5 A circular transition for biomass and food

This chapter develops policy recommendations to support the transition to a circular approach in Hungary's biomass and food priority area, with a specific focus on the bioeconomy. It provides an overview of the current context and policy framework, identifies critical areas for potential improvement, and puts forward a set of concrete policy recommendations. Findings from relevant international good practices guide these recommendations.

5.1. Role of the bioeconomy in the transition to a circular economy

5.1.1. Defining biomass, food, food waste and bio-waste

Biomass, food, food waste and bio-waste are defined in this chapter based on EU legislation.

- **Biomass** is defined as "the biodegradable fraction of products, waste and residues from biological origin from agriculture, including vegetal and animal substances, from forestry and related industries, including fisheries and aquaculture, as well as the biodegradable fraction of waste, including industrial and municipal waste of biological origin" (Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources) (European Parliament and the Council, 2018[1]).
- **Food or foodstuff** is defined as the "[...] means any substance or product, whether processed, partially processed or unprocessed, intended to be, or reasonably expected to be ingested by humans. 'Food' includes drinks, chewing gum and any substance, including water, intentionally incorporated into the food during its manufacture, preparation or treatment". It also includes water for human consumption (EU Regulation on the general principles and requirements of food law, EC/2002/178) (European Parliament and the Council, 2002[2])[1].
- **Food waste** is defined as "any food that has become waste under these conditions: it has entered the food supply chain; it then has been removed or discarded from the food supply chain or at the final consumption stage; it is finally destined to be processed as waste" (revised EU Waste Framework Directive (WFD), EC/2018/851) (European Parliament and the Council, 2018[3]).
- **Bio-waste** is defined as "[…] biodegradable garden and park waste, food and kitchen waste from households, restaurants, wholesale, canteens, caterers and retail premises, and comparable waste from food processing plants" (revised WFD, EC/2018/851) (European Parliament and the Council, 2018[3]).

5.1.2. The circular bioeconomy in the biomass and food priority area

According to the 2018 update of the European Bioeconomy Strategy, the bioeconomy covers all sectors and systems that rely on biological resources: animals, plants, micro-organisms and derived biomass, including organic waste, their functions and principles. The bioeconomy includes and interlinks land and marine ecosystems and the services they provide, all primary production sectors that use and produce biological resources (agriculture, forestry, fisheries and aquaculture), and all economic and industrial sectors that use biological resources and processes to produce food, feed, bio-based products, energy and services (European Commission, 2018[4]).

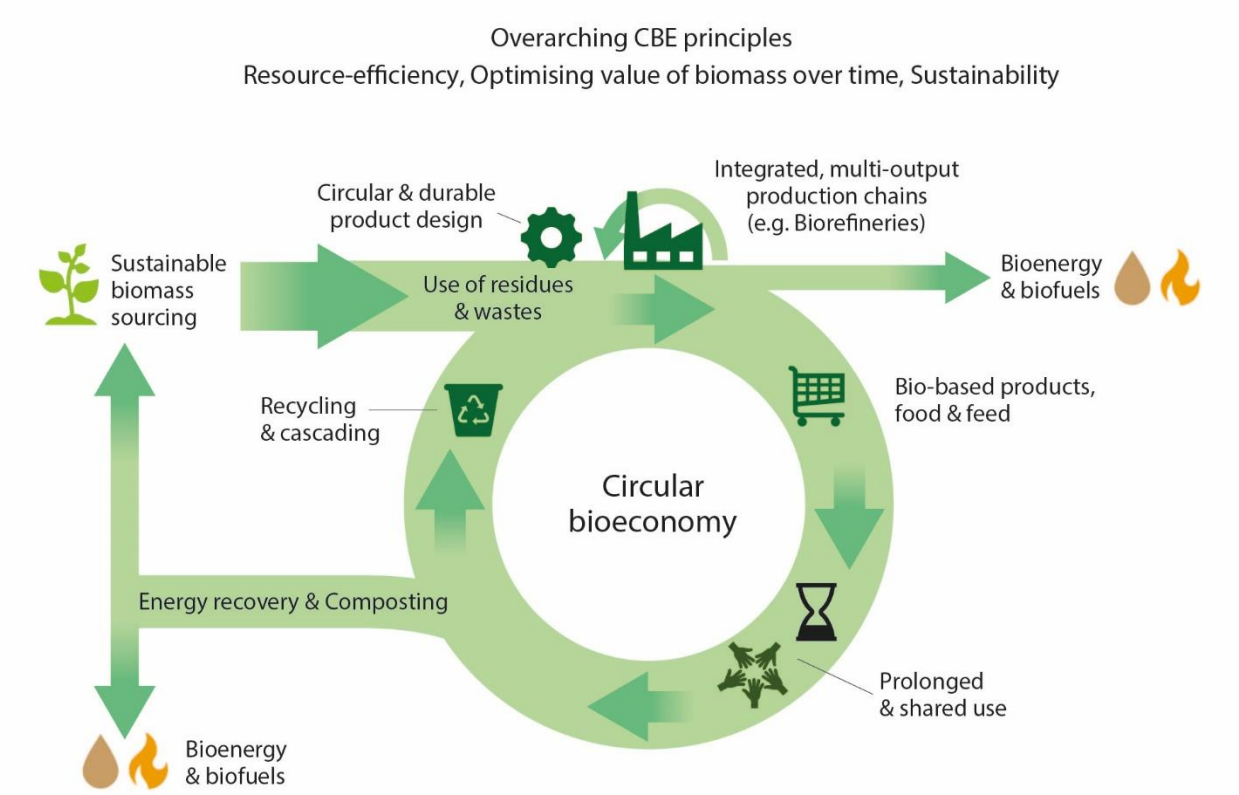
The bioeconomy is not, however, inherently renewable or sustainable. In the Updated Bioeconomy Strategy 2018, the European Commission states that "the European Bioeconomy needs to have sustainability and circularity at its heart" to manage concerns around increasing demands for biomass for short-lived and linear use. In contrast, a comprehensive circular economy needs to include the bioeconomy, which consists of organic material from agriculture, forestry, fisheries, the food and feed industry and organic processes of waste, as well as knowledge-based processes and applications (Carus, 2017[5]). Annex Box 5.A.1 provides an overview of the concepts related to the circular bioeconomy, such as the green economy, the bio-based economy and the circular economy, and the linkages between them.

