production of chemicals, plastics and advanced biofuels than for the production of energy, especially electricity. Biomass use for functionalised chemicals, in particular, is more cost effective. These are chemicals with nitrogen, oxygen or sulphate compounds. The cost-effectiveness of using biomass for bulk chemicals is more comparable with that of biomass application in transport fuels.

[14] JRC, Wageningen UR-LEI, PBL 2014: Evaluating the macroeconomic impacts of bio-based applications in the EU LEI, Copernicus Institute 2009: Bio-based economy in the Netherlands. Macro-economic survey of the large-scale introduction of green raw materials in the Dutch energy supply. Assumptions: biomass price of $8.8/GJ including transport and pre-processing, and with energy prices in accordance with the IEA.

BECCS[15] or CO_2 storage originating from biomass
According to the scenarios of the United Nation's Intergovernmental Panel on Climate Change (IPCC) and the Netherlands Environmental Assessment Agency (PBL), negative emission technologies are essential in order to limit global warming to a maximum of 2 degrees Celsius. An important option for this purpose is the combination of bioenergy production with CO_2 storage or bioenergy carbon capture storage (BECCS)[16].

However, this option has a relatively poor cost-effectiveness and CO_2 storage does not enjoy much social acceptance. Whether we will need negative CO_2 emissions in 2030, and whether BECCS will be the best option for this, will depend on the speed at which other affordable alternatives emerge. The direct use of CO_2 (known as carbon use) as a raw material for products is another way to capture CO2 in the long term, provided that it is kept in the chain long enough. However, the cost-effectiveness of this application will also have to improve greatly in future.

3.2.Opportunities for biomass in energy supply

Increase in bioenergy
Institutes such as the Energy research Centre of the Netherlands (ECN), the Netherlands Environmental Assessment Agency (PBL), Statistics Netherlands (CBS) and the Netherlands Enterprise Agency (RVO) have made estimates of energy consumption in 2030 on the basis of existing and proposed policy and energy demand expectations[17].

Although the relative share of bioenergy in electricity, heating and transport fuels in the total amount of renewable energy decreases from around 70% in 2015 to 56% in 2030, the quantity of bioenergy increases significantly in absolute terms. The expected increase in biomass use can materialise only through the large-scale import of biomass.
In contrast to renewable sources like sun and wind, biomass does not make the Netherlands less dependent on imports. What does change is the origin of fossil sources especially from the Middle East and Russia to countries and regions that produce biomass, such as Europe, the United States and Canada.

Breakdown into applications
For the implementation of the Energy Agreement for Sustainable Growth (*Energieakkoord*), to which more than forty organisations (including the government) signed up in 2013, the picture for the different bioenergy applications is reasonably clear[18].

With the exception of the maximum biomass use (25 PJ/year) for co-firing in coal power plants, this relates, for example, to use for local, decentralised energy generation and industrial applications (steam produced from biomass). The main uncertainties and largest potential growth in the Netherlands relate to fermentation and co-fermentation of manure and biogas production.

The increased biomass demand for various applications has caused a rise in the price of co-substrates, which has adversely affected the business case for co-fermentation. Improved manure management can

[15] Bio-Energy with Carbon Capture Storage/usage
[16] IPCC 2014: Climate Change 2014 – Synthesis report – summary for policy makers
[17] Energy research Centre of the Netherlands (ECN), PBL Netherlands Environmental Assessment Agency (PBL), Statistics Netherlands (CBS), Netherlands Enterprise Agency (RVO) 2015: National Energy Outlook (NEV) 2014
[18] Energy research Centre of the Netherlands (ECN) 2014: Survey of biomass markets and renewable energy policy

lead to a sharp decrease in CO_2 emissions. Mono-fermentation of manure is difficult to introduce, but is a potential opportunity. For this reason, the Minister of Economic Affairs and Minister for Agriculture have announced a programme for mono-fermentation of manure[19].

Cost-effectiveness
The cost-effectiveness of different forms of bioenergy varies greatly. Some routes are cost-effective and have no profitability ceiling, such as combined heat and power (CHP) in sewage treatment plants; other routes have a relatively high profitability ceiling, such as mono-fermentation of manure. In mono-fermentation of manure, only manure is fermented, mostly on the farm. No other raw materials, such as maize, are added to the fermenter.

Most options for generating bioenergy lie in between. Examples include the use of domestic wood in a CHP plant and co-firing wood pellets in coal power plants. A major difference to most other forms of renewable energy is that many bioenergy options, in addition to their investment costs, have to contend with substantial variable costs for the purchase of biomass.

Because of the raw material price, these bioenergy applications are expected to maintain a long-term profitability ceiling – just like many other forms of renewable energy over the coming years. Due to the relatively limited availability of other profitable renewable options and cost-effectiveness, bioenergy will continue to be stimulated from within the climate and renewable energy policy.

Additional incentive for long-term targets
An additional incentive for bioenergy will probably be necessary in order for long-term targets to be achieved. The following developments are envisaged for 2030:

Electricity production: from combustion to value creation & combustion
Wood pellets can be used for the production of electricity through co-firing. These wood pellets are made from forestry waste flows (as a by-product of wood production for building, for example). In the short and medium term, co-firing is expected to be a cost-effective manner in which to produce renewable energy.

Biomass in heat production
Energy savings lead to a reduction in the demand for heat in industry and the heating of buildings and greenhouses. Increasingly less natural gas will be used for the heat demand that remains for heating spaces. Natural gas is being significantly replaced by biomass from wood, waste flows and other sustainable options. Examples include geothermal heat, residual heat, heat pumps and solar boilers. The main developments in this regard are biomass-fired heat networks (wood) combined with geothermal and residual heat, combined heat and power and, lastly, green gas from various sources (sludge and manure). It is cost-effective to use biomass boilers and stoves on a smaller scale.

Biomass heating in industry
Mostly high temperature heat is used in industry, normally in the form of steam. This heat cannot simply be made sustainable with sources other than biomass (biogas, biomass boilers)[20]. The plants that are specifically developed for heat production have a high-yield conversion of wood into heat.

