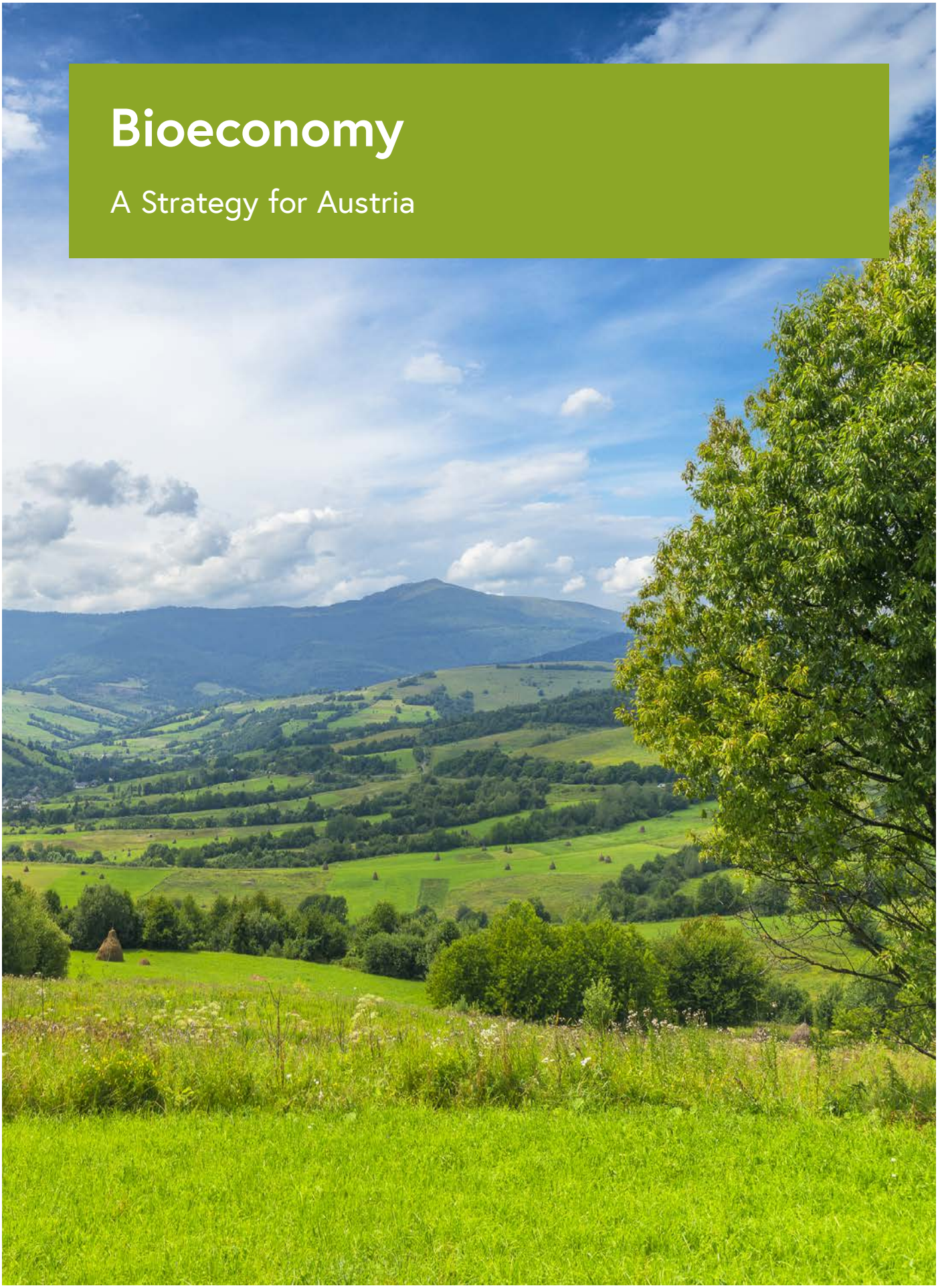
Federal Ministry
Republic of Austria
Sustainability and Tourism

Federal Ministry
Republic of Austria
Education, Science
and Research

Federal Ministry
Republic of Austria
Transport, Innovation
and Technology

Bioeconomy

A Strategy for Austria



Bioeconomy

A Strategy for Austria

Vienna 2019

Imprint

Media proprietor and publisher:
Federal Ministry for Sustainability and Tourism, Stubenring, Vienna
www.bmnt.gv.at
Federal Ministry of Education, Science and Research, Minoritenplatz, Vienna
www.bmbwf.gv.at
Federal Ministry for Transport, Innovation and Technology, Radetzkystraße, Vienna
www.bmvit.gv.at

Editorial staff: Rene Albert, Karolina Begusch-Pfefferkorn, Georg Kanz, Gottfried Lamers, Christian Plas, Isabella Plimon, Hubertus Schmid-Schmidsfelden, Lorenz Strimitzer, Katrin Völk, Andreas Weber, Bernhard Zenz, Theodor Zillner
The responsible Ministries would like to sincerely thank all the members of the Bioeconomy Platform for the valuable contributions and support in this project.
Design: Lisa Lehensteiner
English translation: Bao An Phan Quoc
Picture credits: Oxana Gracheva/shutterstock (Cover), BMNT/Paul Gruber (p. 7), BMNT/BKA (p. 8), BMNT/Martin Lusser (p. 9), BMNT/Stefan Leitner (p. 10, p. 67), Stock Rocket/shutterstock (p. 21), BMNT/Alexander Haiden (p. 22, p. 50), Simply day/shutterstock (p. 29), BMNT/bah (p. 35), Louis Hiemstra/istock (p. 41), Toa55/istock (p. 45), Main_sail/istock (p. 49), Büro HoHo (p. 58), loraks/Fotolia (p. 63), g-stockstudio/istock (p. 64)

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Preface Elisabeth Köstinger

Elisabeth Köstinger
Federal Minister for
Sustainability and Tourism

Global environmental damage, climate change and the growing scarcity of natural resources are closely linked to the use of fossil raw materials. Thus, the development of a bioeconomy strategy for Austria is a crucial step towards achieving the objectives of the Paris Agreement. "Bioeconomy" stands for an economic approach that aims to replace fossil resources with renewable resources in as many areas and applications as possible. It encompasses all industrial and economic sectors that produce, process, handle or use biological resources.

Through the use of regional, renewable raw materials, the bioeconomy offers a multitude of new opportunities to Austria as a business location. In this context, we are already well-positioned to build on strong (bioeconomic) value chains. In the present Bioeconomy Strategy we have identified the most important fields of action for converting the fossil economic system to a bioeconomy.

- We need yield increases in agriculture and forestry, new raw materials from waste management and a follow-up of research approaches in water management.
- However, we also need the associated land areas and must not repurpose and use them for construction to the same extent.
- We need new manufacturing processes in the industry to produce new materials from residuals and by-products.
- And above all, we need a more conscious and efficient use of raw materials.

The most important thing, however, is to motivate you as consumers to buy these new products and to be open to being convinced of the quality and the advantages of domestic and bio-based raw materials. And we need you personally to facilitate the breakthrough of this new climate-friendly economic system.

Come join us!

Yours,
Elisabeth Köstinger
Federal Minister for Sustainability and Tourism

Preface Norbert Hofer

Norbert Hofer
Federal Minister for
Transport, Innovation and
Technology

We are facing tremendous changes. The decarbonisation of our society requires not only a shift to renewable energy sources, but also to highly efficient energy and resource management. In this context, the bioeconomy with its focus on renewable raw materials and biogenic material cycles plays a key role, a fact which is also reflected in the Integrated Climate and Energy Strategy #mission2030.

Aspects of the bioeconomy have long been an important focus of research and innovation policy. Bioenergy research and the question of how our economy can realise innovative products and manufacturing processes based on renewable raw materials have been for years at the centre of many RTI initiatives.

For Austria as a business location, the significance of the so-called bio-based industry will increase notably in the future. Targeted development and relevant roll-out will reduce dependency on fossil fuels and energy sources while adding value, for instance, for chemical products, composite materials, fuels or energy in the region.

All in all, the bioeconomy offers the great opportunity to successfully develop markets at home and abroad, to generate jobs in the region and, at the same time, to promote the decarbonisation of society through sustainable economic activity. For us to succeed, business, research and consumers must pull together.

Yours,
Norbert Hofer
Federal Minister for Transport, Innovation and Technology

Preface Heinz Faßmann

Heinz Faßmann
Federal Minister for Education, Science and Research

We are facing one of the central questions of the future with respect to the "bioeconomy": How can we, as a society, deal sustainably and responsibly with natural resources and, at the same time, operate successfully? New approaches and solutions are required – not merely of a technical nature. For the transformation towards a sustainable economy we need the systemic linking of technical and scientific aspects with political and social views, which must also be considered in a global context.

Research, Technology and Innovation (RTI) are essential pillars of a successful bioeconomy. Austria has already positioned itself in recent years as a competent player for bioeconomy. One third of the Austrian universities are actively invested in this field in one form or another. A good example is the University of Natural Resources and Life Sciences Vienna. It proactively helped to shape the international developing trend at an early stage and envisages the establishment of a Centre for Bioeconomy in 2019, which will serve as a contact point for stakeholders from society, business and politics. The outstanding performance of Austrian research institutions is also noticeable in their participation in H2020 projects with a focus on bioeconomy.

The Austrian Bioeconomy RTI Strategy, which is based on a broad involvement of stakeholders, focuses on the scientific and technological fundamentals, with the aim of positioning Austria globally as a bioeconomy RTI competence location. Due to the high importance of RTI for bio-based and sustainable economic activity, experts from science and research are involved in the "Platform Bioeconomy" and contribute RTI potential and needs to this overall strategy.

The prerequisite for the successful implementation of the Bioeconomy Strategy are adequate RTI instruments, which cover all innovation phases and can be easily combined with each other. Instruments for fundamental research and for the development of research infrastructures are funded via the global budget of universities and non-university research institutions, making my ministry a major contributor to advancing RTI in the bioeconomy area and increasing international visibility in this emerging field.

Yours,
Heinz Faßmann
Federal Minister for Education, Science and Research

1 Requirements for a Bioeconomy Strategy

1.1 Vision

Bioeconomy stands for an economic concept that aims to replace fossil resources (raw materials and energy sources) with renewable raw materials in as many areas and applications as possible. It covers all industrial and economic sectors that produce, process, handle or use biological resources. The bioeconomy thus offers a great opportunity to tackle global challenges, such as increasing climate change, food and water scarcity or growing environmental pollution, while at the same time strengthening economic development. In order to make the step towards the implementation of the hitherto knowledge-based bioeconomy – involving the relevant stakeholders and using all political instruments –, the Government has undertaken in the government programme and #mission2030 to create a strategy for bioeconomy in Austria. This Austrian Bioeconomy Strategy is intended to be an essential cornerstone of the Climate and Energy Strategy and to support the decarbonisation of the economic system.

1.2 Mission

The concept of the bioeconomy includes raw material sources (agriculture and forestry, water management and waste) as well as the use of these bio-based raw materials (food and feed, chemicals, materials, energy). The objective is an economic system that reconciles technology and ecology and interacts with the requirements and developments of the European research and economic area.

These goals can only be achieved if, in addition to the decarbonisation of the energy system, fossil raw materials are largely replaced in all everyday products. To ensure this, three levels must be addressed:

- Increase of efficiency at all levels of the value chain, from raw material generation, logistics and material use to energy recovery, as well as rethinking of consumer behaviour with regard to extending the lifetime of products
- Exploitation of all renewable raw material sources through the use of residues, by-products, wastes and the production of new raw materials, such as algae
- Highlighting the opportunities for replacing fossil with renewable, bio-based resources

1.2.1 The Bioeconomy Strategy

The process of converting the current fossil economic system – being the #mission2030 lighthouse project – should be initiated and supported by a bioeconomy strategy. The aim is to strengthen the competitiveness of the Austrian economy, safeguard the supply of quality food, create jobs in rural areas, minimise negative environmental effects, reduce greenhouse gas emissions and, at the same time, encourage societal rethinking.

The process of developing the Bioeconomy Strategy was launched in May 2018 with the adoption of the Integrated Climate and Energy strategy #mission2030 by the ministries involved (BMNT and BMVIT) in cooperation with the BMBWF. In the following months, the strategy was drafted together with recognised experts involving the general public in two online consultations. In November 2018, the public was informed during a conference on the state of play of the process, and the impact of the revised EU Bioeconomy Strategy on Austria was discussed. Based on this Austrian Bioeconomy Strategy, an action plan will be devised in 2019 to implement it.