The Hungarian Ministry of Agriculture understands the circular bioeconomy as the economy that uses renewable biological resources to sustainably produce food, feed, bio-based materials, products, fuels and bioenergy, and in which waste products are kept within the system. Hungary focuses on the sustainable conversion of biomass and bio-based resources into marketable products, and places biomass production and processing in a single system, while underscoring the role of technology in biological resources to create added value and encourage new business models.

Figure 5.1 summarises the central elements of the circular bioeconomy. A closer look through the life cycle processes along the biomass and food priority area helps identify many opportunities for the circular bioeconomy:

- **Primary production**. This refers to the sustainable management of land and forests, including the distribution of land, water, biodiversity and other environmental resources, the efficient and sustainable use of natural resources in agricultural and forestry management practices, and carbon farming and sequestration. Several bio-based sources originating from any life cycle stage, such as biomass waste and residues, can be utilised in this stage as feed, fertiliser, soil conditioner or other purposes without pre-treatment.
- **Industrial processing and distribution**. This includes the bio-based production of processed food, feed, fertilisers, chemicals, pharmaceuticals, nutraceuticals, cosmetic compounds, biomaterials, packaging processes and consumer delivery. The design of a product and its production process is crucial to ensuring a longer lifespan, both in terms of its primary use and the potential to reduce waste and increase recycling. There is also potential for greater efficiency in processing, and using processing residues and waste from agriculture and forestry by cascading (i.e. reprocessing of biomass at its highest material value before its conversion into bioenergy). Packaging and products distribution can be directed towards greater circularity and less food waste, including by ensuring recyclability and limiting overall environmental impact.
- **Consumption**. At the core of this stage are changing consumption patterns, waste prevention, and prolonging the use of products by cascading their use in line with the waste hierarchy: with redistribution, reuse and recycling at the top of the hierarchy, followed by recovery and disposal. This is particularly relevant for the consumption, use and disposal of food and bio-based products.
- **End-of-life**. This stage refers to the treatment of materials and products when they become waste products. This includes waste from primary biomass production, processing, consumption and bioenergy production stages. The circularity of waste produced from biomass and bio-based products means improving waste sorting to facilitate use and recycling, enhancing recycling technologies and processes, and extracting valuable chemicals as components from processing. Furthermore, biomass and organic waste are critical inputs for bioenergy production. However, energy recovery should be used only when the options higher up in the waste hierarchy cannot be achieved.

Figure 5.1. The circular bioeconomy (CBE) and its principles



Source: Stegmann, Londo and Junginger (2020[6]).

5.1.3. The rationale for a circular bioeconomy in the priority area of biomass and food

The rationale for a circular bioeconomy in the priority area of biomass and food lies in its potential to contribute to climate change mitigation, socio-economic development and environmental protection over time by maintaining the value of bio-based products, materials and resources in the economy for as long as possible. From a systems-thinking approach, Hungary understands the circular bioeconomy as a new techno-socio-economic paradigm of production and consumption. This requires: i) rethinking its development orientations and principles; ii) taking advantage of its technological solutions; iii) setting economic thinking on a new pathway; iv) strengthening political and institutional support; v) ensuring policy coherence across objectives, instruments and practices; and vi) involving relevant stakeholders in policy design processes to a greater extent.

Biomass brings an opportunity for the EU by providing additional natural resources for the economy and products, and closing the biological cycle of biodegradable materials. Biomass also helps diversify Europe's energy supply, create growth and jobs, and lower GHG emissions. According to the latest available data, the total biomass supply in the EU27 added up to 1 billion tonnes of dry matter[2]. The agriculture sector is the biggest producer of biomass (69%), followed by forestry (31%) and fisheries (<1%). Around 60% of the biomass in the European Union is used for food and feed, with 24% of identified biomass used for energy and 16% for biomaterials[3] (Gurria Albusac, 2022[7]).

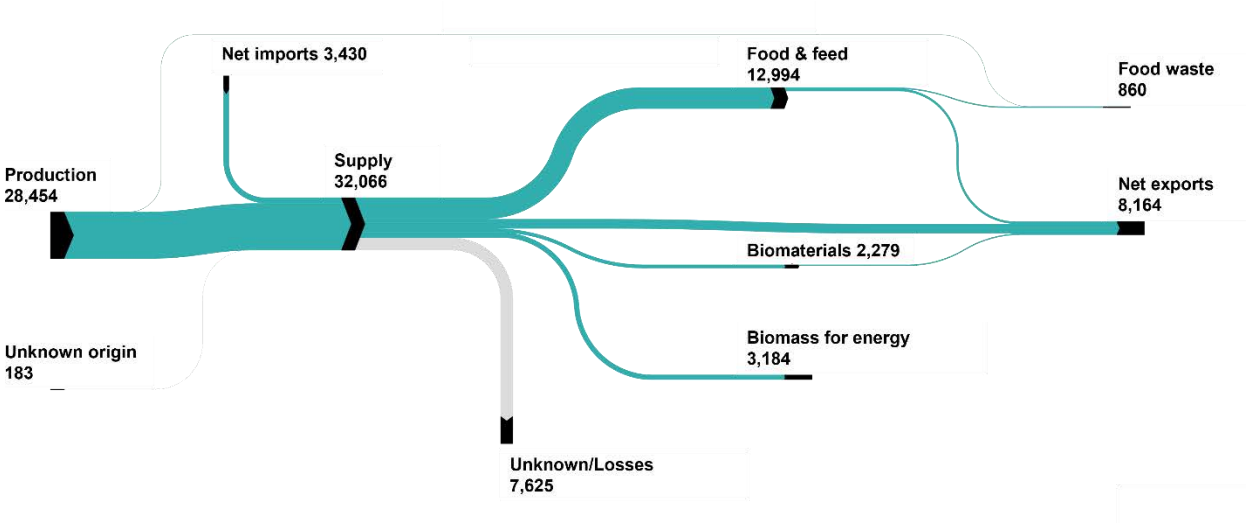
Today's food system is unsustainable and is both affected by and a driver of climate change, resource scarcity, environmental degradation, loss of biodiversity, and pollution and waste (European Commission, 2016[8]). Indeed, the food system is one of the most frequently targeted priority areas in national circular economy strategies given its high land, water and energy consumption and large waste production

(Salvatori, Holstein and Böhme, 2019[9]). The available estimates show that the level of food waste generated annually in the EU and its Member States is cause for concern. Around 88 Mt of food waste was generated in 2012 across the food value chain, representing approximately 20% of all food produced within the EU. Its associated costs were estimated at EUR 143 billion in 2012 (Stenmarck et al., 2016[10]). The most recent estimates of European food waste levels reveal that 70% of EU food waste originates in the household, food service and retail sectors, with production and processing sectors contributing the remaining 30% (Stenmarck et al., 2016[10]).