[19] NEV 2015
[20] *Energieadvies 2050* (Energy advice 2050), Council for the Environment and Infrastructure (RLI) 2015

Biomass use for this application is therefore preferable, in principle, to its use for heating buildings and greenhouses. Low-temperature heat is needed for this purpose and this can be made sustainable through other renewable resources.

3.3.Opportunities for biomass in transport and logistics

The large-scale import of biomass for energy (including biofuels) offers opportunities to ports and for high-value processing. The Netherlands leads the way in this regard in Europe, which can be a unique selling point.

Development of biofuels

The EU directive on renewable energy in transport is currently the main driving force behind the development of biofuels. Biofuel blending within this sector is a cost-effective way to comply with this directive. Biofuel production is already a significant economic activity in the Netherlands.
The added value of the production of biofuels in the Netherlands was around €100 million in 2011. The port of Rotterdam is a major hub for the import and export of biofuels. Biodiesel production in the Netherlands amounted to 52.8 PJ in 2012. By comparison, national user demand was 10.1 PJ.

Green energy carriers

In addition to savings and large-scale use of electrical power trains, green gas (including bio-LNG) and liquid biofuels will be the green carriers for transport. In the longer term, biofuels are the main alternative to fossil resources for aviation and shipping[21]. As 2030 approaches, biofuels will be one of the main renewable options for heavy road haulage. As long as the production costs of biogas and green gas remain higher than for natural gas, this gas will fall behind the development of natural gas in transport[22]. Some niche modes of transport could make a complete switch to green gas.

In order to make the requested quantities of biofuel for aviation and shipping possible as we approach 2050, it is necessary to develop sustainable, cheap, advanced biofuels. However, this still requires a lot of research and innovation.

3.4.Opportunities for biomass in chemicals and materials

Traditionally, biomass has been used for the production of paper and cardboard, products from wood and textiles. As the demand for paper for newspapers and magazines decreases in Europe, the demand for packaging cardboard has risen due to the increase in the number of online sales. These two contrasting trends are presently balanced in the Netherlands.

Even so, we are seeing a shift in the traditional pulp and paper industry to Asia (strongly expanding market) and South America (raw material availability). The paper and cardboard industry in the Netherlands moreover mostly operates on recycled paper. There are opportunities in the woodworking industry for innovations in traditional applications, such as construction, where climate gains can be made from replacing energy-intensive materials such as steel and concrete.

Savings in fossil resources and process energy

Replacing a fossil product with a comparable bio-based product normally leads to a larger reduction in greenhouse gas emissions, through savings on the required process energy, than using that biomass directly for energy[23]. The production of biomaterials or chemicals from vegetable oils, for example, leads

[21] Social and Economic Council of the Netherlands (SER), I&M 2014: a sustainable fuel vision with LEF
[22] Biogas is the crude gas produced after the fermentation of biomass. Green gas is biogas that is upgraded to natural gas quality by increasing its energy content and removing impurities.
[23] Wageningen UR-FBR 2011,2013: sustainability of bio-based products

to a greater reduction of fossil energy and greenhouse gas emissions than the production of biodiesel from this oil. Sugar beet, wheat and maize even produce double the savings in the use of fossil energy when used for bioplastics than when these are used for the production of bioethanol. The released waste flows can be used for the production of process energy.

Development of bio-based chemicals and materials towards 2030
The main driving force behind the development of biochemicals and biomaterials, such as bioplastics, is market demand. Various bio-based applications can already compete with fossil ones, particularly because of their unique properties. However, only a limited number of applications are able to compete in terms of cost price. The use of biomass as a raw material for the chemical industry is still limited in scope, but will increase in importance in future.

The market share of bio-based chemicals and products is expected to grow by an average of 6.5% per year until 2030[24]. Bio-based PET (polyethylene terephthalate) and the new biopolymer PLA (polylactic acid) are currently experiencing the quickest market growth. Production capacity for bio-based polymers is presently growing worldwide at the impressive rate of almost 20% per year. Most of this growth is now happening outside Europe.

Impending investments
An increasing number of companies are strongly considering investing in the Netherlands. In order to secure these investments for the Netherlands, there is a strong need to support flagship projects. Scaling up to a commercial scale of operations, construction and start-up involve significantly higher risks and costs than investing in subsequent factories. This is because learning curves have to be completed and higher risk premiums need to be paid for the capital and loans to finance the factories. Some companies that are on the point of investing indicate that conditions elsewhere in the world, and even elsewhere in Europe, are more favourable than in the Netherlands. In order to improve conditions in the Netherlands, there is a need to support scaling-up projects. This is what can finally bring investors on board. This will place the Netherlands on the map as a bio-based country and boost further innovation, which will, in turn, result in higher added value for our country and lead to employment. As such, innovations that have been supported by the Dutch government for years can also lead to value creation in the Netherlands.

Think in terms of first and second generation
The chemical industry uses crops that contain sugars, starch and oils as raw materials. These crops are called first-generation raw materials. Significant technological development is also taking place with regard to lignocellulosic raw materials, such as agricultural waste flows and wood. These flows are also referred to as second-generation biomass.

The production of chemicals from food crops is normally accompanied by higher productivity because use is made of functionalities that are already present in the crop. The co-production of chemicals with other applications is also possible. Lastly, the per-hectare productivity of food crops is often higher than for non-food crops. Biorefinery technology enables co-production and prevents the single-use application of biomass. If biomass is used optimally, it is not appropriate to discourage the use of first-generation raw materials for chemicals and materials.

[24] Nova 2015: Market study and Trend Reports on 'Bio-based Building Blocks and Polymers in the World – Capacities, Production and Applications: Status Quo and Trends Towards 2020'

3.5.Opportunities for sectors that supply biomass

There is currently more than enough food available in Europe. This is expected to be the case for decades to come. Agriculture is the main sector within the bioeconomy in terms of added value and employment. The agrifood sector is the largest sector in the Netherlands, contributing almost 10% to the economy and employment. The Netherlands import many raw materials for animal feed and is the second global exporter of agricultural and food products, which amount to more than 13% of Dutch exports (including meat, dairy products, flowers and plants).

Sugar and starch as an opportunity

A recent report found[25] that Dutch sugar beet can compete economically with crops like tapioca from Thailand, maize from the United States and sugar cane from Brazil. With the abolition of the quota for beet sugar and isoglucose (sweeteners from maize or wheat) at the end of 2017, it will be possible to produce more sugar within the Netherlands and Europe. This provides certainty and development opportunities for the bio-based chemical industry in the Netherlands.