1.2.2 Objectives of the Bioeconomy Strategy

The objective of the national Bioeconomy Strategy is to identify concrete measures for the further establishment of the bioeconomy in Austria in order to generate sustained growth spurts for bio-based products, bioenergy and related technologies and services. The Bioeconomy Strategy and the Action Plan based on it are both aimed at all relevant players in agriculture, forestry, water and waste management, processing and especially retail sectors, as well as consumers who should benefit from the advantages of bio-based products. The graphic below shows the target areas of the Austrian Bioeconomy Strategy.

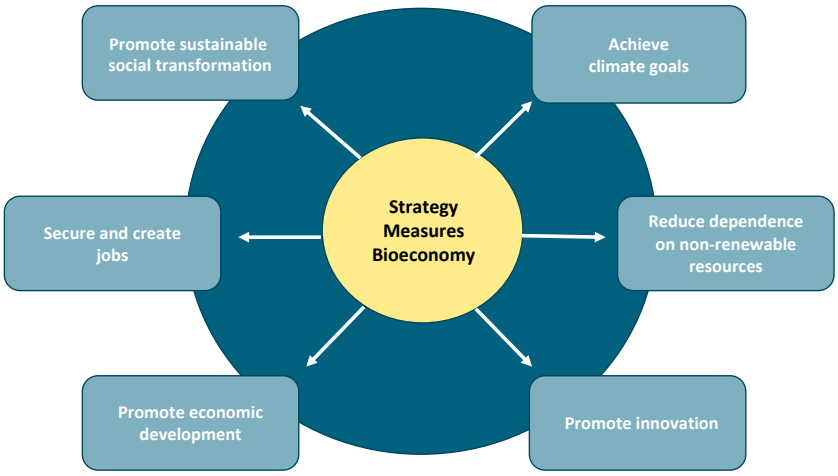


Figure 1: Presentation of the Target Areas of the Austrian Bioeconomy Strategy

These strategic objectives have been broken down into operational targets by the experts of the Bioeconomy Platform, which will enable an effective transition to the actions in the Action Plan. These operational objectives were confirmed and partially quantified in a public web survey in October 2018.

a) Achieving the Climate Goals

As a vital measure of the Austrian Climate and Energy Strategy, the national Bioeconomy Strategy makes a significant contribution to achieving climate goals. The bioeconomy has a double effect on the climate: on the one hand, carbon sequestration in renewable raw materials is associated with CO_2 reductions in the atmosphere, and on the other, bioenergy is one of the pillars of decarbonisation of the energy system.

The implementation of the national Bioeconomy Strategy decisively supports the achievement of the Austrian climate targets. The goal is to make a significant contribution to greenhouse gas emission savings by 2030 through the bio-based economy.

b) Reducing Dependence on Non-renewable Resources

In order to reduce dependence on non-renewable, mostly imported raw materials, the share of renewable raw materials in the total use of raw materials must be significantly increased by 2030.[1] This can be done by strengthening existing sectors of the economy, supporting innovative technologies and services, promoting networking and knowledge transfer, raising awareness and creating public acceptance concerning bio-based products and services.

However, substituting all fossil materials with bio-based materials would require between 0.9 and 3.8 million hectares of land.[1] Currently, about 7.3 million hectares are used for agricultural and silvicultural purposes in Austria.[2] These figures show that a mere substitution of fossil raw materials with additional biomass production is not possible and that sustainable intensification of agricultural and forestry production will, therefore, be a key success factor. According to experts, it is possible to increase production output by 20 percent, but it also requires a large number of measures to provide the bio-based raw materials, while at the same time increasing the efficiency of the materials used through circular economy and improved cascading use options. The strategy pursues the goal of significantly reducing annual soil sealing by 2030 in cooperation with the Austrian Federal Provinces. Only then can valuable land for agricultural and forestry production be preserved.

- The soil sealing in Austria is to be massively reduced by 2030.
- The contribution to economic output from renewable raw materials is to be significantly increased by 2030 in Austria compared to 2012.

c) Promoting Innovation

Austria should continue to be a pioneer in the implementation of innovative, bioeconomy-relevant concepts, services and goods. Therefore, the policy strategy aims to increase the number of scientific publications, transdisciplinary projects and patents in the field of bioeconomics - e.g. biorefinery concepts, efficiency measures for resources, new products and services. In addition to the close cooperation with scientific institutes, moreover, the implementation of innovations is to be pursued more persistently through demonstration projects. In this context it is aimed to significantly raise the number of application patents in Austria.

- By 2030, the number of scientific publications as well as transdisciplinary projects and patents in the area of bioeconomics (e.g. biorefineries, resource efficiency, new products and services, etc.) is to be doubled compared to 2017.

[1] https://www.klimaaktiv.at/erneuerbare/nawaro_markt/aktionsplan.html
[2] BMNT: Daten, Zahlen, Fakten 2018, Seite 30

- By 2030, the number of bioeconomic application patents (such as biorefineries, resource efficiency, new products and services, etc.) is expected to be doubled from 2017 levels.

d) Promoting Economic Development

Austria as a business location should, in the long term, position itself as an exporter of highly developed, innovative bio-based products and services. At the same time, Austria's domestic economy will in future be significantly supported by the material and energetic use of renewable local raw materials. The Bioeconomy Strategy aims to further the mobilisation of private capital and thereby also strengthen the Austrian financial market.

- By 2030, the proportion of investments in bioeconomy companies of all sizes from private sources is to be increased considerably.
- By 2030, Austria will have national accounts, which will include monetary variables as well as other parameters. The bioeconomy should be an important component in increasing economic performance and improving other non-monetary outcomes, e.g. health, environment or education. The goal is to boost value creation in several dimensions: economic performance, as well as social and natural capital.

e) Securing and Creating Jobs

The production and processing of renewable raw materials into high-quality products represents a substantial economic development potential for rural areas. As early as 2016, Statistics Austria reported more than 183,000 workers in the environmental sector in Austria. The objectives of this strategy and the promotion of the bioeconomy are aimed at further accelerating the existing growth of green jobs.

- By 2030, additional jobs will be created in the bioeconomy.

f) Promoting Sustainable Societal Transformation

In principle, new concepts and solutions are required for the bioeconomy – and not just technical ones. Therefore, in addition to the advancement of technological development, it is of central importance to link systemically technical and scientific aspects with economic perspectives as well as political and social views with ecological and ethical positions. It is also crucial to transfer the knowledge about the bioeconomy to the broader public, so that people will understand and support the goals, measures and recommendations for action. Only in this way can a profound change in lifestyle be achieved.

- The knowledge about the bioeconomy is so widespread in the population by 2030 that people are able to form a qualified opinion on the content of the topic.
- Bioeconomic topics are comprehensively anchored in education and research until 2030.

1.2.3 Reference to Existing Strategies

The Austrian Bioeconomy Strategy can build on extensive preparatory work in Austria. A non-exhaustive list of the existing strategies and documents can be found in the "Mission Statement Bioeconomy – A Strategy for Austria".[3]

a) The EU Bioeconomy Strategy 2012[4]

As part of the Europe 2020 strategy, the European Commission has called for the development of the bioeconomy sector. The publication "Innovating for Sustainable Growth: A Bioeconomy for Europe" in 2012 proposes a bioeconomy strategy at European level, which primarily provided for the implementation of structures and sufficient research funding. The European Bioeconomy Strategy views food and nutritional security as the top priority and at the time already mentioned sustainability as a decisive factor in dealing with future challenges.

b) Revised EU Bioeconomy Strategy 2018[5]

The revision aims to further develop the Bioeconomy Strategy to strengthen market integration and stimulate the modernisation of the economy.

What is new is the strong focus on biodiversity conservation and the promotion of healthy ecosystems, which are considered key in dealing with climate change.

According to the European Commission, a doubling of demand for bio-based products is expected by 2030. For this reason, supportive measures are also recommended to the Member States to ensure innovation and financing thereof.

To support these concerns, the European Commission proposes three main areas of action:

[3] https://www.bmnt.gv.at/umwelt/klimaschutz/Bio-konomie/Mission-Statement-Bio-konomie.html
[4] https://publications.europa.eu/en/publication-detail/-/publication/1f0d8515-8dc0-4435-ba53-9570e47dbd51
[5] https://publications.europa.eu/en/publication-detail/-/publication/f57a0695-04d9-11e9-adde-01aa75ed71a1/language-en/format-PDF/source-84695789

1. Strengthening and expanding the bio-based economy by supporting innovative technologies, facilitating investments and developing markets
2. Europe-wide introduction of national and regional strategic plans
3. Operating the bioeconomy within its natural limits

The Austrian Bioeconomy Strategy is based in many aspects on the revised European Bioeconomy Strategy.

c) Agenda 2030[6]

A knowledge-based bioeconomy combines a multitude of raw materials, techniques, procedures, applications and products with a wide variety of topics. These in turn affect people, natural spaces, agriculture, forestry, industry and society. It is thus necessary to assess these interactions and to largely exclude negative consequences.

This is why the diverse bioeconomic issues have been aligned with the objectives of the 2030 Agenda for Sustainable Development, which, with its 17 Sustainable Development Goals, was adopted by all 193 United Nation Member States in 2015 and is now being implemented at national, regional and international levels until 2030. Through the Government Programme 2017–2022 all federal ministries were also tasked with taking the 2030 Agenda at national level into consideration.

Figure 2: Sustainable Development Goals of the UN (illustration: Stockholm Resilience Centre)

In the Chapter "Guidelines of the Bioeconomy", the reference to the sustainability goals is explained in more detail.

[6] https://www.bundeskanzleramt.gv.at/entwicklungsziele-agenda2030

1.3 Science and Research

esearch, technology and innovation (RTI)* are important pillars of a successful bioeconomy. In addition to technological development, the systemic combination of technical and scientific aspects with economic, political, social and ethical positions is a key success factor of the knowledge-based bioeconomy. Only in this way can transformation strategies for the reorientation of the economic system also be treated socio-politically. Accordingly, bioeconomic research – based on fundamental research – must be interdisciplinary and transdisciplinary, characterised by improved research cooperation and the principles of "open innovation" and "responsible science".

The Austrian working paper "Bioeconomy RTI Strategy" focuses on the scientific and technological fundamentals for the design of the bioeconomy with the aim of positioning Austria as an RTI location of excellence globally. In this context, nine thematic fields[7] are formulated, which are also considered in the Bioeconomy Strategy for Austria.

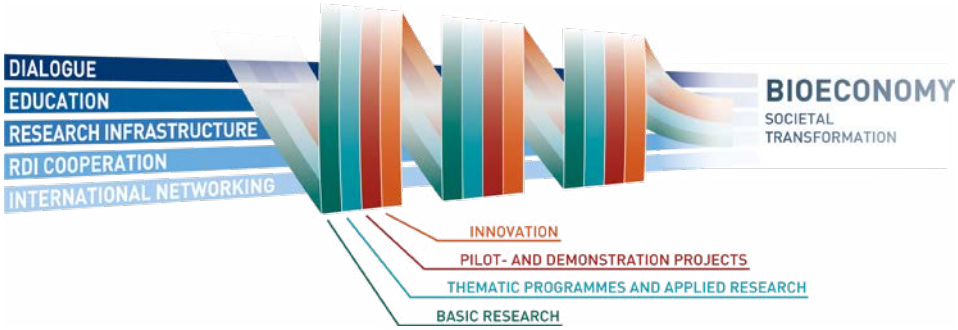


Figure 3: Interaction of RTI Instruments

1.3.1 Implementation-oriented RTI Instruments

The transformation towards a bioeconomy is a complex process. The prerequisite for the successful implementation of the bioeconomy is adequate RTI instruments covering all innovation phases. RTI instruments that can easily be combined must be available in the medium term (see Figure 3).

1.3.2 Bioeconomy-oriented Research Structures and Institutions

Today, Austria is an innovative and research-intensive country with a research quota of 3.14%, as of 2017. Thus, Austria has very well caught up with the "innovation leaders".

* RTI also stands for Research, Development and Innovation (RDI)

[7] https://www.bmvit.gv.at/service/publikationen/innovation/forschungspolitik/downloads/fti_strategie.pdf

Research on primary production and its conversion into recyclables has a long tradition in Austria, namely in the fields of initial production, food and feed, as well as non-food.