5.2. Biomass and food in the Hungarian economy

This section approaches the biomass and food priority area from the perspective of the agriculture sector, which is the primary source of biomass resources and raw materials for the food industry and an important part of the Hungarian economy. Forestry is also addressed due to its essential contributions to biomass and the construction and packaging industries. This section also looks at the material recovery of agricultural and industrial food waste and biomass consumption, which amounts to above one-third of Hungary's consumed materials in 2016, and on which Hungary relies for its renewable energy supply (OECD, 2018[11]) (see Figure 5.2).

Figure 5.2. Biomass flows in 1 000 T of dry matter (net trade) for Hungary



Source: "EU Biomass Flows tool" (European Commission – Joint Research Centre, n.d.[12]) presenting harmonised data from the various Joint Research Centre (JRC) units contributing to the BIOMASS Assessment study (European Commission, JRC, Data from the BIOMASS project) (Gurria Albusac, 2022[7]).

5.2.1. The agricultural sector remains essential in Hungary's economy, yet its labour productivity is relatively low

Hungary's value added in the agricultural sector outperforms the rest of the EU. The value added in the net agricultural sector, including crop and livestock production, forestry and fisheries, was 3.9% in 2020, the third largest value in the EU (the EU average is 1.7%) (World Bank, n.d.[13]) and one of the highest among OECD countries (OECD, n.d.[14]). The agriculture sector provides 90% of Hungary's biomass when considering production and net trade, as estimated in dry matter equivalent, in the EU. This is higher than the 65% share in the former EU 28 (Camia, A. et al., 2018[15]). Furthermore, while the country's agriculture and food industry is firmly integrated into European markets, the national food industry purchases two-

thirds of agricultural production. However, the production potential of Hungary's food economy could be 60% higher than it is today (Ministry of Agriculture, 2017[16]). Almost 80% of Hungary's land area is productive land (Hungarian Central Statistical Office, 2018[17]), and small farms prevail across the agricultural sector (83% in 2016) (Eurostat, 2020[18]). Employment in agriculture remained stable at around 5% between 2010-2019 (World Bank, n.d.[19]), excluding the significant sectors' undeclared work (Eurofound, 2013[20]).

Despite the positive developments, the Hungarian agri-food sector suffers from low labour productivity compared to other European countries (European Commission, n.d.[21]). This is notably due to less advanced production technologies and a lack of financial resources for technological development and innovation. In terms of production technologies, the limited resources to invest in R&D are related to the relatively low profitability of the sector, particularly in small companies (fi-compass, 2020[22]). In addition, there is also a risk of soil depletion because of the low levels of phosphorus in the soil, even if Hungary is among the top three EU countries with the highest phosphorus consumption per hectare (Eurostat, n.d.[23]).

Forestry also plays an important role owing to its biomass contribution to renewable energy production, and to the construction and packaging industries. However, Hungary is one of the least forested countries in Europe (OECD, 2018[11]), and forestry and logging, as well as fishing and aquaculture, contribute negligibly to gross value added (GVA). Forestry contributes 0.5% of national employment (Research Institute of Agricultural Economics, 2019[24]), with solid employment growth observed between 2008 and 2018 (Eurostat, 2020[18]).

5.2.2. Food production is central in Hungary's industry and represents the lion's share of national household-level consumption

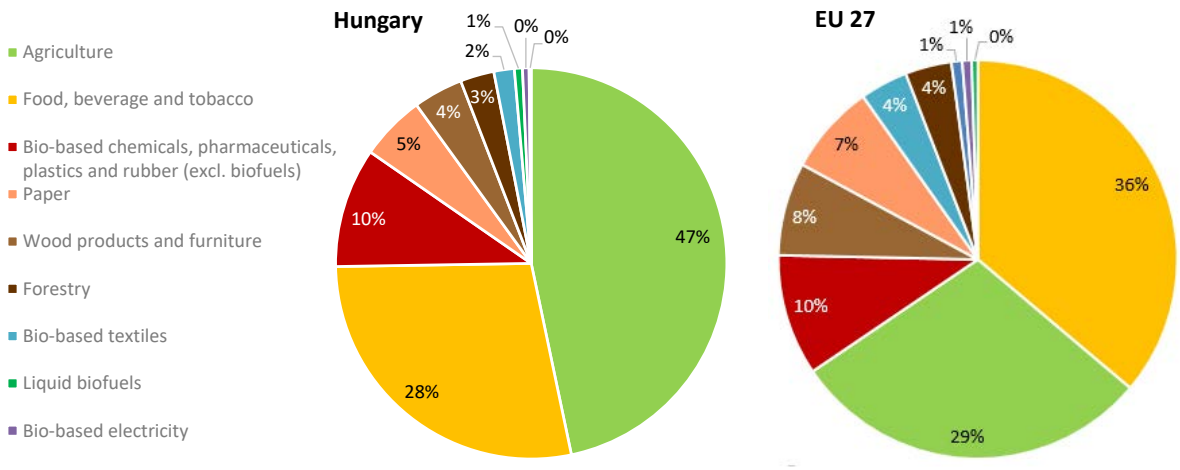
Industrial processing and distribution of food products, beverages and tobacco is the third largest sector in Hungary's manufacturing sector. The share of food, beverages and tobacco reached 10.5% of Hungary's GVA in manufacturing in 2020 (World Bank, n.d.[25]), with the share of the food industry at 2% of GVA in 2019 (Hungarian Central Statistical Office, 2020[26])[4]. The employment rate in the biomass and food processing sectors is in line with the EU-27 average, adding up to 3.1%[5] of the total workforce in Hungary in 2020 (Eurostat, n.d.[27]).