The modern Dutch agricultural sector and the beet sugar industry have a promising future in this changing market. The Dutch sugar cooperation expects production to increase with its current members, partly through higher per-hectare production (from 14 tonnes to 18 tonnes per hectare in 2020) and partly through a limited increase of the farming area. The per-hectare yield has increased by 50% over the last 20 years. Experts estimate that this increase will continue for the time being.

Starch from wheat: an attractive option for the chemical industry

At European level, starch from wheat is a very attractive proposition for the agrifood and chemical industries. Starch provides the chemical industry with a cheaper raw material than sugars from beet (starch and sugars are both carbohydrates that are suitable for use as raw materials in chemicals). The reason for this is that proteins in wheat are the main product (food applications) and starch is the by-product. The increase in wheat production is still gradual because the demand from the chemical industry is also only just starting.

Forests, nature, landscape and wood

Domestic and imported wood has the potential to be a significant source of biomass, firstly for energy and new bio-based chemical applications, and secondly for traditional applications such as paper, panels and solid wood. Opportunities for the woodworking industry lie particularly in innovations in traditional applications, such as construction.

Keeping carbon in the chain longer, through years of application and recycling, produces a real gain over other materials that are produced with a high energy input (such as steel and concrete and dependent on their useful life). The better use of biomass can contribute towards making the management of forests, nature, the landscape and urban green areas affordable. Lastly, the application of biomass from forests, nature, the landscape and wood for bioenergy will remain significant. In particular, sustainable forestry management, including retaining ecosystem services and biodiversity, is possible if forestry is economically profitable. Extracting value from biomass (wood flows and waste flows) ensures a solid basis.

3.6.Conclusions

Biomass is an important and cost-effective source for making energy supply sustainable in the Netherlands and therefore reducing CO_2 emissions and achieving climate objectives. The CO_2 avoidance

[25] Deloitte 2014: Opportunities for the fermentation-based chemical industry

costs of bioenergy will remain relatively high for a number of options in the future (co-firing, BECCS). BECCS refers to bioenergy with CO_2 capture and storage/usage. In the short and medium term, the co-firing of biomass in coal power plants can be a cost-effective option to make existing coal power plants sustainable. High-temperature heat for industry, decentralised energy production and biogas from fermentation are options with many future prospects and opportunities for development. BECCS is one of the few options for achieving negative CO_2 emissions.

No sustainable alternatives for heavy transport
Apart from biofuels, there are no other sustainability options in sight for heavy transport such as aviation, long-haul shipping and some road haulage. The same applies to biomass for chemicals, materials and industrial heat. Using biomass for the production of chemicals, plastics and advanced biofuels delivers high economic added value to Dutch industry. The production of advanced biofuels in the Netherlands for heavy transport offers promising opportunities from both a social and economic perspective.

Biochemicals and materials: an enormous growth market
Biochemicals and materials represent an enormous growth market worldwide and an opportunity for the chemical industry in the Netherlands because it will be able to compete with the fossil-based chemical industry within the foreseeable future. The use of biomass in the Dutch chemical industry thus significantly contributes towards the reduction of fossil resources and the concurrent reduction of CO_2 emissions.

Because more than 20% of the current fossil resources are used for this purpose in the Netherlands, bio-based is important for the future of this Dutch industry. Bio-based materials generally yield at least the same CO_2 reduction as energy applications for each unit of biomass used. However, the application of biomass as a raw material for chemicals and material is not directly stimulated by the emissions trading system (ETS), which rewards the reduction of CO_2 emissions only if the products are incinerated. There is accordingly no incentive under the ETS for replacing fossil resources with biomass for the production of chemicals and materials.

Sugar beet offers the most economical opportunities
Dutch agriculture and horticulture are still important economic drivers. The development of bio-based applications, such as the production of high value ingredients and materials, and enhancing the value of waste flows are promising opportunities for these sectors. Sugar beet is the crop with the greatest economic bio-based opportunities for 2030 in Dutch agriculture.

4. Towards optimal biomass use

In Chapter 2, the Biomass Vision 2030 analyses the trend in the supply of and demand for sustainable biomass and Chapter 3 looks at the opportunities for the Netherlands in greater detail. Based on that, this chapter answers the key question from Chapter 1:

How can the Netherlands best contribute through biomass use to achieving the policy objectives for 2030 in the area of food, energy, climate, mobility and a bio-based and circular economy, and simultaneously develop an innovative and competitive economy? The precondition for this is that sustainably produced biomass must be used as much as possible.

In order to satisfy Dutch demand for food, animal feed, energy, transport, chemicals and materials, adequate sustainable biomass could become available, provided that successful efforts are made to increase biomass supply and pursue optimal biomass use. The government will also continue to press for the sustainability of production and application of biomass. Section 4.1 contains a list of measures that are needed to achieve an adequate and sustainable biomass supply.

Biomass can make a significant contribution in all applications towards the replacement of fossil resources with renewable ones, as well as the resultant reduction in CO_2 emissions. Measures that contribute towards optimal biomass use for the various policy objectives are described in section 4.2.

Biomass also offers good opportunities for green growth. The Netherlands is strongly positioned for biomass investment: a strategic connection to good seaports, a strong agricultural, chemical and energy sector and high-quality knowledge institutions. The number of investments in the bio-based economy is increasing worldwide. Measures that contribute towards opportunities for biomass within green growth are described in section 4.3.

Lastly, section 4.4 deals with the need for an integrated biomass innovation policy.

The conclusions of this policy vision are based on a large number of research reports. This research often contains extrapolations for the future, which make assumptions that obviously bring about uncertainty. The measures formulated in this chapter are what are known as 'no regret' options. However, it remains essential to monitor the policy effects both in terms of figures and in dialogue with stakeholders and, where necessary, to adjust the policy if undesirable effects arise.