One of the hot spots of university research is the University of Natural Resources and Life Sciences Vienna (BOKU). It has been proactive in shaping the international development trend towards bioeconomy at an early stage and plans to set up a Centre of Bioeconomics in 2019 to coordinate bioeconomy research at BOKU and to serve as a contact point for business and political stakeholders.

One of the outstanding university facilities is the NAWI Graz Central Lab Bio-based Products, which focuses on bio-relevant materials and processes, and pools its expertise in Styria.

Bioeconomy is anchored in the university research institutions via the central instrument of performance agreements with the BMBWF. Non-university research institutions, universities of applied sciences, and research centres of the BMNT are also dedicated to bioeconomy research.

When it comes to finding solutions for major societal challenges, the humanities, social sciences and cultural studies are particularly challenged. This also applies to the European level with regard to the planned, more mission-oriented orientation of the next EU research and innovation framework programme, Horizon Europe.

In addition to specialised institutions, interdisciplinary socio-scientific research institutes are engaged in various ways in bioeconomy. The strategic development of the framework conditions for the humanities, social and cultural sciences envisages increasing the participation of these areas of science in the relevant research programmes.

1.3.3 Cooperation Platforms and Centres of Excellence

Besides institutional facilities cooperation platforms in particular are dedicated to the process chains “agriculture – food – biotechnology“ and “forestry – timber industry“ as well as the links between the resource flows. Under the guidance of highly qualified scientists, research groups are working in close contact with companies on innovative answers to practice-oriented and entrepreneurial research questions, for example within the framework of the Christian Doppler Laboratories (CD) and Josef Ressel Centres (JR). At present, 16 CD Laboratories and four JR Centres involving universities, universities of applied sciences and companies are working on bioeconomy-relevant topics.

Essential for the development of the bioeconomy are competence centres which strengthen the cooperation of science and industry. The COMET programme, which is jointly supported by the BMVIT and BMDW, builds on the competence centre programmes “Kplus“, “K_ind“ and “K_net“, which have been running since 1998. Within these programmes central research skills have been developed in 45 centres and networks, drawing a map of high-quality research hubs.

1.3.4 Industrial Research – Bio-based Industry

In the bio-based industry (BBI), cooperation of applied research organisations with companies is particularly important. Among other things, support programmes for applied research, such as "Production of the Future" with a focus on "Bio-based Industry", which emphasises the material use of biogenic raw materials and the networking of the individual players, are considered to be the forerunners of such cooperations. The initiative will drive industrial research and experimental technology development, enabling companies to further their international leadership role. The regional implementation of these projects will also reduce dependence on fossil fuels and boost regional added value. Austria is already at the forefront of selected specialisations in Europe, for example in textile, cellulose, construction and insulation, paper and polysaccharide applications (quantitative indicators for the bio-based industry in Austria).[8]

1.3.5 International Networking and Cooperation

In order to respond adequately to global challenges, international networking and cooperation are crucial for research institutions as well as for innovation-oriented companies. The creation of international networks in the Austrian research system is comprehensively supported by strategies of the Federal Government (amongst others: ERA roadmap), because the access of Austrian research institutions and companies to European funding programmes is essential for their success.

In bioeconomy-relevant fields, it has repeatedly been possible to illustrate Austria´s special strengths through international cooperation. As a result, Austrian solutions and technologies have been used worldwide in prestigious projects. For example, in November 2018, the BOKU joined forces with five other European universities to form a think tank entitled "European Bioeconomy University".

European research has been addressing the topic of "bioeconomy" since the Seventh Framework Programme (FP7) as part of its own thematic priority. At least ten new bio-based value creation chains and five advanced biorefineries were planned to be realised and are already surpassed. Currently, four Austrian organisations are members of the BBI JU (Bio-based Industries Joint Undertaking). In an international context, the IEA Technology Collaboration Programme (TCP) should also be mentioned. Austria is also a member of the international "Mission Innovation" alliance, which together with private investors aims to combat climate change and promote the development of clean energy technologies. In addition, the evaluation "Bioeconomy 2018" of the Austria Research Promotion Agency (FFG) shows that within Horizon 2020, Austria occupies the sixth place among the EU-28 countries, with the success rate of 20.2% within the projects with bioeconomic relevance, which puts it in the absolute top spot.

[8] nachhaltigwirtschaften.at/de/projekte/quantitative-indikatoren-fuer-die-biobasierte-Industrie-in-oesterreich.php

Fields of action in the sphere of science and research (RTI)

- Basic research on resource availability, ecological functions (soil, biodiversity, etc.), site conditions and social conditions of bio-based economy
- (physical, chemical, biological) Analysis of material properties
- Assessment of the institutional and legal framework as well as regional and local effects of the bioeconomy
- Topic-specific, interdisciplinary (combining basic and applied research) analyses and evaluations, taking into account humanities, social sciences and cultural studies
- Applied research: increasing the efforts in the area of product and process development during the material and energy recovery of biogenic materials
- Survey of the potential use of bio-based materials taking into account ecological, economic and social effects
- Systemic assessment of the interactions between climate change and increased biomass production and biodiversity
- Development of new products from biogenic raw materials or waste and by-products
- Topic-oriented initiatives of universities and colleges on education and training (in the context of the overall Austrian university development plan)
- Creation of legal and organisational framework conditions for the bioeconomy and private investors

Figure 4: Networking of International Research Institutes

2 The Basis of a Sustainable Bioeconomy

2.1 Guidelines of the Bioeconomy

2.1.1 Framework of the Bioeconomy

The "Sustainable Development Goals" (SDGs) that have been adopted and are binding in the 2030 Agenda, such as the fight against climate change, have a positive impact on the bioeconomy, but also highlight the limiting factors. For the Austrian Bioeconomy Strategy, guidelines have been developed to align with these sustainability goals. The guidelines form the framework for the planning of the measures to counter potential conflicts of interest and to optimise synergies with other objectives of the 2030 Agenda.

2.1.2 Prevention of Climate Change

a) A Coherent Strategy for All Ministries and All Policy Instruments

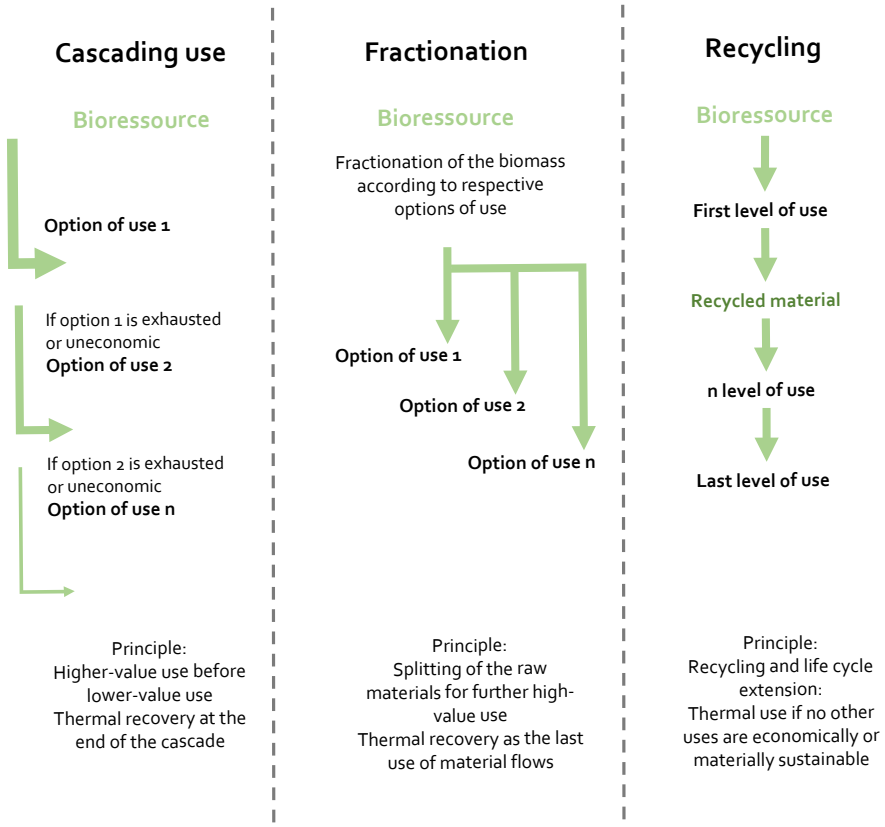
The bioeconomy contributes significantly to the reduction of greenhouse gas emissions. The Bioeconomy Strategy is an instrument to achieve the set climate protection goals. Therefore, policy instruments and communication channels are also to be oriented towards the transformation of an economy based on renewable resources.

b) Resource Efficiency, Cascading Use Options and Circular Economy

The long-term goal of the bioeconomy is to reduce fossil material and energy consumption and to replace it with renewable raw materials. However, this can only be achieved if the total resource consumption is reduced at the same time. In addition to the cascading use option, both the enhanced use of residuals, by-products and wastes as well as the flexible use of agricultural and forestry products, which fluctuate in terms of weather and quality and quantity, are necessary. At the same time, as many fossil products as possible should be replaced by products based on renewable raw materials in order to acquire the highest possible CO_2 binding and CO_2 storage. The aim of a "cascading use" in terms of resource efficiency is to make the wood or biomass fraction that is suitable for material recycling available for recycling, provided that this is appropriate and cost-effective, whereby the person entitled to dispose the wood or biomass fraction ultimately also decides the path of exploitation. In addition, bio-based and mineral raw materials should be processed as efficiently as possible, and as many recycling cycles as possible, taking into account the energy recovery paths, should be supported by suitable framework conditions. Innovative environmental technologies facilitate the recovery of biogenic materials and their recirculation, and support the bioeconomy.

Particular attention should be paid to select the most resource-efficient recovery option (see Figure 5).

Figure 5: Resource-efficient Recovery



c) The Responsibility of Each Individual

To change the economic system is also the responsibility of consumers, as the bioeconomy in the current system is only an additional option and cannot be achieved only through regulatory measures. Measures to motivate consumers to choose bio-based products consciously (such as the "Buying Consciously"[9] initiative) and to avoid wastage of food (for instance, the "Food is precious"[10] and "Austrian Eco-label"[11] initiatives) are to be accelerated and simplified by the Bioeconomy Strategy. Local authorities must assume their share of responsibility through innovation-friendly and sustainable public procurement and try to influence the market in favour of bio-based products.

d) Energy Recovery at the End of a Life Cycle

The increased use of biogenic energy sources is a declared goal of the bioeconomy, but with the highest possible efficiency criteria. As to the transformation, taking into account economic aspects and regional value added effects, a cascading use is to be preferred. It is crucial to maintain the principle of short supply logistics routes and the high level of air protection with regard to pollutants and other emissions.

e) Protection of Soils, Forests and Biodiversity

Due to the changing climatic conditions the management of forests and agricultural land has to be accordingly adjusted. The bioeconomy can back these changes in crop production through research and science in the areas of "climate-resistant crops and plant matter" and "sustainable forest management". In order to ensure the carbon-reducing effect of the local forests in the future, existing usage restrictions and protective functions must be maintained. In agriculture the objectives of the biodiversity strategy should also be continuously pursued.

2.1.3 High-quality Food Products have Particular Priority

a) Fair and Sustainable Trade

The Bioeconomy Strategy also assumes global responsibility and takes into account population growth and rising food demand. Price and competitive advantages that result from ecologically and socially unacceptable production must be scrutinised and included in trade agreements and consumer decisions. Imbalances along the production chain should be levelled. Cases of non-compliance should be disclosed to the established EU hotlines.

[9] https://www.bmnt.gv.at/umwelt/nachhaltigkeit/nachhaltiger_konsum/infoportal.htm
[10] https://www.bmnt.gv.at/land/lebensmittel/kostbare_lebensmittel.html
[11] https://www.umweltzeichen.at/de/home/start

b) Foods have Priority

The agricultural production of high-quality food and the secure supply of quality food is one of the top goals of the Austrian Bioeconomy Strategy: the principle of "food-feed-fuel"[12] applies. Health policy objectives and a respective handling of food must be taken into account in the food supply. In addition, the aim should be to secure high standards with regard to environmental performance, animal welfare and social fairness, and to promote them internationally. A sustainable, eco-social agriculture and food model will ensure, on the one hand, that soil fertility is preserved and land availability assured and, on the other hand, that fair prices along the entire production chain – from primary production to the consumers – are guaranteed.

c) Optimisation of Yields

Increased research should support the performance of crops (including tree species in the forest) to improve tolerances with respect to biotic and abiotic factors as a result of climate change. However, new plant varieties, cultivation methods or biochemical processes should also make allowances for environmental compatibility, soil quality and avoidance of invasive or genetically modified species.