Food industry products is the most significant sector of consumption in Hungary. Expenditure for food, beverages and tobacco accounted for 28% of per capita expenditure of households in 2019 (Hungarian Central Statistical Office, n.d.[28]), a higher share than housing, maintenance and household energy (18.5%). Consumer preference for eating locally produced fruits and vegetables, as well as seasonal products and organically farmed produce, has increased in recent years (Hungarian Chamber of Agriculture, n.d.[29]). However, the annual consumption of meat and meat-derived products has remained stable in the last decade (Hungarian Central Statistical Office, n.d.[28]).

5.2.3. Hungary's bioeconomy grew by about one-third in the last decade, but its focus remains on agricultural production

The value added of Hungary's bioeconomy was around EUR 10 billion in 2019, a 35% increase from 2008 (Ronzon et al., 2022[30]). The liquid biofuels sector (bioethanol and biodiesel production) had the highest growth rate in terms of value added during this period (2 405% increase), however, this sector corresponded only to 1% of the total value added in Hungary's bioeconomy. Almost 50% of Hungary's bioeconomy by value added in 2019 related to the agricultural sector (Figure 5.3), and this share has not changed in the past ten years. In the EU, the focus lay primarily on the food, beverage and tobacco sector in 2019 (36% of the total value added in bioeconomy-relevant sectors), with agriculture at around 30%.

Figure 5.3. Bioeconomy value added by sector in Hungary and EU 27 in 2019



Source : Based on JRC Dataset (Ronzon et al., 2022[30])

Looking at the value added per person employed, Hungary's average was around EUR 26 000 in 2019, which was considerably lower than the EU 27 average of EUR 38 000 (Ronzon et al., 2022[30]). This may be the result of the combination of the high share of agriculture in Hungary's bioeconomy (close to 50%) and the relatively low value added per person employed in the agricultural sector. In the EU 27, the agricultural sector had the lowest value added per person employed in all the bioeconomy-related sectors in 2019.

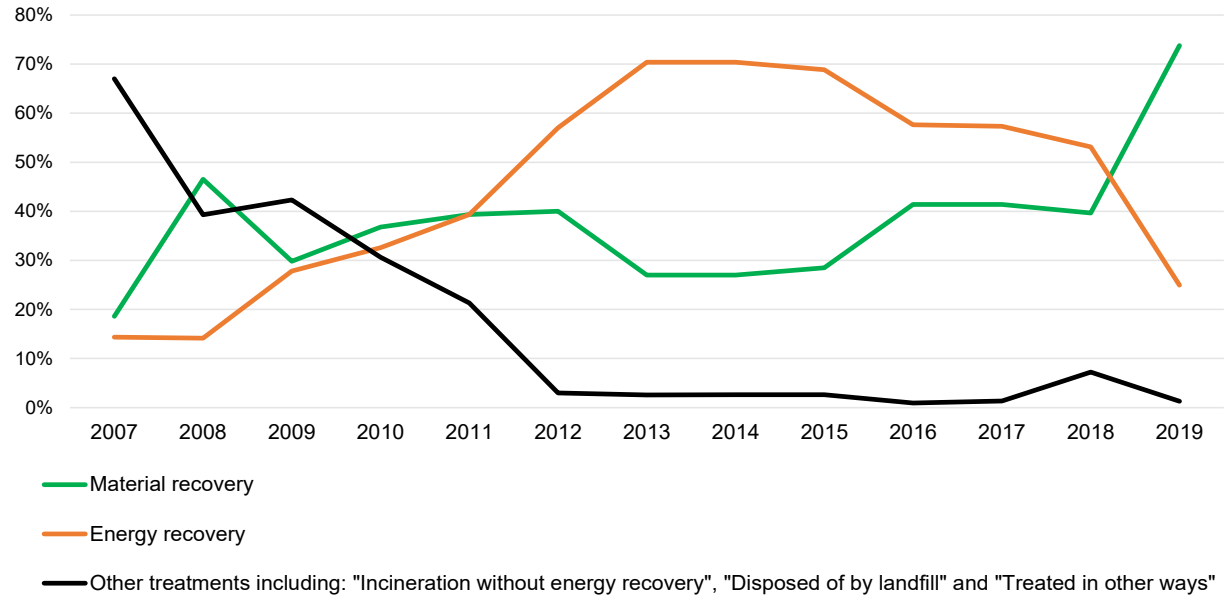
This implies that Hungary's bioeconomy, while growing, has remained material-focused, with an overemphasis on the primary production of biomass and the processing of primary biomass over bio-based products and services in higher end value added sectors of the bioeconomy.

5.2.4. Materials recovery of agricultural and industrial food waste is increasing in Hungary, but half of per capita food waste could also be avoided

Hungary produced 749 000 tonnes of agricultural and industrial food waste in 2020, half of which, on average, was treated by materials recovery in the last decade (Hungarian Central Statistical Office, n.d.[28])[6]. Estimates show that annually, in per capita terms, almost half of the 68 kg of food waste generated by Hungarian households in 2016 could have been avoided (Kasza, G. et al, 2020[31]). In 2020, Hungary's household food waste in per capita terms stood at 66 kg, just below the EU 27 average of 70 kg (Eurostat, 2022[32]). Nevertheless, Hungary's annual per capita total food waste amounts to 93 kg, which is far below the EU 27 average of total food waste at 127 kg in 2020 (Eurostat, 2022[32]). In line with the concept of supporting cascading use, materials recovery in Hungary has increased, and energy recovery has decreased since 2007 (Figure 5.4). In the last decade, more than 92% of agricultural and industrial food waste was utilised as materials or energy recovery, which is an important achievement, even though further efforts are needed.

Figure 5.4. Percentage volume of agricultural and food industrial wastes treated by materials recovery, energy recovery and other options in Hungary

As registered by the Hungarian Central Statistical Office



Source: Adapted from data in table no. 15.1.1.28. of the HCSO (Hungarian Central Statistical Office, n.d.[28]).