4.1.Stimulating the supply and demand of sustainable biomass

4.1.1. Increasing the supply of sustainable biomass

An adequate supply of biomass is not automatic. The absolute demand for biomass is increasingly strongly, both in the Netherlands and worldwide. This is caused, on the one hand, by the growing world population and, on the other hand, because the application of biomass is essential in order to comply with the climate policy objectives (keeping global warming below two degrees Celsius as far as possible). Estimates of biomass supply in 2030 vary greatly. A biomass supply that rises above the bottom of the range requires considerable policy efforts. This is difficult because there is currently no market incentive to aim towards a larger supply of sustainable biomass.
Owners of waste flows in the Netherlands indicate that there is hardly any demand for high-quality applications. This is possibly because waste flows are only available in low volumes of varying qualities and properties in many places, and also not available throughout the year. At European level, the

agricultural sector indicates that although there are presently various options for increasing supply, market demand is lacking. As a result, investments are not being made in increasing production and efficiency or in innovation.

It is therefore particularly important in the short-term (< five years) to:

- make efforts at EU level to strengthen the bio-based economy further by means of the Common Agricultural Policy (CAP). The recent CAP 2015 supports the transition to a bio-based economy far better than before;
- to stimulate the production of various biomass flows in a demonstrably sustainable way;
- to stimulate commodity creation from agriculture and forestry waste flows. The abundance of small flows that vary in composition does not currently meet the demand for uniform flows from the energy and industrial sectors. Both technological aspects (conversion technology) and organisational aspects (spatial scale level, establishment of consortia, and apportionment of income and expenditure) are important in this regard.

For the longer term:

- further measures aimed at increasing productivity in agriculture and forestry in the EU and developing countries, their water efficiency, and retaining the ecological basis. Capacity building to be able to guarantee sustainability and an international institutional governance framework are also needed.

4.1.2. More efficient and circular biomass use

The more efficient use of available areas for agriculture and forestry (while preserving soil fertility and water management) and limiting losses in the supply chain produce significant sustainability gains and moreover ensure a strongly increase in supply.

Cascading is crucial

Biomass cascading is also extremely important. In cascading, all biomass flow components are used in the best possible way. Cross-sectoral cooperation across the various applications of biomass is essential in this regard. One business operating independently will seldom be able to market all of the fractions that arise from refining. Each fraction will be processed into a product for a specific market via an agreed conversion route. A great deal of research, development, application and market analysis is usually needed for this purpose. Working with the 'Biomass Utilization Efficiency (BUE[26])' of biomass products might be a useful resource in this regard.

Cascading requires cooperation

Cross-sectoral cooperation raises questions about how various risks will be borne among parties and how income and expenditure will be apportioned across the supply chain. Successful encouragement of cascading through government instruments must therefore relate to these cooperative arrangements. Cascading would have to be rewarded in all stimulus instruments.

The following measures are important:

- guaranteeing proper soil management that aims to maintain the nutrient balance and retain adequate organic matter in the soil;
- vigorously pursuing a policy to combat waste in the food chain;

[26] Nova paper #8 on bio-based economy 2015-11: Definition, Calculation and Comparison of the 'Biomass Utilization Efficiency (BUE)' of Various Bio-based Chemicals, Polymers and Fuels

- intensified efforts to encourage cross-sectoral cooperation that facilitates biomass cascading and co-production. This is possible through commitment to Green Deals and by reinforcing national platforms and regional clusters[27]. It also involves organising instruments in such a way that cascading is stimulated.

4.1.3. Towards an integrated sustainability framework

The current situation in which sustainability criteria differ for each type of biomass, each region or each application, and where there are multiple certification schemes in the market, leads to uncertainty and high costs. Additionally, if market protection is suspected, this can lead to trade disputes. There is a pressing need among producers and buyers of biomass, both within and outside Europe, for a clear sustainability framework.

Furthermore, it must always be kept in mind that biomass applications compete in the market with fossil products. The unilateral introduction of sustainability requirements for biomass has the undesirable effect that market entry for biomass in a fossil-dominated market becomes impossible.

The following measures could be adopted in order to work towards a single sustainability framework for all raw materials:

- exploring the possibilities of arriving at a single overarching basic sustainability framework for all raw materials;
- additional criteria, including quality assurance, can be formulated for biomass flows that are encouraged by the government and for high-risk flows;
- the aim for these biomass flows remains the development of a harmonised European sustainability system, based on the continued development of existing systems. The sustainability criteria of the Energy Agreement for Sustainable Growth (*Energieakkoord*), including the initial growth path for full testing at area level, are some of the most progressive and far-reaching criteria in the world.
- supporting the Biomass Sustainability Platform of the Organisation for Economic Cooperation and Development (OECD). The main tasks of this initiative are creating a supported method for measuring biomass sustainability and estimating how much biomass can be produced in a sustainable manner;
- using European standards (CEN) and international standards (ISO) as instruments to harmonise criteria;
- supporting producing countries in the application of sustainability criteria in their policies and regulations, and capacity building in developing countries for their implementation;
- further stimulation of the CSR policy of the Netherlands;
- encouraging the application of the 'Ruggie Principles' and the 'Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests';
- determining ambitious and realistic initial growth paths in consultation with stakeholders, aimed at making priority raw material flows sustainable. Key to this are market initiatives to increase demand for sustainable biomass, thereby making production sustainable;
- stimulating and facilitating private initiatives aimed at the application and harmonisation of sustainability criteria (for example, the Green Deal Green Certificates with the chemical and plastics sector).

[27] In a Green Deal, the central government and other parties agree on activities that they will perform as part of their initiative, and record these activities in a Green Deal.

4.2.Contribution of biomass to policy objectives

Biomass contributes to policy objectives in the area of food, energy, climate, mobility and a bio-based and circular economy. Cascading is essential for optimal biomass use. A number of measures are needed to make high-quality use of biomass combined with biomass use for energy and materials possible via cascading:

- the Netherlands strives for integration at EU level of policies aimed at renewable energy, climate and materials by focusing on one parameter, namely CO_2 reduction. The climate benefit from biomass use in chemicals and materials through CO_2 capture is only being partially reflected in the business case and emission reduction targets. In order to stimulate increased use, ways in which to reward this benefit further are being sought;
- until 2023, the Netherlands will stimulate biomass use for renewable energy in accordance with the Energy Agreement. The Netherlands will also make concerted efforts towards the innovation of all renewable sources so making the demand for energy and materials sustainable at socially acceptable costs can become a reality (also see section 4.3);
- biomass is being used on an increasing scale where there are few other renewable alternatives: chemicals and materials, aviation and shipping, and high-temperature heat for industry. Waste flows from cascading that are not used for food, animal feed or the priority applications mentioned above can also be used for bioenergy. Within the current system of renewable energy subsidies, subsidies and investments in bioenergy ensure the start of sustainable woody biomass flows. A shift from combustion to value creation and combustion provides impetus to the bio-based economy in the Netherlands.