2.1.4 Bio-based Economy as an Opportunity and a Challenge

a) Enabling New exploitations within Existing Limits

The bio-based economy is based on natural processes, creates innovative technologies, makes them more efficient and, as a result, makes the use of natural resources more efficient and sustainable. In this respect, the existing policies and strategies (for example on drinking water, biodiversity, civil protection and the Forest Strategy 2020+) form the framework of the Bioeconomy Strategy.

b) Integration of All Biogenic Raw Materials

Biogenic waste, waste water and sewage sludge are important raw material sources of the bioeconomy and are to be used as a resource as efficiently as possible. The local supply of farm manure is to be ensured, and any remaining waste material[13] is to be recycled. The Bioeconomy Strategy is aimed to assign a value to previously unused residuals and by-products and make their recovery both climate and environmentally-friendly and economically feasible. Cities, in particular, will play a key role as residual suppliers through collection and logistics concepts. Therefore, it is necessary to research, develop and expand new concepts of recovery.

[12] "Food-feed-fuel" generally describes the competition of different forms of use relating to agricultural production areas. The main focus in this respect is the competition between the cultivation of energy crops for the production of bioenergy and the cultivation of food and feed crops.

[13] see also Chapter 2

c) Sufficiency, Efficiency and Consistency: the Three Basic Principles of the Bioeconomy

Austria´s land and raw material sources are limited, so efficiency must be increased in production – through higher yields per hectare. At the same time, it is critical to take account of the natural features of the area and to intensify the use via the recycling of residues and by-products. Technology developments must be oriented more intensively towards a circular economy. Nevertheless, it will not be possible straight away to replace all fossil fuels with biogenic products. A substitution of domestic mineral raw materials is not possible either nor pursued in a bioeconomy. A functioning and sustainable bioeconomy, thus, also needs a reduction of consumption with a special focus on waste prevention.

2.1.5 Agriculture, Forestry and Water Management are Key Sectors

a) New Crops as a Sustainable Source of Income

In order for agriculture, forestry and water management to be able to cope with future challenges, especially with regard to supply and climate change adaptation, the bioeconomy relies on optimised plant breeding of the main crops and tree species of forests. However, additional protein sources and special crops for niche markets are to be developed. This will allow disadvantaged regions in particular to expand the economic base of agricultural and forestry holdings and to improve the income situation.

b) Preservation of Agricultural Land

In order to have sufficient land available for sustainable production in the future, the use of soil for other purposes must be reduced. The decline in areas suitable for agriculture is to be counteracted by zoning and increased brownfield management. The bioeconomy will help maintain and improve the quality of the soil, and highlight opportunities through new marketing potentials.

c) Stronger Focus on Aquaculture

Aquacultures are viewed as a useful supplement to agriculture and forestry. They do not compete for land and offer the bioeconomy the opportunity to produce on all three dimensions and, additionally, to cultivate already sealed areas. For this reason, aquacultures are considered to have a high ecological and economic potential. In addition to the wide spectrum of use of algae biomass, from the food sector, pharmaceuticals to supplementing the already existing biological wastewater treatment, sustainable fish farming in aquacultures in conjunction with changed consumer behaviour offers a

conceivable alternative to sea fish. The bioeconomy can help Austria position itself as a leader in the globally growing market of aquaculture technologies.

d) More Local Wood from Intact, Climate-friendly Forests for More Wood Products
The bioeconomy strategy aims to accelerate timber mobilisation from local forests. On the one hand, yield per hectare is to be increased by site-adapted tree species or forest ecosystems and, on the other hand, the vitality and resilience of the forest must be improved through adequate forest management and thinning measures. Decentralised forestry structures allow the processing and thermal utilisation of by-products and residues in the region and thus reduce transport and environmental impact. The companies in the Austrian value chain "wood" compete in the international arena and can only be successful in the long term by complying with internationally recognised sustainability standards and through future-oriented innovations.

2.1.6 Austria Needs New, Intelligent and Bio-based Products

a) Austria as a Global Player
Similarly to the wide range of raw materials available is the range of bio-based products. Building on existing areas of strength Austria should position itself as a technology leader within Europe for e.g. pulp and fibre products as well as saw and wood products. Targeted measures are intended to support start-ups and settlements of companies in the bio-based industry, strengthen the market for these products, promote job creation and adapt relevant training.

b) Highlighting the Benefits of Bio-based Products
In addition to the intensified market penetration of new bio-based products, measures must be executed in parallel to replace fossil products. In this case, the sustainable use of these new products is also to be considered. The benefits of bio-based products must be evaluated through science and research. Certificates and labelling can provide orientation on the market and emphasise the positive environmental effects. The role and responsibility of consumers must be strengthened by simple, transparent, product-neutral and correct information.

2.1.7 Governance

a) Support during the Transformation

The Bioeconomy Strategy does not create new structures, processes or institutions, but builds on those already in place and ensures that the development of innovative bio-based products, resources and technologies is promoted. The current economy system can only be transformed into a bioeconomy by means of high specialisation and know-how. Economic partnerships across product chains are to be developed on the basis of new and existing clusters and communication between science and business must be enhanced to support the implementation of the strategy.

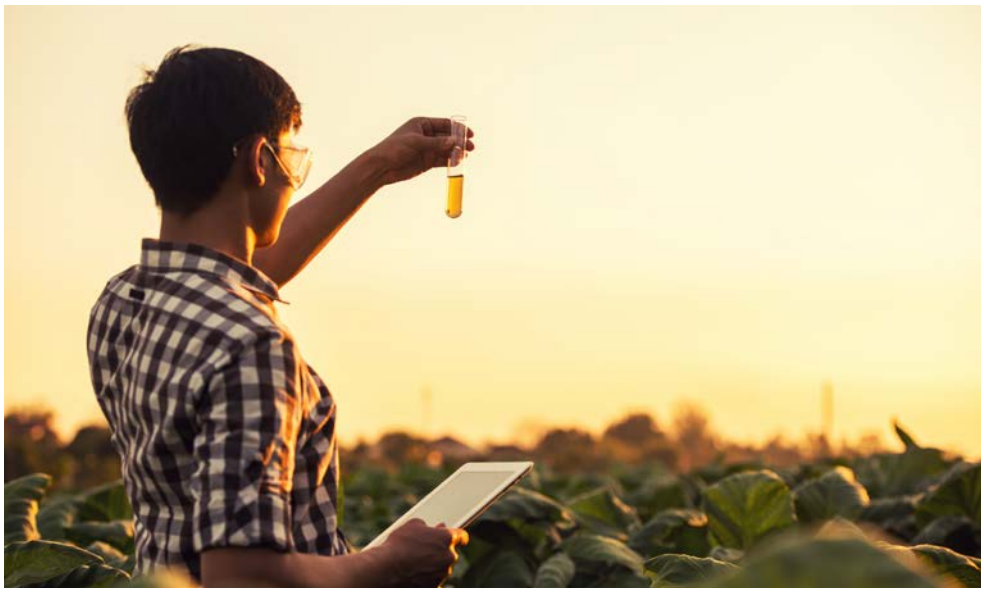


Figure 6: Increased Efficiency through Technical Support

b) New Jobs and Trainings

The development and application of new technologies on an industrial scale should lead to the creation of high-quality, sustainable jobs. The bioeconomy supports this goal by focusing on education and research as well as by reinforcing the bio-based market. The increased demand for experts in the labour market should be met by expanding the offer – supported by corresponding awareness-raising measures at all levels.

c) Bioeconomy as a Way to Eliminate Plastic

In Austria, a total of between 5,000 and 7,000 tonnes of plastic carrier bags are produced each year. Of these, over 100 kg per day are carried by the Danube to the seas. Regulatory measures, such as prohibitions and requirements, can be used to swiftly create effective framework conditions. This method is particularly suitable for ecotoxical substances, such as chemicals, or environmentally harmful products, e.g. plastic. The prospect to effectuate a complete system change was initiated by the ban on plastic carrier bags and microplastics uses. The ban on plastic carrier bags will, on the one hand, contribute to the promotion of reusable shopping bags and thus to waste prevention. On the other hand, it is to be expected that new innovative packaging ideas will emerge and the sustainable transition to bio-based products will be facilitated.

2.2 Sustainable Consumption

The bioeconomy can be a future-oriented and sustainable economy – but it must follow the guidelines outlined above as a mere increase in efficiency runs the risk that the profits made will be wiped out by rebound effects. Behavioural and value changes are required as a result, both by producers and consumers, to achieve all the goals of the Bioeconomy Strategy.

For this reason, in addition to efficiency, sufficiency measures as well as circulatory concepts are essential pillars of the Bioeconomy Strategy. A wealth of existing national and international strategies as well as the EU circular economy package is already aimed at this development.[14] The Austrian Bioeconomy Strategy is intended to build on sustainable consumption as an essential cornerstone.

Austria has a high consumption level of raw materials by international standards[15]. In terms of sustainable resource management, per capita consumption should be reduced and the focus should be put on sustainable services, accompanied by information and awareness-raising measures and political incentive systems. The bioeconomy is currently viewed not merely in Europe as a way out of the shortage of fossil raw materials, but is also a global trend. An increasing demand for natural resources can therefore be expected across Europe. The Bioeconomy Strategy will take this development into account and actively counteract a shortage of fossil raw materials through new consumption concepts.

[14] RESET2020, REAP and the EEA Report 8/2018

[15] Research Group "Sustainable Resource Use", Institute for Ecological Economics, Vienna University of Economics and Business (WU)

2.2.1 Sufficiency

Consumers decide on the choice of products and thus have a share in which goods will remain in the market and will prevail. Hence, they have significant influence on the environmental impact of the Austrian national economy.

The concept of sufficiency represents the approach of influencing values and needs in such a way that adapted consumption behaviour changes overall consumer behaviour. Additional consumption then does not increase the well-being of individuals. As a result, a reduction does not lead to a loss of quality of life. Measures to change consumer behaviour must be implemented at the right stage of consumption[16].

Concerning consumption, a variety of policy instruments must be deployed. Influencing consumption towards the bioeconomy can be facilitated through factual and product-neutral information and through labels, which are e.g. life cycle, recycling properties, repairability or amount and type of packaging materials used. Creating effective framework conditions promptly is possible via regulatory measures, such as prohibitions and requirements. Particularly for ecotoxical substances, e.g. chemicals, or environmentally harmful products, such as plastic, this method is highly suitable. The ban on plastic carrier bags and uses of microplastics will lead to new innovative packaging ideas and, presumably, to a sustainable transition to bio-based products. Another possibility is to address usage behaviour, e.g. the duration of useful life, the handling of repairs and the disposal of goods. These topics are currently being taken up, above all, by the economy models that have emerged in recent years, such as the "sharing economy", all of which place emphasis rather on the use than on the ownership of products (e.g. mobility, home and garden equipment). These considerations lead to a more conscious cost-benefit analysis, in which, of course, the price of the products plays an essential role. Supporting such initiatives also reduces resource consumption.

[16] Stages of consumption: consumption decision (information search), purchase decision, use und disposal.

Fields of Action in the Sphere of Sufficiency

- Continued development of existing sustainability criteria in terms of resource and energy consumption
- Intensified image campaigns for bio-based products to communicate environmental and economic benefits
- Advancement and adaptation of existing national and European quality labels as well as labels for the designation of bio-based products
- Increasing the presence of bio-based products in society
- Enhancing the presence of bio-based products in the public sphere
- Focus on the longevity of bio-based products (CO_2 binding)
- Customer-friendly labelling of the recyclability of products
- Targeted support of the sharing economy with the aim of reducing the consumption of goods
- Raising awareness towards bioeconomy
- Creating awareness for production conditions
- Raising awareness among consumers
- Expansion of repair and maintenance services
- Measures to influence preference for bio-based products and increase efficiency
- Development of education and knowledge activities as well as knowledge management in the field of bioeconomy
- Reinforced integration of the bioeconomy in school-based and academic education as well as in continuing vocational trainings

2.2.2 Efficiency

The term "efficiency" is used differently by different actors. "Economic efficiency" is based on a constant input and aims to maximise production. In contrast, "ecological efficiency" attempts to minimise the required input materials while maintaining the same output. For the bioeconomy, both concepts are necessary: the ecological approach with respect to the production of goods, the economic relating to the production of raw materials.