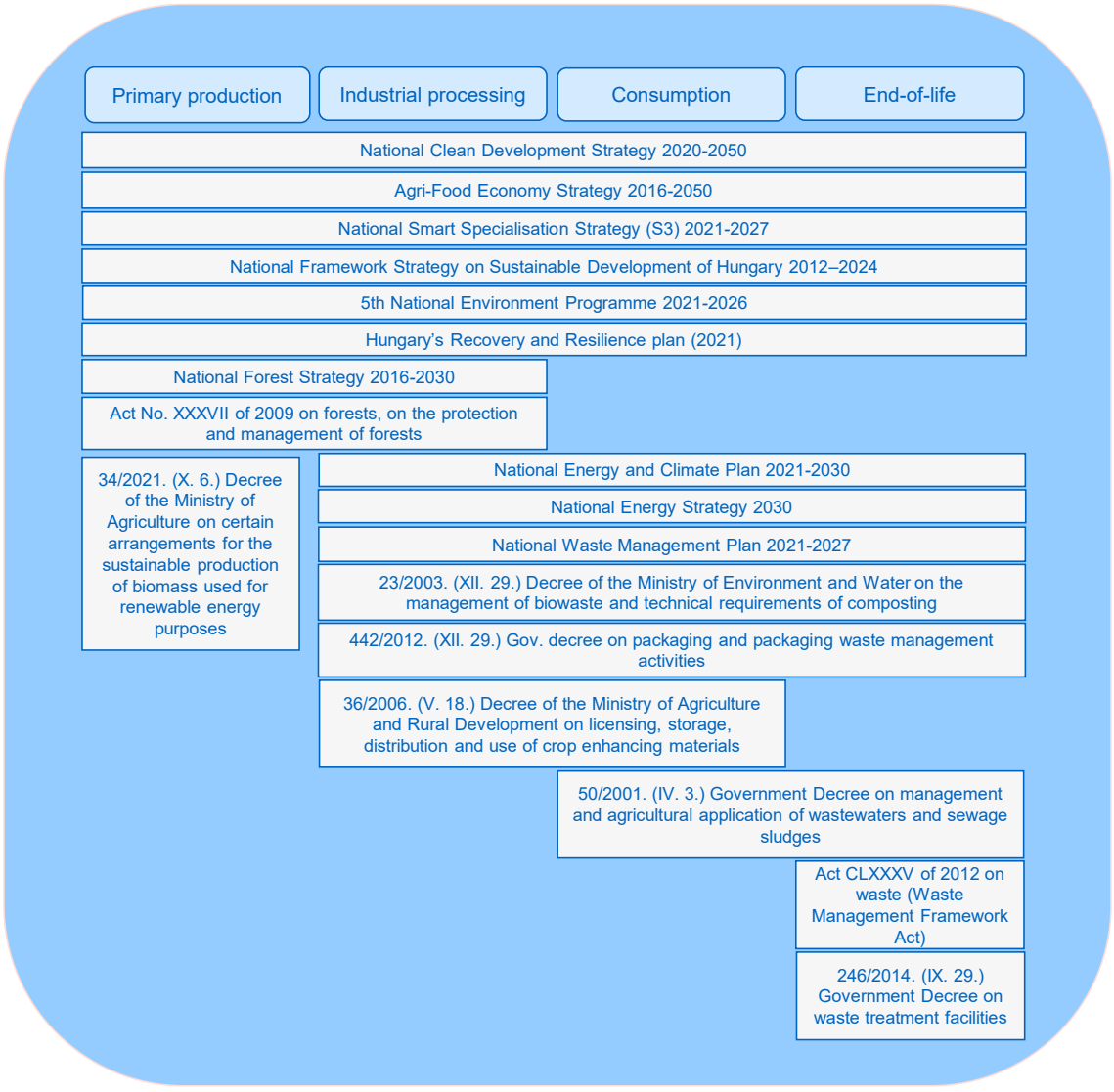
5.3. Hungarian policy and the legal context relevant to biomass and food

This section presents the central objectives, targets and shortcomings in Hungary's policy and legal context relevant to the biomass and food priority area, in particular, the agri-food sector, waste management, consumer behaviour, and biomass' contribution to the bioeconomy. While this section does not aim to exhaustively list all the strategies and policies in Hungary that directly or indirectly relate to the biomass and food priority area, it does cover the most important ones.

5.3.1. Hungary's strategies and policies in the biomass and food priority area are in line with EU legislation

Hungary has adopted legislation and strategies relevant to the biomass and food priority area. Hungary can count on six main national strategies that deal with materials and resource management across the entire biomass and food life cycle (Figure 5.5) and which are aligned with relevant EU legislation and policy (see Annex Figure 5.A.2 for an overview of the applicable EU legislation).

Figure 5.5. Overview of the biomass and food related policy landscape in Hungary



5.3.2. Hungary's policy framework focuses on primary production and industrial processing, but implementation is not enough

The Hungarian agri-food sector addresses circular economy principles through environmental protection, the sustainable use of natural resources and viable agricultural production. These elements are outlined in the National Rural Development Strategy 2012-2020 (Ministry of Rural Development, 2012[33]) and linked to the Irinyi Plan (Ministry for Innovation and Technology, 2016[34]) and complementary policies and laws, for instance, targeting organic farming (Ministry of Agriculture, 2016[35]), genetically modified organisms (GMO)-free agriculture (Parliament of Hungary, 2011[36]) and the digitalisation of agricultural production (Ministry for Innovation and Technology, 2021[37]). In addition, food production processes, local food chain development and food consumption in Hungary are examined in its Medium- and Long-term Development Strategy for Food Industry 2014-2020 (Ministry of Agriculture, 2015[38]) and the Food Industry Concept of Hungary 2017-2050 (Ministry of Agriculture, 2017[16]). Hungary also benefits from additional complementary strategies in the agri-food's industrial processing stage. In this regard, the National Smart Specialisation Strategy (S3) refers to food from innovation and technology, and the National Energy

Strategy 2030 (Ministry of National Development, 2012[39]) introduces the concept of "bipolar agriculture" to enable a flexible switch between food and energy crop farming as required by the market.