4.3. Opportunities for the Netherlands

The bio-based economy provides the Netherlands with opportunities for green growth.

- The Netherlands processes very large quantities of biomass for food and animal feed due to its strong agrifood sector. By increasing efforts in efficiency, such as via biorefining and co-production, additional biomass can become available for non-food applications through the current flows.
- Importing biomass is necessary to turn ambition into reality. By using the biomass that is available within Europe as far as possible, supply lines remain short and the sustainability of biomass can be better guaranteed. Importing biomass creates opportunities for ports and the logistics sector. Companies, knowledge institutes and organisations that are leaders in making value chains sustainable can make this knowledge available elsewhere and increase its value.
- The bio-based economy provides good opportunities for agriculture and forestry because these sectors have increasingly more sales channels for crops and waste flows. Waste flows are now often used for energy and animal feed. Co-production makes it possible for some of these waste flows to be used for high-quality products.
- Biomass opens the door to new investments and employment in the industry: new factories (or expansion of existing factories) for advanced biofuels, chemicals and materials. The number of investments in the bio-based economy is increasing worldwide, but hardly in the Netherlands. In order to secure these investments for the Netherlands, there is a strong need to support flagship projects. Scaling up to a commercial scale of operations, construction and start-up involve significantly higher risks and costs than investing in a subsequent factory. This is because learning curves have to be completed and higher risk premiums need to be paid for the capital and loans to finance the first factory.

In order to take advantage of these opportunities, it is important to make it through the start-up phase of the bio-based economy and support market players in this regard. Producers of sustainable bio-based products indicate that market demand is still lacking or very limited. The reasons for this include the unfamiliarity of the market with new products and the higher cost price (because environmental costs

are not included in existing prices and a learning curve still needs to be completed for the new production processes).

The government can assist the market to move beyond this stalemate by making these products economically more attractive or even by making certain applications compulsory.

The measures below are needed to take advantage of these opportunities.
In the short term:

- encouraging investment in new production capacity in the Netherlands for chemicals and materials;
- following developments abroad in relation to a tax on fossil resources or tax credits on bio-based end products;
- adjusting policy when this turns out to be demonstrably less than ideal for the combined policy objectives (adaptive policy).

In the long term:

- high-quality biomass applications through product policy at EU level. This can be done in three ways:
  - phasing out harmful substances if there is a good bio-based alternative;
  - encouraging the use of bio-based and biodegradable products in applications that leak uncontrollably into the environment (lubricants, agricultural plastics and drilling fluids):
  - encouraging the use of bio-based products that have a better sustainability and health rating than current alternatives (plasticisers, ingredients for cosmetics and materials for construction, packaging and the automotive industry).

4.4. Innovation

In the short term, it is important for the Netherlands to make concerted efforts in developing biorefining technology, because this is indispensable for the cascaded use of biomass. Furthermore, it is necessary to ensure that innovations are really implemented in the Netherlands. In the long term, there is a need for alternative protein production (through the cultivation of algae and seaweed, for instance) in order to strongly reduce the amount of land required for fodder. Studies also point to the importance of negative CO_2 emissions for staying within the climate policy objective. Innovation relating to CO_2 as a raw material and bioenergy carbon capture storage (BECCS) is essential for this purpose.

The innovation policy for biomass can be strengthened on the following points:

- implementing the agenda of the Top Consortium for Knowledge and Innovation in the Biobased Economy (TKI-BBE) for 2015-2027;
- an additional incentive for innovations that are very important in the long term (including BECCS, alternative protein production, breakthrough technologies such as deep eutectic solvents and direct conversion of sunlight into chemical building blocks and fuels);
- extending the scope of the innovation policy to include investments in flagship projects (also see section 4.3).

4.5. Conclusion

In 2016, further details will be provided in the umbrella programme on the circular economy that has been promised to the House of Representatives. This will be in conjunction with the activities relating to the *Voedselvisie* (vision for food), *het Energierapport* (the Dutch report on progress in sustainable energy), *Groene Groei* (the Dutch green growth policy) and the implementation plan for the sustainable fuel vision with LEF, as well as the talks scheduled in that regard.

Appendix 1: Background to biomass supply and demand in 2030

Current biomass use in the Netherlands

Recent biomass use in the Netherlands is looked at first (Figure 4[28]). The figures are provided in metric tonnes (MT) and joules (J) because the agricultural sectors uses tonnes and the energy sector expresses quantities in joules.

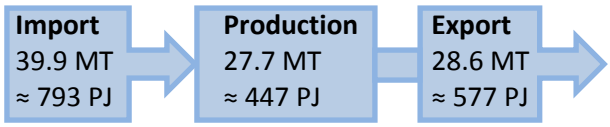

Figure 4. Biomass availability in the Netherlands in MT of dry matter and in petajoules (PJ)

This figure provides a good overview of the import, domestic production and export of biomass. The figures relate to all types of biomass: food (such as vegetables, fruit and meat), cereals and oilseeds, paper and cardboard, wood and waste flows. The total biomass available for processing in the Netherlands is 67.6 MT.

In 2012, 6.6 MT of biomass was applied to material use (wood, paper, oils and fats) and 10.2 MT for energy use (of which 2.3 MT was again exported in the form of biofuels). On a net basis, around 14.5 MT of biomass was thus used in 2012 for materials and energy[29,30]. Figure 5 shows a breakdown of biomass use in the Netherlands by type of application and type of biomass.