The Austrian domestic demand considerably exceeds the domestic raw material extraction in some cases. Efficiency measures are vital for companies because they combine ecological improvements with economic benefits. The efficiency in the production cycle can be increased through normative or financial incentives, such as those innovative concepts already in operation funded by the environmental support system in Austria.

At consumer level, efficiency primarily affects the usage phase. Awareness-raising initiatives are hence required in all areas of goods and energy use. There is high efficiency potential in the proper use of equipment (e.g. heaters), which can also be supported by digitisation (e.g. automatic consumption balances).

Fields of Action in the Sphere of Efficiency Measures

- Use of the most resource-efficient possibility of exploitation in all sectors of the bio-economy
- Creating increased awareness of possible improvements of efficiency measures
- Differentiation of promotion and incentive systems in terms of resource efficiency
- Estimation of the rebound effects of efficiency measures

2.2.3 Consistency (Circular Economy)

In the context of the bioeconomy, the term "consistency" primarily means "circular economy", a type of economy in which products and raw materials are extracted from waste. Waste products are considered as recyclable and usable resources. Such ideal types of chains are also called "cradle to cradle", new value chains can be established.

The circular economy and the use of secondary raw materials are fundamental to the EU Bioeconomy Strategy. The prerequisite for that is adherence to corresponding quality criteria for raw materials. Austria can revert to a well-established and functioning disposal system in which waste is collected and recovered as much as possible. Discounting excavated materials, 65% of the waste in Austria is already being recycled. For glass and paper packaging, recycling rates are 85%. Metal packaging is recycled up to 88%. The circular economy package of the European Union and the collection rates laid down therein as well as the national implementation will require additional efforts. Municipal waste also includes biogenic waste from households, for which there is also a well-established collection system in Austria, which today already meets the required collection rate of 55% by 2025. It is therefore assumed that the raw material potential of biogenic waste, by-products and residual materials from agriculture and forestry as well as water and waste management will also be available to new and innovative processes of the bioeconomy. The willingness of the Austrian population to collect waste separately must be used more intensively in order to expand the raw material potential of by-products and residues from agriculture and forestry as well as water and waste management.

The considerations of future exploitation possibilities included in the product designs of individual products and groups of substances contained in them are essential for the success of a future-oriented sustainable economy. The cross-sectoral linking of companies should be supported in order to explore new uses in the entire raw material chain.

Fields of Action in the Sphere of the Circular Economy

- Strengthening the cascading options of use in all sectors of the bioeconomy
- Promotion of the standardisation of secondary raw materials
- Securing private investments through long-term orientation of support measures
- Exploring the natural limits of circular economy concepts
- Expansion of suitable communication and information tools

3 Resources of the Bioeconomy in Austria

3.1 Agriculture

Austria´s agricultural businesses can produce a variety of raw materials for the bioeconomy. In order to enhance this production within the framework of a bioeconomy, the corresponding surface availability as well as a certain yield per hectare is necessary, both of which cannot be increased indefinitely. A bioeconomy must therefore deal with these limitations and recognise that there are naturally given and socially desirable goals of overriding importance.

Austrian agriculture has a small-scale structure in comparison to the European and international level. The share of agricultural land (arable land, grassland, areas for fruit and wine growing, and pastures) accounted for 43% of the national territory in 2016.[17] Compared to 1960, agricultural land has been reduced by around 12%. From 2013 to 2017, a stabilisation of the competitiveness of agricultural businesses was observed in parallel with a 7% reduction in their numbers. The average size of agricultural holdings in 2016 was about 19.8 hectares[18] and has increased by about 5% in the last 20 years. A total of 55% of the farms are operated as a supplementary source of income. This stabilisation of the number of agricultural holdings is also due to the consistent use of EU Common Agricultural Policy funds within the rural development programme. Austria has used these funds to invest heavily in the modernisation and the improvement of competitiveness of the businesses. In the next programming period 2021–2027, the EU and Austria will provide more resources to the bioeconomy.

20% of the agricultural holdings are managed according to the principles of organic principles. In the implementation of the "Organic Action Programme 2015–2020" and the Austrian Agri-environmental Programme (ÖPUL), almost 22% of the agricultural land (excluding pastures and mountain meadows) is currently organic arable land. It is mainly cultivated for animal feed production covering the businesses' own needs and with a smaller – but rapidly growing – share for the direct marketing of farm products and the food industry. As the circular economy, partly because of the ban on the use of mineral fertilisers, plays a more important role in organic farming than in conventional farming, it is expected that from these areas fewer by-products will be available for further processing to bio-economic products. In addition, farmers take voluntary measures to improve soil fertility and soil protection. Biodiversity also requires more extensively used land and thus an increased demand for land. Preserving biodiversity is at the same time an important climate protection measure and also has a positive effect on productivity. Studies show that, for these targets, biodiversity can be equated with the factors fertilisation and climate.

49% of the land and agricultural production in Austria are needed for animal feed.[19] Animal raw materials (wool, milk, etc.) can also be used for technical applications, but the climate effect must be taken into account when doing so. For example, wool,

[17] Foods in Austria 2018; BMNT
[18] Green Report 2016: Agricultural holdings and land compared over time, Statistics Austria
[19] Foods in Austria 2018, BMNT

traditionally used for clothes, as a by-product of sheep breeding makes sense; however, an expansion of wool production merely for the purpose of building insulation would have a negative impact on the carbon footprint. Extending the use of animal products beyond that of by-products should therefore be accompanied by climate balances.

For the bioeconomy, the increasing soil sealing has already reached critical levels. It is desirable to revitalise existing unused commercial buildings and industrial ruins, and to preserve town centres in order to relieve agronomically valuable areas that would otherwise be irretrievably lost for generations. The rate of land use is currently 12 ha/day and would have to be reduced in any case. In addition to avoiding further land losses, concepts for the reuse of already existing brownfields (such as industrial wastelands) should also be implemented. In the future, these brownfields on the outskirts of cities or in industrial parks will primarily be used for new commercial construction in order to reduce the settlement pressure on grassland. In particular, these areas can also be used for urban farming or glasshouses, thus contributing to the provision of raw materials.

In terms of added value per hectare, the use of catch crops and by-products still has potential. The bioeconomy also requires new raw materials. This can be well-known plants, which are cultivated more intensively, or crops with high fibre or protein content.

Due to the small-scale agriculture in Austria, cooperation structures (cooperatives, machinery ring) are pronounced. However, new investment-intensive developments such as precision farming are not yet sufficiently widespread, even though they allegedly have great potential for increasing yields. It shall be examined whether digitisation and new services (e.g. contract fertiliser) can be used in the existing forms of cooperation.

The effects of climate change on land, plants and yields are currently noticeable: drought and extreme weather events lead to massive crop failures and pest pressure in agriculture and forestry.[20] This poses a major challenge for agricultural and forestry companies and raises questions about security of supply.

Fields of Action for Agriculture

- Reinforcement of climate protection measures in the area of agriculture
- Avoiding area loss
- General avoidance of soil sealing
- Securing land for the bio-economy
- Using industrial brownfields for business settlements to reduce land pressure on agriculture
- Increased support for special crops, catch crops and contract farming while avoiding possible negative impacts on biodiversity
- Breeding optimisation of crop plants
- Marketing of by-products of field crops
- Maintaining and developing jobs in the region during the transformation to the bioeconomy
- Combination of protective functions (retention areas) with yield increases

[20] BMNT projects: BEAT (land requirements for food security) – showing the effects of climate change on soil fertility

- Increasing added value in agriculture through new cascade uses
- Development of new value creation and production concepts for the optimisation of agriculture
- Services to increase the efficiency of crops and stocks
- Measures to increase the vitality of crops and stocks
- Support for investments in logistics infrastructure and logistics cooperation
- Securing the supply of biogenic raw materials
- Creation of usage concepts for vacant areas through measures to reduce the surface pressure
- Establishment of a national satellite account for bioeconomy (recording within the scope of ÖSTAT)

Challenges:

- The increased demand for sustainably produced food leads to an extensification of agriculture and thus to more land requirements. The positive development of organic farming is desirable and is also supported by the Organic Action Programme and the ÖPUL.
- Biodiversity objectives, nature conservation areas and protected area designations are specified in national and European law and are mandatory for all businesses. The BMNT‘s political goal is to achieve a further voluntary increase in these areas through appropriate incentives.
- According to the government›s programme, enhancing national self-sufficiency with food is an objective of domestic agriculture. This requires sufficient land for production and thus limits the available area for the production of biogenic raw materials for technical use.
- Agricultural waste recycling (e.g. crop residues) is limited by the required maintenance of soil fertility (carbon bond, soil structure, soil water balance) and biodiversity conservation (soil life, etc.).
- In any case, the use of new (or re-planted) plants requires scientific support in order to avoid undesirable effects or the spread of invasive species.

3.2 Forestry

Wood as a raw material plays a central role in the Austrian bioeconomy. Austria's 48% share of forests is high compared to other EU countries and has for centuries been characterised by sustainable forestry use. For decades, both the forest areas and the wood stocks per hectare have increased.

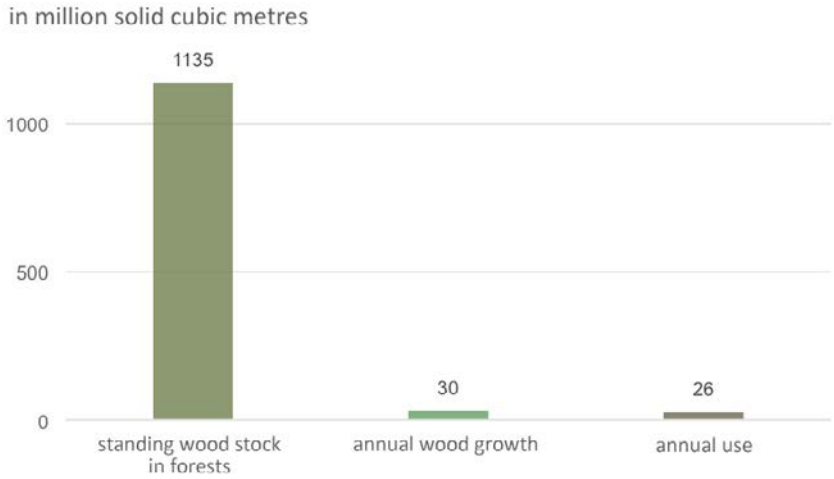


Figure 7: Wood in Austria; Federal Research and Training Centre for Forests, Natural Hazards and Landscape 2018, Austrian Forest Inventory 2007/09

In detail, the annual wood growth in the harvested forest amounts to 30.4 million cubic metres of standing timber (Vfm).[21] In contrast, the annual usage is around 26 million Vfm (see Figure 7). Overall, the Austrian forest area has recently increased by about 4,000 hectares per year. Taking into account all aspects of sustainability, the theoretically usable potential is about 3–4 million solid cubic metres of harvested timber per year.[22] Around 80% of the fresh wood produced from logging and through import goes through the woodworking industry as sawlogs and industrial roundwood, and around 20% are made available for direct energy recovery as firewood and wood chips.[23]

The Bioeconomy Strategy aims to contribute to the efficient sustainable use of wood as a raw material, e.g. to obtain the best possible CO_2-fixing effect through the expansion of material utilisation possibilities (such as timber construction). At the end of the useful life, these products can also still be used for energy purposes, thus

[21] Austrian Forest Inventory 2007/09
[22] Wood and biomass stock of Austria; Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW)
[23] Austrian Energy Agency, klimaaktiv energy wood – Wood Flows in Austria

substituting fossil fuels. The expansion of material use requires an increased amount of sawmill by-products, which are available for material and/or energy use.

Whereas the focus of businesses is on utility, the forest also fulfils protective, welfare and recreational functions. The substitution effects of fossil carbon through wood use and the positive impacts of sustainably managed forests as a carbon sink are at the heart of the national bioeconomy and must be preserved accordingly.