Although agriculture and food policy frameworks in Hungary connect well with the circular economy on a conceptual level, these concepts lack implementation in practice. For instance, the biological treatment of agricultural by-products and food waste, and their use as compost and feedstock for energy, are referred to in some policies. However, those policies do not outline specific measures or targets for their operationalisation. Moreover, Hungary does not yet have a dedicated bioeconomy policy framework[7] nor is there an effective integration of bioeconomy principles, beyond the references in the National Smart Specialisation Strategy (S3) 2021-2027.

5.3.3. Hungary's strategies and policies on waste management focus on separate collection, recycling and composting of bio-waste

Hungary has a long developed legal and policy framework for waste management, notably driven by EU legislation (OECD, 2018[11]). Complemented with the National Framework Strategy on Sustainable Development (Nemzeti Fenntartható Fejlödési Tanács, 2013[40]) and the New Széchenyi Plan (Government of Hungary, 2011[41]), the main legal instruments are the National Waste Management Plan 2021-2027 (Ministry for Innovation and Technology, 2021[42]) and the Waste Management Framework Act (Act CLXXXV of 2012 on waste) (Parliament of Hungary, 2012[43]). The Act underlines the need to respect the waste hierarchy, and provides the principle for biodegradable waste utilisation.

Consumer behaviour plays a central role in the separate collection of bio-waste. The National Clean Development Strategy 2020-2050 (Ministry for Innovation and Technology, 2021[44]), in line with the Fifth National Environmental Programme 2021-2026, acknowledges that consumption patterns must evolve to reduce waste and food loss in Hungary. Moreover, the National Waste Management Plan (NWMP 2021-2027) introduces the separate mandatory collection of bio-waste by 2024, and emphasises that waste management can effectively support the circular economy only if all stakeholders are encouraged to apply the higher levels of the waste hierarchy. The plan also aims to halve food waste per capita by 2030 at the consumer and retail level as well as reduce food losses along production and supply chains (Ministry for Innovation and Technology, 2021[42]). Despite progress in this area, Hungary could further improve the management of bio-waste at the municipal level, including through enhanced infrastructure for separate collection and expanded bio-waste sorting.

Hungary's waste policy framework emphasises recycling and composting. The NWMP 2021-2027 spells out actions for non-hazardous bio-based wastes from the agriculture and food industry, for example, by: i) increasing the rate of bio-based wastes treated by composting; ii) promoting household and local community composting; or iii) collecting and recycling agricultural foil wastes at the country level. To move towards a strengthened circular bioeconomy, Hungary could introduce complementary strategies and policies higher up in the waste hierarchy on waste prevention, redistribution and reuse.

5.3.4. There is scope for expanding the contribution of biomass to the bioeconomy beyond its use in the renewable energy sector

Bioenergy and bioeconomy goals compete for biomass resources in Hungary's policy context. On the one hand, the current Hungarian policy framework on biomass focuses on its energy applications. Indeed, biomass-based energy production remains critical among renewable energy resources in Hungary, notably due to the country's dependence on fossil fuel imports. On the other hand, biomass can be directed to the production of bio-based products, maintaining resources longer in the economy based on the waste hierarchy principle. Hungary aims to increase renewable energy sources to at least 21% of gross final energy consumption and to diversify renewable energy consumption, reducing biomass dominance in renewable energy sources to 75% by 2030 (National Energy and Climate Plan 2021-2030) (Ministry for

Innovation and Technology, 2020[45]), in line with the National Framework Strategy on Sustainable Development (Nemzeti Fenntartható Fejlödési Tanács, 2013[40]) and the New Széchenyi Plan (Government of Hungary, 2011[41]).

Developing and implementing solutions for managing sewage sludge and other bio-waste provide an opportunity for the Hungarian circular bioeconomy, particularly with regard to livestock production and soil fertilisation in agriculture. This is well reflected in the National Clean Development Strategy 2020-2050 and the NWMP 2021-2027, which underline the potential of sewage sludge on agricultural land. Hungary could benefit from spelling out these strategies by tackling soil depletion with sewage sludge and feeding it back to agricultural soils. These efforts would contribute to increasing the targeted rate of bio-based wastes treated by composting from 200 000~300 000 to 700 000~800 000 tonnes per year (Ministry for Innovation and Technology, 2021[42]). In the long term, Hungary would need to refocus its strategies on targeting higher levels of the waste hierarchy.

5.4. Life cycle gap analysis and policy recommendations for a transition towards more circular biomass and food

The previous sections defined the key concepts and established the key elements of a circular bioeconomy, including the four key life cycle stages along the priority area of biomass and food. They provided an overview of the current state of play of this priority area in Hungary, mapping out the key trends and policy landscape for each stage of the biomass and food life cycle. The overview showed that, while Hungary's policy landscape is in line with EU legislation – and the circular economy principles are to some extent embedded in the national policy framework – the focus is on the primary production of biomass for energy purposes as well as waste management. Concrete measures to implement a circular bioeconomy in Hungary are also absent. There is also a lack of more granular data in this priority area, which would provide a stronger basis for policy decision making.

This section identifies 12 key areas for improvement for the biomass and food priority area, which address these challenges thanks to the analysis made of the circularity potential and the existing regulatory framework, including stakeholder consultations and evidence gathered from international good practices. The 12 identified areas for improvement and the related policy recommendations are structured along the biomass and food life cycle, but they also include areas that cut across the entire life cycle.

5.4.1. Promoting the circular bioeconomy in primary production

The analysis of the circularity potential in the Hungarian primary production sector and the stakeholder consultation process identified the need to promote the use of natural bio-based solutions for soil in agriculture, such as compost. It also identified the need to support new initiatives for alternative protein production. The national circular economy strategy should focus efforts on these two key areas of primary production. According to the consulted stakeholders, soil plays a critical role in Hungarian sustainable food production and the circular bioeconomy. The production of alternative protein sources could provide a more sustainable solution to the current system, which is based on animal production.