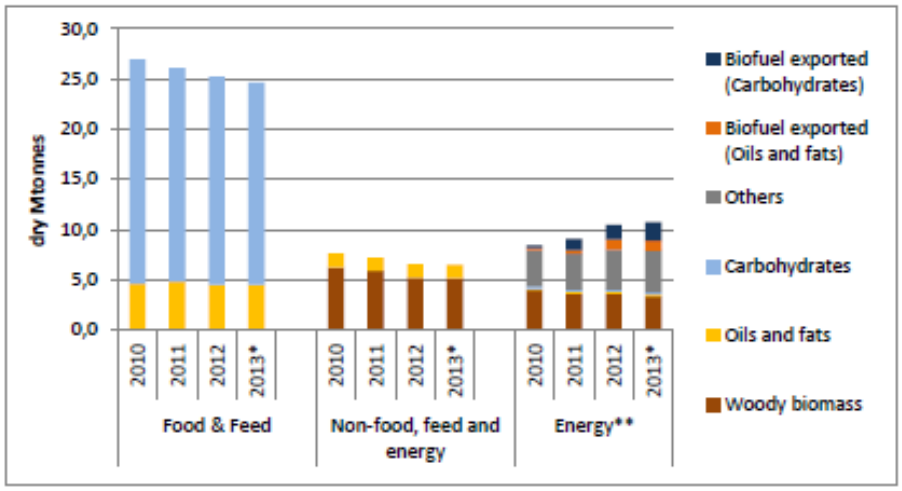

Figure 5. Final consumption of different types of biomass in the Netherlands, broken down in application, measured from the first point where biomass is applied in the chain/sector

[28] Wageningen-UR 2010: Monitoring of green raw materials. Report for the green raw materials platform
[29] Netherlands Enterprise Agency (RVO) 2014: Monitoring biobased economy in Nederland 2014
[30] Copernicus Institute, Utrecht University 2014: Sustainable Biomass and Bioenergy in the Netherlands: Report 2014

Developments in biomass supply towards 2030
Despite the many studies into the availability of biomass, future biomass supply for non-food applications is difficult to predict. It is therefore necessary to work with ranges, uncertainties in future scenarios and projections of assessment agencies, as well as to take alternatives and technological breakthroughs into account.

An analysis of a number of leading studies was carried out for the sustainable fuel vision with LEF, which was drawn up as part of the Energy Agreement of the Social and Economic Council of the Netherlands (SER) in 2014[31]. Based on research of the Netherlands Environmental Assessment Agency (PBL)[32] a range has been determined for global non-food biomass supply of 50-150 exajoules (EJ) in 2030 (including waste flows from agriculture and forestry).

What part of global biomass will become available?
To get a feel for what part of this global biomass could become available to the Netherlands in 2030, the sustainable fuel vision with LEF has converted the global supply into availability for the Netherlands. This conversion has resulted in 120 PJ for the bottom of the range (per-capital allocation of the low prediction of 50 EJ[33]) and 780 PJ for the top of the range (allocation according to the share in primary energy consumption of the high prediction of 150 EJ).
This range was then adjusted in the fuel vision by deducting a national provision for international aviation and shipping. The range including that adjustment is 115 PJ – 753 PJ.

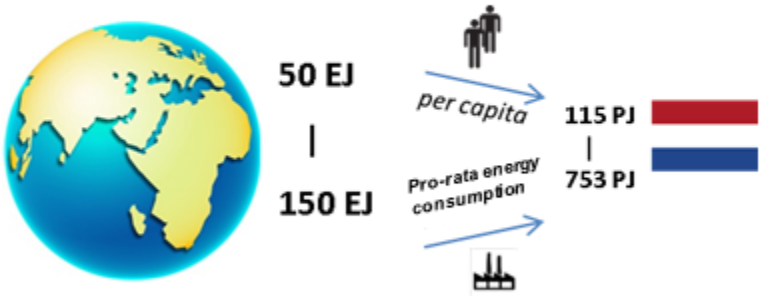

Figure 6. Apportionment of global availability according to available biomass for the Netherlands

At the end of 2014, the Dutch Sustainable Biomass Commission (Corbey Commissie) also analysed the quantity of biomass that could become available for export to the Netherlands[34]. The Commission took a global supply of 100 EJ in 2050 as the starting point for its analysis. This is in the middle of the above range, but relates to 2050 instead of 2030.

With an average biomass energy content of 17 GJ/tonne, the range applied for the Netherlands amounts to 7 MT of biomass (dry matter) for the bottom of the range and 45 MT for the top of the range. This supply relates to biomass that is available for non-food applications, such as electricity, heating, transport fuels and raw materials for chemicals and materials.

[31] SER 2014: Sustainable fuel vision with LEF
[32] Netherlands Environmental Assessment Agency (PBL) 2013: Biomassa: wensen en grenzen
[33] This approach is based on each inhabitant in the world being allocated the same quantity of biomass.
[34] Biomass Sustainability Issues Committee 2014: Appendix 1 Biomass. Supply and demand in the Netherlands in 2030, and Appendix 2: Availability of biomass for export to the Netherlands. Memoranda detailing the Bioeconomy Vision 2030 for the Commission.

Ranges, variables and scenarios
It is unlikely that biomass supply will be at the bottom or top of the range in practice because these represent the most extreme approaches: from very cautious and averse to risk, to very hopeful and with full confidence in technological developments and international cooperation.

The low estimates are based on strict sustainability requirements for the production of biomass and are very conservative in their evaluation of the possibilities for increasing biomass supply in future. The high estimates are based on what is possible from a biophysical perspective and assume that there will be international agreements and standards on sustainability. Achieving a biomass supply in the vicinity of these high estimates will be possible only with concerted policy efforts.

Without a targeted policy for increasing the biomass supply, this will be at the bottom of the range by 2030.

Efficiency of biomass production
Local agricultural productivity, particularly outside Western Europe, is an important factor. Bottlenecks in food supply are to be expected if global productivity remains the same. If productivity in developing countries and emerging economies can develop to Western levels, there will be adequate biomass to meet demand from all applications.

In addition to agricultural productivity, the development of biorefining technology is of major importance for the optimal use and processing of biomass that is farmed once (known as cascading).

The cost level of production, transport, processing and application also plays a part in the question of how much biomass becomes available for transport. It will often be too expensive to ship agricultural waste flows to the Netherlands. Access to commercial chains is also important for availability in the Netherlands.