Fields of Action in the Sphere of Forestry

- Enhanced awareness raising with respect to bioeconomy
- Emphasising wood mobilisation
- Strengthening of forest land use planning
- Combination of protective functions (protective forest, retention areas) with yield increases
- Compensation of the additional costs of bio-based production through market interventions, such as a ban on the new installation of oil-fired boilers for space heat generation
- Setting research priorities along the entire value chain of the bioeconomy sector
- Development of new value creation and production concepts to optimise forestry
- Measures to strengthen the domestic market
- Services to increase the efficiency of crops and stocks
- Measures to increase the vitality of crops and stocks
- Digitisation and data management in forestry (regional)
- Increasing the added value of forestry through new cascade uses
- Securing the supply of biogenic raw materials
- Maintaining and developing jobs in the region during the transformation to the bioeconomy

Challenges:

- Consideration of long-term planning periods and the effects of climate change: forestry businesses plan and operate across generations. Interactions of climate change with growth conditions and calamities mean increased risks with increasing population age. Short-term intervention in the economy can lead to unintended long-term developments.

- Sustainably managed forest as a raw material supplier substituting fossil carbon and as carbon storage: preservation of the greenhouse gas reducing impact of domestic commercial forests
- Climate change also has implications for protective functions and biodiversity goals: bioeconomy must contribute to the protection of soils, forests and biodiversity.

3.3 Water Management and its Special Types

Austria has one of the highest connection rates to municipal sewage systems in Europe and is a technology leader in many areas. This universal service should be supplemented by further exploitation possibilities (energetic, material) and supported by corresponding means in the framework of the Environmental Support Act relating to the objectives of water management in residential areas.

In Austria, a portfolio of algae products can be offered thanks to many years of research activities and existing production facilities, which ranges from fat and oil-containing to starch and protein-containing biomasses. In addition, algae biomass can be utilised for energy recovery. In Austria, moreover, attempts are being made on a laboratory scale to produce chemical raw materials for plastic using blue-green algae. There are also approaches to use other microalgae which can provide essential raw materials for the pharmaceutical industry. Since it is a young technology, the current product yield is low. There are research and development needs along the entire production chain: for harvesting, drainage, purification and the production of valuable materials. Closed systems such as photobioreactors under artificial lighting are seen as a promising approach. Intensive research could offer further opportunities to use unicellular algae in wastewater treatment. Co-products include biogas, biomethane and valuable substances such as phosphorus.

Another special type is protein production through insects. While it is unlikely that this source of protein will be widely accepted for human consumption in Austria,

Figure 8: Vertical Farming

the production of insects for animal feed is an option equivalent to the production of meat-and-bone meal. In both cases, necessary protein can be produced without using additional land. The breeding of insects possible in closed systems could thus also represent a meaningful utilisation of otherwise unused nutrients in sludges from biogas or sewage treatment plants.

Fields of Action in the Sphere of Water Management and its Special Types

- Energy production from sewage treatment plants
- Development of new recycling options for sewage sludge and fermentation residues
- Development of new sources of raw materials (e.g. new proteins) in closed production systems
- Vertical and urban farming as an opportunity of the bioeconomy

Challenges:

- The agricultural recovery of harmless sewage sludge from digestion towers and fermentation residues from biogas plants has priority, but is limited, among other things, by the available land. Recycling in industry or biorefineries should be regarded as equally important treatments, with mono-combustion being the preferred option for the recovery of raw materials.
- Even in closed systems, the precautionary principle must be observed. Therefore, genetically modified organisms should generally be avoided.
- In urban animal breeding concepts (such as fish) similar standards have to be set for animal welfare as in agriculture.

3.4 Residuals, By-products and Wastes

The Austrian waste industry is one of the best organised in Europe and has nationwide collection and logistics systems. Biogenic waste, in particular food waste, has sophisticated disposal rails, the diversion of which into potential uses in the bioeconomy should be discussed.

The total amount of waste generated in Austria in 2016 was around 62 million tonnes. These amounts of waste have increased significantly since the 1990s with the rise in living standards, but have been well utilised by an established Austrian waste management, which is one of the world›s pioneers. With regard to collection and recycling rates, Austria holds a top position among the EU countries, but additional measures will

be needed to reach recycling rates set for 2025.[24] As part of these efforts, new impulses for the collection and treatment of biogenic waste can also be initiated.

In Austria´s agriculture and forestry there is extensive knowledge about the use of agricultural residues. Principally, attempts are made to minimise the use of mineral fertilisers by optimising the use of manure and residues. In agriculture and forestry, however, there is great potential to increase the use of by-products whose value could be increased through incentive systems. Corresponding regional logistics and utilisation concepts are necessary and could be created via the LEADER structures.

The separate collection and recycling of biogenic waste is well developed in this country. Another significant strength is the energetic and material use of sawmill by-products of the wood-processing industry or of alkalis and by-products of the paper and pulp industry. In total, around 13.4 million solid cubic metre equivalents of (industrial) waste wood, sawmill by-products, alkalis and bark were used in 2016 for energy purposes.[25]

Intra-company recycling of substances is widespread in the industrial environment for cost reasons, but could be intensified. In addition to existing utilisation paths, however, new utilisation concepts, such as the combination of anaerobic energy production with subsequent composting or the use of sludge as growing medium for fungi or insects, are not yet established and require further research. It is crucial for the bioeconomy whether substrates still contain nutrients or fibres for further exploitation stages, which can be used.

[24] http://www.europarl.europa.eu/news/de/headlines/society/20170120STO59356/paket-zur-kreislaufwirtschaft-neue-eu-recyclingziele

[25] klimaaktiv energy wood: Wood Flows in Austria – Energy use

Fields of Action in the Sphere of Residues, By-products and Wastes

- Expansion of regional raw materials logistics
- Enhanced use of by-products (as currently defined)
- Marketing of by-products of field crops
- Specification of criteria for specific substances and objects in accordance with Article 5 of the Waste Framework Directive, unless criteria have been defined at EU level
- Use of municipal biogenic waste
- Extension of recycling options for residual materials from biogas plants
- Expansion of the supply of raw materials through imports of biogenic residues, by-products and wastes
- Development of a national catalogue of criteria (in accordance with Article 5 of the Waste Framework Directive, Section 3) for the classification as by-product

Challenges:

- The aim of composting biogenic waste and applying compost is the soil improvement (recycling of organic matter, carbon, nutrients and minerals), whereby part of the biogenic waste is not available for energy recovery. However, it is paramount to coordinate the extent of composting with the necessary fertiliser requirement.

4 Technologies of the Bioeconomy

Due to the complex characteristics of the biogenic starting materials, the industrial processing of biogenic raw materials into high-quality products requires mature technologies and processes. Integrated concepts for the material and energetic use of these raw materials are a central topic. The technology areas and processing stages listed below are only highlighted as examples and should identify concrete starting points for the action plan to be drawn up.

4.1 Agricultural Cultivation, Processing and Harvesting Technologies

In the area of primary production, precision agriculture can achieve a substantial increase in efficiency. Seed, water, pest control and harvesting become more predictable and efficient through the implementation of the latest findings using digitisation (agriculture 4.0). This is expected to improve productivity and the ability to cope with the consequences of climate change.

Fields of Action in the Sphere of Agricultural Cultivation, Processing and Harvesting Technologies

- Digitisation and data management in agriculture (regional)
- Development of apps tailored to regional needs
- Promotional measures (not only financial) to support environmentally responsible cultivation methods and management
- Measures to support environmentally responsible cultivation methods and management for precision farming
- Methods for harvesting and utilisation of all plant parts

4.2 Transport and Logistics

Currently, transport and logistics systems are, above all, focused on main products. There are hardly any collection systems for biogenic by-products or residues, as in many cases there is no market for lack of usable quantities. As a result, valuable biomass often remains in the fields and rots. However, aside from those amounts needed for soil improvement and humus formation, these residues are potential input materials for further recovery operations. In forestry there are inter-company cooperation models for temporary storage and drying of wood. Such cooperations can also be initiated via regional groups in agriculture. In addition to the required technologies, sites for first processing (drying, storage, etc.) and corresponding operators are primarily required.

Fields of Action in the Sphere of Transport und Logistics

- Establishing cooperation models for cross-sector residues logistics
- Technology development for drying and initial processing of residues
- Fertiliser management to determine the necessary residues for the soil structure
- Expansion of waste logistics for biogenic waste of the food trade

4.3 Conversion

4.3.1 Biorefinery

The term “biorefinery“ does not refer to a specific combination of plants, but describes production sites that can produce a variety of products from (different) raw materials. Paper and pulp mills, starch and fuel producing factories as well as dairies and the like can, therefore, be biorefineries. The aim is not only to produce the main products, but also to make the best possible use of co-products and by-products. Biorefineries are currently classified in accordance with the new guideline VDI 6310 Sheet 1, which defines the standards with regard to ecological, technical, economic and social criteria. These standards are suitable for evaluating and optimising existing as well as for planning new biorefinery concepts.

4.3.2 Un-Locking and Processing

Many industrial and commercial processing routes are already well established. However, it is necessary to further develop or reorient existing technologies and procedures for biomass conversion (physical-mechanical, chemical, biotechnological-enzymatic, biochemical, thermochemical conversion), and to make process technologies more (resource-) efficient. A promising option is aerobic fermentation, which is an essential element in conversion, and is used as a biotechnological process to produce industrial products, such as bulk and fine chemicals, food, food additives and feed additives, agricultural and pharmaceutical precursors as well as technical enzymes and biofuels.

Yet, current research questions are concerned not only with primary raw materials and main products, but also by-products and biogenic waste and sewage sludge.

Although their processing technologies are also well established, even greater efforts in processing will be needed to meet the new EU collection rates.

4.3.3 Anaerobic Energy Recovery

Biogas plants have been used in the energy sector for several years, but if operated exclusively with agricultural raw materials, are only profitable with high subsidies. Anaerobic reactors have been in use for a long time in the waste and especially sewage sector, but often do not focus on the energy output of the plants. A linking of these concepts should therefore be examined. In addition to the energy and process engineering challenges, however, there is a need for action with respect to the assessment and recycling of the residues from the reactors. So far, these residues have either been returned to agriculture or have been energetically recycled due to the contamination with waste. In a bioeconomy, however, the residues from anaerobic utilisation are also possible input materials for further processing steps.

4.3.4 Pyrolysis

Pyrolysis is not yet established in Austria, but is to be brought to market maturity. The advantage of the BioCrack process, for example, a method already being used on a pilot scale, is that the biomass can be introduced directly into the conventional mineral oil refining process and thus an existing infrastructure can be exploited.

4.3.5 Combustion Technologies

Austria is at the forefront of technology development for biomass combustion internationally, especially in smaller-scale plants. There is still a need for development with regard to particulate matter and NOx values so as not to lose touch with the technology leaders. Additional research is also required on the possibility of recycling ashes. In the case of larger quantities, introducing it in agricultural or forestry areas requires a thorough analysis of the ingredients and suitable collection and release options. Austria is also among the European leaders in environmentally sound waste incineration. The high emission standards have led to a general acceptance of incinerators in the population. The challenge still lies in increasing fuel efficiency, by which the efficiency of existing and newly built heating and cogeneration plants – for instance, through flue gas condensation – can be significantly boosted.

Fields of Action in the Sphere of Conversion

- Development of new conversion processes and technologies
- Research on utilisation and recovery concepts
- Research into new technological approaches in the treating and processing of biogenic raw materials with special consideration of the use options as cost-effective renewable energy storage
- Advancing the Industry 4.0 suitability in bio-based conversion
- Assessing the consequences on resource and raw material security as well as the market impact
- Adjusting the subsidies, e.g. equal treatment of different biogas technologies and graduation of funding levels to improve resource efficiency
- Optimisation of resource efficiency in thermal utilisation, for example through the use of thermodynamic heat recovery processes, such as ORC or heat pumps
- Increasing the added value in agriculture and forestry through new cascading uses
- Further development of emission standards for smaller incinerators to ensure acceptance of the technology
- Spatial energy planning for the preferred energetic and thermal supply through renewable local and district heating
- Appropriate positioning and highlighting of combustion technologies in the “Exportinitiative Umwelttechnik“ (export initiative environmental technology)
- Development and improvement of production processes of the bio-economy

Figure 9: Recycling of Biomass

5 Products of the Bioeconomy

5.1 Food and Animal Feed

The high quality of food is one of the main strengths of Austrian agriculture and should be further supported by the Bioeconomy Strategy. The food industry, as an integral part of the national economy, encompasses a wide range of economic activities which together form complex value chains. At the end of 2017, around 4,500 companies were attributable to the catering trade and around 200 to the food industry. Austria is self-sufficient in many products and able to export (processed) food to an increasing extent. Already in 2017 this amounted to 11.12 billion euros, which also allowed the agricultural trade deficit to be reduced to 0.8 billion euros.