The need for a regulatory framework to increase the use of products from bio-waste in agriculture

The National Clean Development Strategy 2020-2050 and the consulted stakeholders underlined the need to increase the use of natural bio-based solutions in soil management in Hungary. Natural bio-based solutions for improving soil resources include the use of bio-based fertilisers, soil conditioners, plant bio-stimulants, as well as the extended use of composts and possibly digestate. Their use enhances the soil's quality, but it also provides opportunities to utilise bio-waste for other applications and to decrease the

amount of sludge, as well as to capture CO_2 emissions (Ministry for Innovation and Technology, 2021[44]). The NWMP 2021-2027 also emphasises the potential benefits of using composts produced from bio-waste and the use of sewage sludges in agriculture to recycle the nutrients from bio-waste back into the soil. However, despite these benefits, the composts produced from bio-waste and sewage sludge have only been used to a limited extent in Hungarian agriculture, particularly because of restrictions introduced in the legislation on using bio-waste for composting[8] and sewage sludge on agricultural land.[9] In addition, Hungary lacks a supportive regulatory framework providing the necessary conditions, technical requirements and quality assurance for the use of compost and sewage sludge in agricultural applications (Ministry for Innovation and Technology, 2021[42]). Supporting organic farming and integrated farming is also essential as they pay extra attention to the intake of local biomass and organic manure, which is also beneficial for soil life.

Hungary can enhance the use of composts (and digestate) produced from bio-waste in agriculture by improving the quality assurance system for their use as well as for inputs to the composting facilities. This can be achieved through the legislation regulating the management of bio-waste and by specifying the technical requirements for composting. This may include: i) introducing a compost classification system; ii) stricter quality standards for impurities, including plastics; iii) a positive list of suitable input material for compost; iv) a check-list for the operational quality of the composting plant, as well as product control requirements for compost/digestate quality; and v) application recommendations for product use, which are the essential elements of the ECN-QAS quality label for compost and digestate (ECN, 2018[46]). For example, the quality standards for impurities have recently been strengthened in the quality assurance systems of Flanders and Germany, expressed in terms of weight but also in terms of surface area (European Environment Agency, 2020[47]). Enhancing the use of products from bio-waste in agriculture may also include the development of supportive legislation for the use of digestate on land, which is an output from the anaerobic digestion process (alongside the production of biogas), and that can be classified as an organic fertiliser.[10] A strengthened quality assurance system for compost (and digestate) would reassure farmers when using these products on their agricultural land as these products need to be good quality in order to be used as a soil improver or fertiliser (European Environment Agency, 2020[47]). Hungary could follow the example of Austria, Germany or Slovenia in developing a supportive regulatory framework for the use of compost and digestate in agriculture (see Annex Box 5.A.2). However, the experience of countries suggests that a policy mix of measures is needed to manage bio-waste effectively, including the need to improve the separate collection of bio-waste as inputs for composting (see the section “Incentivising separate collection of municipal bio-waste”), and to implement national standards for compost and digestate quality (European Environment Agency, 2020[47]). The cost of disposing bio-waste in landfills or for energy recovery would also need to increase in order to make it more economically attractive to compost.

Hungary can also investigate the potential to enhance the use of sewage sludges on agricultural land and, if needed, amend its legislation. Hungary has adopted more stringent requirements on using sewage sludges in agriculture compared to the EU Council Directive (86/278/EEC) (currently under evaluation for a potential revision). Hungary’s Government Decree 50/2001 (IV. 3) limits the use of sludge and wastewater for agricultural uses by establishing strict requirements for their use as well as requiring a permit from authorities. The NWMP 2021-2027 has increased pressure on farmers to extend the use of sewage sludges on agricultural land. However, they are less willing to use these wastes due to the environmental and human health risks associated with the use of sludges in agriculture. The literature outlines some of the benefits of the use of sewage sludges in agriculture, for example, their use can lower the production costs of farmers by decreasing the amount of synthetic fertiliser that is typically needed, as well as helping decrease the amount of accumulated sludges (Iticescu et al., 2018[48]). However, evidence from EU countries shows that the use of sewage sludge in agriculture varies, ranging from 0% in Malta, the Slovak Republic and Slovenia, to 80% in Ireland, according to data for 18 EU Member States from 2014 (Hudcová, Vymazal and Rozkošný, 2019[49]). Recently, a few countries, such as Germany and Austria, have introduced even stricter requirements for the use of sewage sludge in agriculture, and

refocused their efforts towards recovering phosphorus from sewage sludge (see Annex Box 5.A.3). The recovery of phosphorus might be particularly relevant for Hungary as the country is among the top three EU countries with the highest phosphorus consumption per hectare (Eurostat, 2022[50]). Hungary also faces a risk of soil depletion due to a negative balance of phosphorus in the soil (i.e. more phosphorus is removed from the soil than is added) (Eurostat, 2022[51]). The use of sludge in agriculture is a complex issue with many risks and any regulation promoting it will therefore need to have the right safety measures in place to prevent possible leakage of contaminants into the soil, surface water and groundwater (Hudcová, Vymazal and Rozkošný, 2019[49]). The safe application of sludges on agricultural land will also require the implementation of a mix of measures, including the continuous monitoring of the composition and microbial characteristics of sludges with special attention paid to human pathogens (Iticescu et al., 2018[48]). It may also require the development of a quality assurance system for sewage sludge products (BDE e.V., 2020[52]).

Support for new initiatives for alternative protein production

Current animal production systems are not considered sustainable as they use huge quantities of water and directly contribute to climate change (FAO, 2022[53]). For sustainability and other reasons, alternative protein sources to animal proteins are expected to claim a substantial part of the protein market in Hungary in the future. The five-year National Protein Feed Programme, which started in 2018, provides HUF 8 billion (EUR 25 million)[11] as financial support for alternative protein production, with a focus on increasing the area of soy production in Hungary (Government of Hungary, 2018[54]). However, according to some stakeholders, it was clear from the start of this programme that soy in itself is not an adequate solution for the country (AGRARSZEKTOR.HU, 2017[55]). As a result, Hungary will need to consider policy support for alternative initiatives in the field of innovative protein production, including:

- The production of crops other than soy (e.g. pea is a versatile protein option that does not lead to allergies like the consumption of soy or wheat-based products [containing gluten]).
- The production of a single cell microalgae with a high protein content, also including various nutrients and bio-active compounds, which provide an added health benefit.
- The use of insects as an alternative protein source for animal feed.
- The extraction of high added value protein products from agricultural and industrial food by-products, in line with the circular bioeconomy.