Efficiency of the food chain
The efficiency of food production is a factor that should not be underestimated. Some 1.3 billion tonnes of food are presently wasted worldwide, a third of total production[35]. Optimisation of the food chain is generally not part of studies into the availability of biomass.
Availability also depends on the requirements set for the biomass.

The development of the global diet plays a role as land requirements for meat are generally greater than for fish or a vegetarian diet. Figure 7 provides an overview of the global biomass requirements for each sector[36]. This figure shows that more than half of the global biomass demand is currently related to the production of animal feed. In the long term, developments aimed at protein production with a more restricted land requirement will be important.

[35] FAO 2011: Global food losses and waste.
[36] NOVA 2014: Environmental Innovation Policy – Greater resource efficiency and climate protection through the sustainable material use of biomass

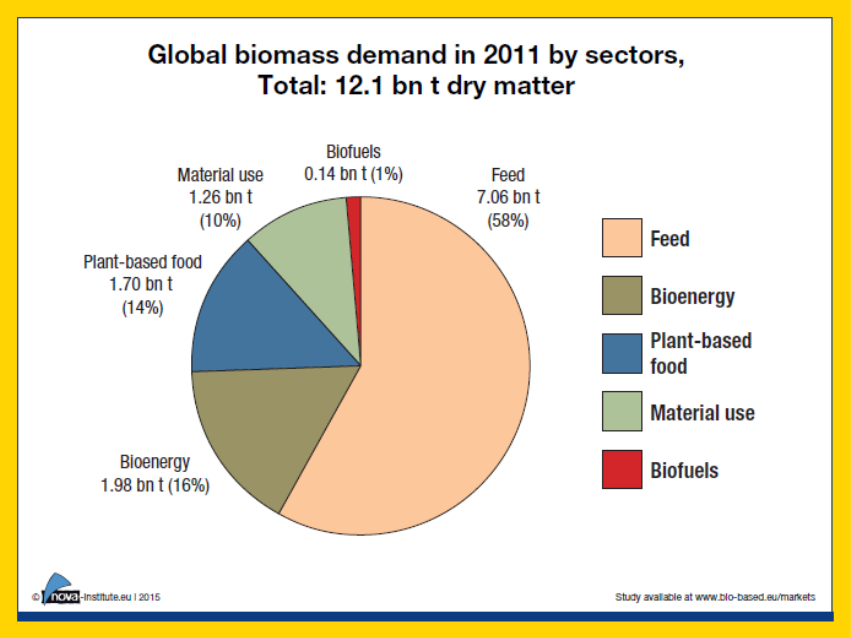

Figure 7. Global use of biomass harvested from forests and agriculture in 2011

There is currently no shortage of biomass. The opportunities for increasing supply are still significant, particularly in developing countries, but must also be looked at in relation to the need for further sustainability and preserving or rehabilitating healthy ecosystems in many other areas, as well as in relation to building the capacity of governments to promote sustainable production and avoid negative social effects. There are also still growth opportunities for biomass production in Europe, particularly Eastern Europe. The advantage of Europe is that it is simpler to guarantee the sustainable production of biomass.

Expected biomass demand for electricity and heating

Institutes such as the Energy research Centre of the Netherlands (ECN), the Netherlands Environmental Assessment Agency (PBL), Statistics Netherlands (CBS) and the Netherlands Enterprise Agency (RVO) have made estimates of energy consumption in 2030 on the basis of existing and proposed policy in the National Energy Outlook (NEV 2015)[37]. NEV 2015 estimates the demand for electricity and heating on the basis of biomass for 2030 at 130 PJ (final energy). These figures are based on an extrapolation of the policy that has been adopted until 2023[38]. According to the NEV, renewable energy will certainly need to be stimulated further after 2023. The question as to where the additional growth must come from still remains relatively open, as do the relationships among solar energy, wind, biomass and other sources. The implementation of the Van Weyenberg/Van Veldhoven motion (Parliamentary Document 34302, no. 99) for drawing up a plan to phase out coal power plants could have an effect on biomass use in the Netherlands for renewable energy as we approach 2030. This aspect will be included in the project that the government starts to implement this motion (Parliamentary Document 30196, no. 380).

[37] Energy research Centre of the Netherlands (ECN), PBL Netherlands Environmental Assessment Agency (PBL), Statistics Netherlands (CBS), Netherlands Enterprise Agency (RVO) 2015: National Energy Outlook (NEV) 2015

[38] The Energy Agreement for Sustainable Growth (*Energieakkoord*) states in respect of 2020 that a maximum of 25 PJ of biomass will be used for large-scale co-firing, including for the production of electricity. Biomass use is also expected for the decentralised generation of electricity and heating. The total expectation for decentralised energy is 186 PJ, but this energy can also come from other decentralised sources such as solar boilers, heat pumps and geothermal heat. However, it is expected that most of this 186 PJ in 2023 will come from bioenergy applications such as biogas, bioheat and bio-CHP.

Expected biomass demand for biofuels
NEV 2015 estimates the biomass demand for biofuels in 2030 to be 34 PJ based on existing and proposed policy. The share is consistently assumed for the period after 2020 by presuming that the obligation to use renewable energy in transport will continue to exist. A decision has yet to be made in this regard. In the action programme of the Fuel Vision, the different modes of transport have set an ambition, independently of each other, of 95 PJ for 2030 (92 PJ for national road haulage and 3 PJ for inland waterway shipping)[39].

Expected biomass demand for chemicals and materials
The Monitoring Biobased Economy[40] of the Netherlands Enterprise Agency (RVO) shows that biomass use for materials (paper and wood products) in 2013 was 5.1 MT, which is approximately 87 PJ. It is assumed that biomass use for paper and wood products will remain the same for 2030.

Growth in the use of biomass as a raw material is expected in the chemical industry. The Association of the Dutch Chemical Industry (VNCI) has expressed the ambition for the industry it represents to be the replacement of 15% of fossil resources by 2030, which corresponds to 43.5 PJ of avoided fossil resources. According to VNCI, this is a realistic estimate of the potential, adjusted for risks. The figures are based on an extrapolation of current projects and on new projects. At European level, the Biobased Industries Consortium (BIC) formulated the replacement of 30% of fossil resources by 2030 as a strategic target for the chemicals and materials sector. This amounts to approximately 87 PJ of avoided fossil use for the Netherlands.