The share of organic farming has risen steadily since 2000 due to consumer demand and the Organic Farming Action Programme 2015–2020. With around 23,000 farms and 620,000 hectares of organic land in 2017, organic farming is making an important contribution to improving soil quality and biodiversity. However, the climate impact of food is also determined by origin and time. For Austrians, the origin of food, regional focus and seasonal availability are among the most important purchasing criteria.

Dietary habits in Austria are slowly changing towards a more conscious and climate-friendly diet according to the Food Report 2018. The Bioeconomy Strategy will not have an active influence on this development, but will include its impact on land and resource consumption in its strategic thinking.

Health and nutrition are topics that are addressed jointly in many bioeconomy strategies. In Austria too, the EU school programme in educational institutions promotes healthy nutrition. A further strengthening of quality, health and climate-related aspects in public-sector nutrition management with a particular focus on regional supply options and practicable concepts for waste reduction could also contribute to a lower consumption of land. All this needs to be supported by product-independent, transparent and accurate information about the health aspects of nutrition.

In order to make land available for new applications of the bioeconomy, it is necessary to use the raw materials efficiently in each production step. In Austria, 760,000 tonnes of food waste and losses are generated each year, with the residues from production surpassing those of consumers by far. For unavoidable food waste, it has to be ascertained whether they can potentially be regarded as by-products of food production and further processed.

Waste prevention measures should always be differentiated according to the source. There is already a successful strategy in trade, through cooperation with social institutions, to enable the use of expired food and thus to reduce waste. In general, residues and wastes from production are also easier to market as by-products and, according to their product properties, can be used more purposefully. It is therefore appropriate to review whether commercial foodstuffs can possibly be returned to producers in order to be fed into existing recycling channels.

Active agents and medicinal plants also have an important influence on human nutrition. In Austria, herbs and medicinal plants are cultivated and utilised to a relevant degree. In particular, the contract cultivation areas for medicines and cosmetics have opened up a lucrative potential for agriculture, so they are to be further developed.

Austria is well connected in the European single market. Trade is therefore an important part of the Austrian Bioeconomy Strategy. However, transport costs play an important role in trade flows of the bioeconomy, since biogenic substances often have significant high water content. On-site processing and thus weight and volume reductions are therefore vital economic factors in rural areas and prepare for further processing and export. The main commodities in the food sector are meat, dairy and beverages. On the other hand, fruits, fish and animal feed are mainly imported. However, especially with feed, efforts have been underway for some years to reduce the quantities and to expand the domestic sources of protein. An important contribution is made by the co-products of biofuel production. Above all, unconventional products such as algae, fungi and insects are an interesting source of protein for the future. Provided these products are produced in closed systems, they can substitute corresponding imports for feed (e.g. fishmeal). In the foreseeable future, though, they will only remain niche areas for human nutrition.

Trade will continue to play a major role in the bioeconomy, since in Austria not all climatic conditions or corresponding land areas are available for all products. It will necessary to ensure that traded goods are equated to domestic production in terms of their sustainability aspects. Austria faces fair competition with its strict environmental and social standards, but it cannot compete with economic practices based on exploitation and overexploitation. Equal opportunities must be established through international economic agreements, but also through the information of consumers

Fields of Action in the Sphere of Food and Feed

- Role model effect of the public sector through the increased use of bio-based products
- Raising awareness of consumers through labels, certificates or quality marks
- Reducing volume losses through improved harvest and post-harvest technologies
- Development of unavoidable waste as raw materials
- Prevention of food waste in households, commerce and in the out-of-home consumption sector
- Reduction of feed imports through co-products of biofuel production and development of new protein sources (for example, insects)
- Raising awareness with regard to production conditions

Challenges:

- The change in eating habits is slow and must be accompanied by health policy measures.
- Climate balances for the production of unconventional raw materials should document the positive climatic effects.

5.2 Materials

Austrian businesses have many years of experience, high added value and significant innovation potential in some key areas of the bioeconomy as well as in plant construction. Particular strengths of Austria are the paper and pulp industry, the construction and wood sector and some sectors of the basic chemicals industry. In 2016, these sectors of the bioeconomy represented around 8% of Austria´s GDP. In addition, the bioeconomy will produce a multitude of as yet unknown new and better products, services and, thus, markets.

To accelerate this development, it is necessary to open suitable access to the market. Tools for raising awareness, labels, eco-labels, standards or public procurement play a key role here. As a result of the European Guidelines on State Aid for Environmental Protection and Energy, support instruments are currently geared primarily towards the energy recovery of biogenic raw materials. Recycling must therefore be promoted by focusing on other promotion instruments.

Flexibility is required when defining bio-based products. As a necessary intermediate technological step, composite materials are developed that contain fossil raw materials or recycled materials. These composites should be included as a necessary intermediate step both in the strategy and in the measures that build on it.

Fields of Action relating to the Use of Materials

- Initiatives to reform the European Guidelines on State Aid for Environmental Protection and Energy to facilitate the promotion of the use of bio-based resources
- Priority for bio-economic products in national funding instruments
- Replacing non-renewable raw materials with biogenic raw materials
- Development of reliable standards for heterogeneous starting materials

The areas listed below are presented as examples so that the fields of action derived can be more easily combined with concrete measures.

5.2.1 Paper and Pulp

The paper and pulp industry is a traditional and strong sector in Austria. Due to the massive market consolidation in the 1980's, those companies that had focused on the (over-) fulfilment of environmental standards at the right time are today often technology leaders. In pulp production, high-quality everyday products are made from industrial round timber and sawmill by-products. In addition, intensive research and development has enabled a greater diversification of products, which today also allows raw materials to be produced for chemicals, building materials, biopolymers and energy.

The production sites of the pulp industry are located in rural areas and, therefore, have great importance for regional added value. Particular investment is required for the application of new recovery technologies from by-products or, more generally, for the development of new products aside from the core business.

In order to meet the demand for raw materials (around 8.8 million cubic metres of wood), 29% were imported from neighbouring countries in 2016[26] resulting in a dependence on logistics costs.

Due to the high demand for raw materials, the purchasing of forest products, even with high amounts of wood from calamity forests, is guaranteed in the long run.

Fields of Action in the Sphere of Paper and Pulp

- Development of new products from waste and by-products
- Increased use of regional added value
- Ensuring and improving the quality of education in bioeconomy-relevant areas
- Standardisation of state aid framework conditions for ETS plants at European level

[26] https://www.klimaaktiv.at/erneuerbare/energieholz/holzstr_oesterr.html

Challenges:

- National and environmental standards should not be lowered because of the bioeconomy.
- New by-products also lead to new kinds of dependency and concern (for example, through regional energy supply).
- The bioeconomy creates new markets, but will also generate new suppliers and processors. Competitiveness and quality become even more important to open up new markets.

5.2.2 Fibres

Fibres are an important area of the bioeconomy within the EU. In Austria, traditional plants such as hemp or flax are rarely cultivated, so manufacturing companies usually source their raw materials from abroad. Fibre plants can be seen as an interesting link in the crop rotation in Austria.

In Austria, these fibres are primarily used for construction and insulation production, for the production of moulded parts or fibre composites. The development of reliable standards and appropriate analytical methods for raw materials must be promoted to facilitate the conversion of fibres such as flax, hemp, reed, straw but also wood to chemical precursors. To reflect the high level of importance of these substances, the extension of arable land for fibre crops to obtain relevant quantities should also be promoted through expert advice on cultivation and subsidies.

Fields of Action in the Sphere of Fibres

- Extension of arable land for fibre plants to obtain relevant production quantities
- Expert advice on cultivation and subsidies of fibre plants
- Training and education of consultants for cultivation and production
- Development of reliable standards for heterogeneous starting materials

Challenges:

- Roadside greenery filters air pollutants, stores them and should therefore not enter the food cycle. In addition to energy recovery, they should be tested for other uses, e.g. as natural fibres, and adapted accordingly.

5.2.3 Chemicals

Platform chemicals based on biogenic carbon can be obtained from a variety of raw materials. These substances, which are one of the fastest growing sector within the EU, play a key role in a bioeconomy. Thanks to bio-based platform chemicals, fossil hydrocarbons - nowadays the basis of organic chemistry - can be increasingly replaced and equivalent alternatives can be found. Austria has e.g. suitable raw materials and production facilities to able to produce and process polysaccharides. The expansion of existing sites into comprehensive biorefineries could strengthen Austria´s global position.

However, in some areas markets and uses of biorefineries[27] still need to be developed for waste, residues and by-products. A particular opportunity for Austria is the biomass of grassland, which could be used by way of example as a new raw material for "green biorefineries". The resulting products can subsequently be exploited to make chemicals or as protein sources.

Fields of Action in the Sphere of Bio-based Chemicals

- Expansion and improvement of comprehensive biorefinery concepts
- Use of bio-based platform chemicals for B2B
- Marketing of bio-based products with a broad impact

5.2.4 Biopolymers

Biopolymers (often also called "bioplastics") have great potential to complement fossil resources thanks to their technical properties and abundance of usable raw materials and areas of applications. The focus is on the production of durable and resistant products, so-called drop-in solutions, and recycling. In addition, the variety of product variants results in niche markets and special applications for bio-based plastics, for example with a focus on degradability. In order to facilitate the differentiation of all types of plastics for end users and to communicate the environmental benefits of individual products, appropriate labelling could be introduced.

Due to the low production volumes in Austria, the domestic bio-based products are currently being produced primarily for special applications.

Fields of Action in the Sphere of Bioplastics

- Communicating the environmental benefits of bio-based products
- Compensation of the additional costs of bio-based production through market intervention

[27] For definition of "biorefinery" see chapter "conversion".

- Expansion of recycling systems for improved sorting
- Customer-friendly labelling of the recyclability of products

Challenges:

- It must not be the goal to replace fossil with bio-based polymers in disposable products.
- The issue is emotionally charged due to the problem of plastic waste in the oceans, but a technical discussion must be guided by national facts.
- Customers cannot differentiate between bioplastics and conventional plastics. Disposal or recycling concepts must therefore always consider the likelihood of confusion.

5.2.5 Construction Sector

A large proportion of the domestic raw material wood is processed as construction and building material. The more than 1,000 companies in the woodworking industry, which are indispensable for rural areas and primary processing, act as a link between the forestry and wood industries. These traditional structures are also prepared for the future thanks to their efficient and innovative production processes. With the establishment of inter-company logistics centres, the sector already partly prepared itself for a much larger role in the bioeconomy.

Austria is one of the technology leaders in the processing of the raw material wood. Above all, domestic companies are particularly specialised in higher-quality products. Modern applications, such as system design and prefabrication, as well as internationally acclaimed architectural concepts are prerequisites for a further increase in added value.

Fields of Action in the Sphere of Wood as a Construction and Building Material

- Expansion of regional raw materials logistics
- Empowering workers through improved training opportunities
- Support digitisation throughout the value chain
- Improved management of residues
- Expansion of the logistics of preliminary, intermediate and finished products
- Harmonisation of laws and standards, e.g. in construction

Figure 10: HoHo Vienna

Challenges:

- Trade barriers (GHG accounting) cannot be decided and implemented single-handedly.
- The bioeconomy creates new markets, but will also generate new suppliers and processors. Competitiveness and quality become even more important to open up new markets.

5.2.6 Insulation Material

In addition to existing synthetic and mineral raw materials, renewable ones can also serve as a basis for insulating materials. Of particular importance are insulating materials based on cellulose, lignin, wood fibre, wood wool as well as fibre plants. The technological maturity of these products and the existing know-how of domestic companies are already proven by numerous examples such as blow-in insulants based on straw.

Due to the prices, natural insulating materials currently play a minor role for the economy. On the one hand, the planned surge in the refurbishment rate of buildings will increase the overall market; on the other hand, the trend towards living with natural materials will greatly boost demand.

Fields of Action in the Sphere of Bio-based Insulation Materials

- Compensation of the additional costs of bio-based production through market intervention
- Initiation of processing concepts across sectors and across sites
- Raising awareness of consumers through labels, certificates or quality marks

Challenges:

- The implemented examples are currently single applications and still far from the economy of scale.
- Achieving a refurbishment rate of 2% will also increase the market for bio-based insulation materials, although these will primarily be in the upper price segment.

5.3 Bioenergy

Bioenergy[28] has become the most important renewable energy source in Austria in recent years and represents an important pillar of domestic energy supply. The proportion of bioenergy in total energy consumption (including transport) increased from 9 to 17% between 1990 and 2017. Austria is thus one of the world leaders in the use of bioenergy. The share of biogenic fuels (solid, liquid, gaseous) in domestic power generation is around 7%; moreover, around 45% of local and district heating is generated by biogenic energy sources.[29] Overall, this sector generated primary sales of around 2.8 billion euros in 2016.[30] In the coming years, an increase in the biogenic share is to be expected thanks to the development of the Renewables Development Act (EAG), which was agreed in December 2018.

Bioenergy not only advances national self-sufficiency with energy and reduces greenhouse gas emissions, but also generates regional added value and employment, especially in rural areas. Technologies for the use of bioenergy have a long tradition in Austria, which resulted in market leadership, patents and research skills. These facts also open up opportunities for domestic companies in the export markets and ensure a high level of national added value in Austria.

All forms of energy (solid, liquid, gaseous) are to be further developed. While some applications are already highly efficient and low in emissions, continued technological development and innovation is required, especially for new concepts for the provision and use of bioenergy.

Fields of Action in the Sphere of Bioenergy

- Increase in the share of renewable energy sources
- Implementation of the requirement of renewables in the area of space heating (#mission2030)
- Establishing clear medium and long-term signals and incentives for early exit from fossil fuels

[28] Bio-based share of renewable energy
[29] Energy balance 2016, Statistics Austria
[30] Renewable Energy in Figures 2017, Development in Austria, Database 2016, BMNT 2017

- Creating attractive support schemes to encourage early exit from fossil fuels and avoid social hardship
- Pushing the switch from fossil fuels to renewable energy sources in public buildings
- Revision of the eligibility criteria towards more consideration of resource efficiency and cascade use options

5.3.1 Solid Biomass

The transformation of the energy system in the heating sector from fossil to renewable energy is one of the central challenges for the success of the energy transition, which requires a long-term conversion of the plants for the production of space heating and hot water as well as of commercial and industrial process heat. The prohibition of the installation of fossil heating systems in new buildings, which is possible in building regulations, can initiate a system change. By far the most important raw material of bioenergy is wood. In 2016, the heat sector saved 6 million tonnes of CO_2 equivalent through the use of wood fuels, 2.2 million tonnes through renewable district heating and 1.3 million tonnes through the energetic use of black liquor. In the field of process heat, bioenergy could increasingly be used in low and medium temperature processes with temperature levels up to 500°C. In the area of district and local heating, the use of bioenergy by 2,100 biomass heating (power) plants plays a key role.

In addition to process and space heat, solid biomass also contributes to green electricity production, especially as a supplement to photovoltaics and wind. The amount fed into the grid is around 2,000 GWh per year. In addition, mainly at industrial sites, about the same amount of electricity is produced by combined heat and power plants outside of the green electricity subsidy scheme.

Alongside wood, other solid biomass fuels are used, for example, agriculturally produced biomass (such as straw, grasses, miscanthus) whose proportions are rather small compared to wood. In the field of district heating, relevant shares are attributable to biogenic waste. At the end of the life cycle of bio-economic products – according to intended recycling steps – a thermal utilisation is particularly favourable and therefore worth pursuing.

Fields of Action in the Sphere of Solid Biomass

- Developing alternatives to wood to expand the raw material base for energy use
- Enabling the continued operation of regional biomass plants by increasing fuel and resource efficiency and thereby reducing operating costs

Challenges:

- Prescribing and complying with air emission levels is not only important for health reasons, but also forms the basis for broad public acceptance of combustion technologies.
- As a result of climate change, the number of heating days in our latitudes is likely to shrink, but the increasing refurbishment rate of private buildings will also lead to a decline in heating and cooling consumption.
- When using combined heat and power production, it is important to make reasonable use of the heat (especially in summer).
- The implementation of the bioeconomy creates new markets, but will also generate new suppliers and processors. Competitiveness and quality become even more important in order to develop new markets and continue to operate successfully in the future.
- For combined heat and power cogeneration, technologies to enhance efficiency are to be considered, e.g. by waste heat recovery.

5.3.2 Liquid Biomass – Biofuels

Renewable raw materials can be used to produce liquid energy sources such as diesel, heating oil, petrol and aviation fuels, which can contribute to achieving the climate goals in the mobility sector. In addition to the hydrogenation of oils and fats – which is already state of the art –, there are a number of other processes that are currently being tested in Austrian pilot and demonstration plants and can be expected to lead to a large-scale implementation in the future. The switch to renewable liquid energy sources is possible with existing distribution and refuelling systems and can therefore be implemented without major investments in infrastructure.

Austria has currently exceeded the target of replacing 5.75% of fossil fuels (measured by energy content) with biofuels with 7% and holds a top position among the EU countries when it comes to using biofuels. There is an industrial plant for the production of ethanol, whose production in 2016 was about twice the domestic consumption. Valuable domestic protein feeds are generated during the production of biofuels to replace imports, as well as other co-products such as glycerine (from biodiesel production), which are processed in the chemical industry. The research stage includes thermo-chemical processes, direct liquefaction from solid biomass and biofuels from algae biomass.

Fields of Action in the Sphere of Liquid Biomass

- Expanding research activity on second generation biofuels (or higher)
- Use of liquid biomass of high energy density as storage medium
- Increasing the level of blending of liquid biofuels

Challenges:

- The advancing bioeconomy could be accompanied by an increase in imports of bio-based products. For bioenergy carriers that are produced worldwide and imported to Austria reliable information on ecological advantages is necessary.
- Transparent communication to avoid food-feed-fuel discussions

5.3.3 Gaseous Biomass – Biogas and Biomethane

In addition to solid and liquid fuels, renewable gases are another important pillar of bioenergy. Gaseous energy sources can be produced from a wide variety of raw materials, from wood, agricultural products (manure, slurry, green waste, energy crops) to organic waste and sewage sludge. Renewable, "green" gas – under the heading of "greening the gas" – will play an important role in the energy system of the future and should form a focal point of energy policy. A significant proportion of natural gas will in future be replaced by renewable methane. "Greening the gas" – through biomethane from biogenic residues, hydrogen and synthetic methane from renewable energy sources based on a much improved system of guarantees of origin – is a key component for the sustainable development of the energy system. Currently, biogas is mainly obtained from fermentation processes. The total number of biogas plants is currently 396 (as of the end of 2018), with a cumulative capacity of 118.05 MW. 108 plants with an average capacity of around 32 kW are therefore permitted without the OeMAG contract. In 2018, therefore, 288 biogas plants with a total installed capacity of just over 85.2 MW were registered as green power plants in Austria. In addition to electricity generation, biogas can also be processed to natural gas quality in order to use it directly or to feed it into the gas grid. As of September 2018, 15 such biomethane plants are in operation. In 2016, electricity generated from biogas saved around 220,000 tonnes of CO_2 equivalents and an additional 135,000 tonnes in the heating sector. As of 2017, a total of 15 biomethane plants – so-called "feeders" of treated biomethane – are located in the Austrian gas grid. The quantity fed in was around 13.6 million m^3, with an energy equivalent of 149 GWh in 2017.

Fields of Action in the Sphere of Gaseous Biomass

- Preferential dispatching of bio-based energy into the grids
- Development of new raw materials for biogas from agriculture, waste/compost and wastewater management
- Perception of biogas plants as an intermediate stage within a recycling chain

Challenges:

- Declining willingness of raw material producers to supply biogas or biomethane plants
- Treatable raw materials for biogas should also be used for food and feed production and as basic substances for materials.

Figure 11: Biogas Plant

6 Cross-sectoral Matters, Instruments and Fields of Action

In order to best implement a knowledge-based bioeconomy for Austria, it is a prerequisite to integrate and coordinate the policy instruments at all levels of state control. This is the only way to ensure a cost-effective transition to a bio-based economy and to achieve the goal of decarbonisation.

6.1 Policy Instruments

Incentive Instruments: Fossil products and processes have a quantitative and developmental advantage in the existing economic system. In the past, this head start was also established through massive direct and indirect subsidies, some of which continue to this day. Many incentives have already been implemented in the bioenergy sector, but in the product sector they are largely missing both at national and European level.
Regulatory Law: The legal framework has to be adapted and changed in many areas. Examples of the need for regulatory regulations include construction, waste management and the development of new sources of raw materials. Prohibitions (such as the now issued plastic carrier bag ban) can represent significant steps to achieving the targets and be a catalyst for the bio-economy.

6.2 The Public Sector as a Front Runner

In order to support the contribution to the bioeconomy, it is necessary to shape the criteria in public tenders so that – in the spirit of the bioeconomy – the climate and energy goals are met.
The aim for the public sector should be to act as a role model, to strengthen the domestic market, to support the green-tech industry and to increase the supply as well as the demand for regional bio-based products In doing so, aspects of risk management should also be included in the procurement processes in order to guarantee the sustainability of the products.

6.3 Awareness Raising and Consulting

Due to its federal structure, Austria has a wide variety of awareness-raising initiatives and consulting programmes. This makes it possible to provide companies and consumers with common content from the federal government and the federal provinces. A central hub is the proven cooperation of the regional consulting programmes with the federal programme “klimaaktiv“. Thus, important contents about climate protection, resource efficiency and renewable raw materials are already being exchanged and communicated. This network structure can also be used increasingly for the bioeconomy.

6.4 Standardisation

In the existing design of standards bio-based products are often disadvantaged. As many of these products have only recently become available or are only just coming on to the market, it is necessary to speed up the procedures for adapting the standards. The aim is to guarantee the safety and harmlessness of bio-based products to consumers without creating additional barriers to market entry. The binding of carbon in the bio-based products must be a positive criterion.

6.5 Education and Training

In addition to research and innovation, education is one of the key growth drivers of modern economies, which has a significant impact on prosperity, quality of life, competitiveness and social cohesion. In view of the complexity of the topic "bioeconomy", comprehensive educational programmes must be established, which in particular build on the principle of future justice. The Innovation Foundation for Education supports the educational institutions that want to improve and develop educational structures and processes according to need via co-sponsored sub-trusts. If bioeconomy-relevant elements exist in the Foundation's performance and funding portfolio, they should be used to implement the bioeconomy RTI strategy.

6.6 Digitisation

Digitisation and new communication technologies in conjunction with technological developments such as artificial intelligence (AI) represent a significant change in production processes towards "biodigitisation". Although this development involves special challenges (such as grid expansion), they are outweighed by the opportunities and benefits in the implementation. Initiated by the Digitisation Strategy of the Federal Government, achieving success for Austria's economic standing is to be expected in the long run. Digitisation and modern communication technologies will also play a major role in product design. As a result, material application can already be optimised in product development and the accumulation of residues and waste can be minimised.

7 Outlook

7.1 Austrian Bioeconomy Action Plan

The present Bioeconomy Strategy provides an orientation for all bioeconomy-relevant fields of action until 2030. Building on this, the preparation of an action plan for the bioeconomy will start at the beginning of 2019, aimed at all relevant players in this field. The particular challenge, taking into account existing programmes and the involvement of all relevant stakeholders, is to accelerate the implementation of the topics identified in the Bioeconomy Strategy as quickly as possible.

7.2 Cluster

By particularly building on its technological und economic strengths and capabilities, Austria will drive the market launch of new products and services. The Austrian cluster landscape is characterised by economic priorities in the federal states and is therefore especially suitable for networking within the bioeconomy-relevant sectors. Already now bioeconomy-relevant issues are addressed to varying degrees. In the future, they should pooled and so strengthen the impact of the activities. An Austria-wide joint action initiative is scheduled for 2019.

7.3 Monitoring

The monitoring supports the implementation with respect to methodological, procedural and structural aspects, and also in terms of a process-accompanying evaluation. Together with the Bioeconomy Platform, adaptation and improvement suggestions are to be worked out on an ongoing basis and possible evaluation results are to be considered in the best possible way. This is to ensure that the targets of the Bioeconomy Strategy and the Action Plan for Bioeconomy will be achieved. This applies particularly to the relevant requirements of the guidelines and objectives defined in the Bioeconomy Strategy.

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