The total biomass demand for domestic use of paper, cardboard, wood products and chemicals is thus 130 PJ (VNCI ambition) – 174 PJ (BIC ambition).

Comparison of biomass supply and demand in 2030
The trend in biomass demand for each application is shown in Figure 8.

- For electricity and heating, the current policy of the National Energy Outlook (NEV)[41] (without the additional policy after 2020/2023) has been extrapolated for 2030.
- In relation to transport, the low curve shows the final biomass consumption for transport based on an extrapolation of the current policy (NEV). The high curve shows the sector's level of ambition in 2030 (sustainable fuel vision with LEF).
- Two levels of ambitions are also shown for the avoided use of fossil resources for chemicals: the ambition of the Association of the Dutch Chemical Industry (VNCI) to replace 15% of fossil resources in chemicals (VNCI, low curve) and the ambition of the European Biobased Industries Consortium, which is based on 30% replacement (BIC, high curve) [42].

[39] The total ambition for biofuels is 179 PJ, distributed among 92 PJ for road haulage, 20 PJ for shipping and 70 PJ for aviation. The main difference between the sectoral ambition and the NEV prediction is that the NEV figure does not include any intensifying of policy or the share for shipping and aviation. Biofuels for international sectors are bunkered in the Netherlands but are not included in the national NEV figures. Biomass use in international sectors does not have to be at the expense of the national biomass budget.
[40] The Netherlands Enterprise Agency (RVO) 2014: Monitoring Biobased Economy
[41] Energy research Centre of the Netherlands (ECN), PBL Netherlands Environmental Assessment Agency (PBL), Statistics Netherlands (CBS), Netherlands Enterprise Agency (RVO) 2015: National Energy Outlook (NEV) 2015
[42] Biomass use for materials (paper, cardboard and wood) is included in the estimate of how much biomass is needed for non-food purposes. It is not included as avoided fossil use in petajoules (PJ) because these materials are already bio-based.

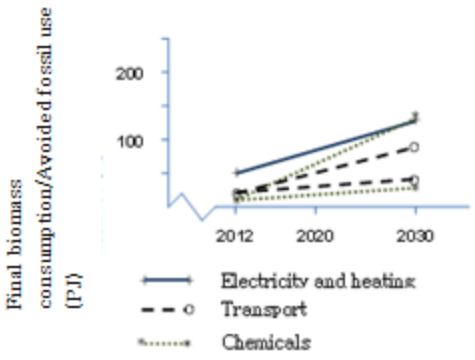

Figure 8. Development of biomass consumption in the Netherlands for each sector, shown in final consumption for electricity, heat and biofuels and in avoided fossil resources for chemicals.

Table 2 shows the comparison of biomass supply and demand in 2030. This table includes the biomass needs of the paper and cardboard industry under the chemicals and materials sector. It should be noted that biomass demand is converted from final consumption/avoided fossil use to required biomass, because there are always yield losses when biomass is converted into a final application. The applied yields are based on weighted averages as calculated by the Commission[43].

Application [PJ]	Electricity & heating [PJ]	Biofuels [PJ]	Chemicals & materials [PJ]	Total	
				[PJ]	[MT]
Supply					
Bottom of range				115	7
Top of range				753	44
Demand					
Final use ambition	130[a] (final)	34[a]-95[b] (final)	130-174[c] (avoided)		
Required biomass in PJ	200	59-164	173-232	432-596	25-35

Table 2 Comparison of biomass supply and demand per application in the Netherlands for 2030

a NEV 2015, final energy consumption. Extrapolation of existing policy for 2020/2023. The applied biomass yield is the weighted average of biomass conversion into electricity and heat: 65%.

b Sustainable fuel vision with LEF. Applied yield: 58%.

c Range of VNCI and BIC visions plus biomass use for paper and wood applications. Applied yield: 75%[44].

The expected biomass demand in 2030 lies somewhat above the middle of the supply range. Although this may seem reassuring, achieving a sustainable, mid-range biomass supply will still require significant policy efforts at national, European and global level. If we compare the expected demand in 2030 (25-35 MT of biomass) with current biomass use for energy and materials (14.5 MT in 2012), it is clear that biomass use is still going to increase sharply in the Netherlands.

[43] Dutch Sustainable Biomass Commission (Corbey Commissie) 2014: Memorandum detailing the Bioeconomy Vision 2030 for the Dutch Sustainable Biomass Commission (Corbey Commissie). Appendix 1: Biomass. Supply and demand in the Netherlands in 2030

[44] Chemical yield depends strongly on the product for which biomass is used. Particularly in the case of functionalised molecules, yields of >100% are also possible because the bio-based process routes are significantly more favourable.

A nuance is therefore appropriate. A crop can be used for different purposes, by dividing it into different components with different applications (cascading in function) or by using the different components after each other (cascading in time). Waste flows that are released during the production of food, animal feed, chemicals and biofuels can be used for chemicals, materials and energy use. However, it is not easy to establish how cascading and the use of waste flows affect the available supply, because this is not always clearly described in the underlying source material.

Appendix 2: Contribution of the parties involved

The chapters have been discussed in detail and commented on by experts. These experts have looked at the accuracy of the information. The experts are from the Energy Research Centre of the Netherlands (ECN), the Netherlands Environmental Assessment Agency (PBL) and Wageningen, Groningen, Utrecht and Delft Universities.
The first three chapters have also been discussed in two dialogue sessions and stakeholders have provided their commentary. This input was also the basis for Chapter 4. The following organisations were involved:
the Association of the Dutch Chemical Industry (VNCI), the Dutch Edible Oils and Fats Producers Association (VERNOF), the Product Board for Margarine, Fats and Oils (MVO), the Dutch Federation of Agricultural and Horticultural Organisations (LTO), the Top Consortium for Knowledge and Innovation in the Biobased Economy (TKI-BBE), the Dutch Biorefinery Cluster, Nature and Environment, Biomassa Beeks, DSM, Avantium, Vattenfall, Energie-Nederland, Dutch Wood Platform (Platform Hout Nederland), Bioenergy Platform (Platform Bio-Energie), Sustainable Energy Dome (Duurzame Energie Koepel), CE Delft, the Rathenau Institute and the Biorenewables Business Platform.

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