To support such initiatives, Hungary can be inspired by the Dutch government, which encourages sustainable food production by supporting alternative protein production in two national policies: the 2018 Transitie-agenda Circulaire Economie – Biomassa en Voedsel [Transition Agenda for Biomass and Food] and the 2020 Nationale Eiwitstrategie [National Protein Strategy]. The evidence from the Netherlands shows that clear and long-term targets and objectives are needed, while also encouraging banks, investors and multinational companies to provide the capital for the transition to a sustainable production of protein (see Annex Box 5.A.4).

5.4.2. Industrial processing and distribution for the development of the circular bioeconomy

A key area for improvement in the industrial processing and distribution stage of the biomass and food area relates to the lack of sufficient technical and financial support for research and innovation in Hungary's circular bioeconomy as well as multi-stakeholder cooperation between industry and the research community. Currently, the approach to the bio-based economy in Hungary (part of the bioeconomy that relates to converting biological resources into products and materials, see Annex Box 5.A.1) is material focused, which undervalues the provision of bio-based products and services, and overemphasises primary production of biomass and the processing of primary biomass. While a few champions operate in

Hungary's bioeconomy market, almost half of Hungary's bioeconomy has been associated with the agricultural sector in terms of value added in the past decade (see Figure 5.3). The agricultural sector provides a relatively low value added per person employed compared to other bioeconomy related sectors, such as bio-based chemicals and pharmaceutical products, liquid biofuels or even the paper sector (Ronzon et al., 2022[30]). Moreover, according to some of the consulted stakeholders, the Hungarian approach favours homogeneous biomass streams and monocultures as the most important natural resource for agriculture and forestry, which could possibly lead to the depletion of natural resources, especially soil.

Strengthening research and innovation around industrial biotechnology and biorefineries

Research and innovation policy – with a focus on the circular bioeconomy – must be strengthened to support biofuels and the processing of biomass into bio-based products with a higher end-value added in Hungary, as well as the transition to a circular bioeconomy. This will need to be combined with technical and financial support offered to companies as well as greater multi-stakeholder cooperation with the international research community (and across sectors) to help drive the development of biorefineries and biotechnology in Hungary. In particular, local SMEs face challenges to succeed in the bioeconomy market as they typically face barriers to access finance, with a lack of skills in mobilising finance, restricted market access and knowledge, and supply chain management issues (European Commission, Directorate-General for Research and Innovation, 2019[56]). In Hungary, it is particularly important to support research and innovation in the business environment, especially as the country is lagging behind in eco-innovation and government spending on R&D.

Hungary can strengthen its support for research and innovation in the area of industrial biotechnology and biorefineries by developing a dedicated bioeconomy research and innovation programme with associated funding and technical support. Numerous regional and EU bioeconomy experts have also advocated for the establishment of research and innovation programmes targeted to the bioeconomy across Central and Eastern Europe as a precondition of further developments in this area (BIOEAST, 2021[57]). Several EU Member States, including Germany, Italy and the Netherlands, have introduced bioeconomy strategies with dedicated research and innovation funding programmes for their domestic bio-based industries, such as the German KMU-innovativ: Bioökonomie [SME Innovative: Bioeconomy] funding scheme or the Dutch TKI Biobased Economy programme (see Annex Box 5.A.5). Similar initiatives are being launched in many other European regions, for example, in Baden-Württemberg and North Rhine-Westphalia in Germany, Bio-based Delta in the Netherlands, Flanders in Belgium and in some regions in Italy (Commission Expert group for bio-based products, n.d.[58]). As is already the case in Hungary, the research and innovation support can also come through dedicated calls under the national/regional Operational Programmes (OPs), which are co-funded by the EU structural and investment funds (see the example of a voucher scheme in the Netherlands in Annex Box 5.A.5).

Dedicated national bioeconomy research and innovation programmes would be particularly impactful in increasing innovation and R&D funding for the bioeconomy and promoting cooperation within the research community for the uptake of industrial biotechnology (cross-sectoral and cross-border cooperation). They would also support the development of new business models and stronger partnerships, and support the improved collection of data and market information.

5.4.3. Towards a sustainable consumption of biomass and food

At the consumption stage of the biomass and food value chain, two key areas for improvement have been identified: i) the need to strengthen the regulatory framework and economic incentives for food donations; and ii) the need to promote Green Public Procurement (GPP) of food and catering services. Both of these areas affect, on the one hand, the producers of food (such as supermarkets, restaurants and catering services) and, on the other hand, the users of such food (charities, vulnerable populations but also public

entities, among others). Awareness-raising initiatives directed at consumers are discussed in the section "Horizontal tools for facilitating the transition to a circular bioeconomy".

Supportive regulatory framework and economic incentives for food donations

When food surpluses cannot be avoided, food redistribution for human consumption (i.e. food donations) is the second-best option according to the waste hierarchy and before food is directed towards non-food applications (e.g. animal feed) (OECD, 2022[59]).

The analysis of the Hungarian policy landscape and the discussions with several stakeholders led to the identification of a number of barriers to food donations in Hungary. These include a lack of an efficient distribution system and scheme at county level to increase the capacities for food redistribution (National Waste Prevention Programme) as well as an existing regulatory framework that makes food donations difficult and economically unattractive for the food industry. The recent amendment to the Act 2008 XLVI and Act 2020 XLV (Act 2021 CLI) tries to support food donations by making them mandatory in some circumstances. For example, businesses with a net revenue of more than HUF 100 bn (EUR 250 million) (where revenues originate from food retail) are obliged to both offer food with a longer shelf life (more than 48 hours) to the Food Rescue Centre Non-profit Kft 48 hours before its "best before" date and to create their own food waste reduction plans. This obligation does not concern food with a short shelf life (less than 48 hours) or companies with a revenue of less than HUF 100 bn. Smaller companies can donate food 48 hours before its "best before" date but are not obliged to do so. According to the VAT Act 2007 CXXVII, food donations are exempt from VAT and, according to Act 1996 LXXXI, businesses that donate food receive tax deductions. However, to benefit from tax deductions, the receiving entity must be a charitable organisation.

To further support food donations in Hungary, instead of obliging large companies to donate food (for food with a longer shelf life that is close to reaching its "best before" date within 48 hours), the country may consider food donations after the "best before" date under specific conditions (for food that is still safe for human consumption but cannot be sold). This has been allowed in a few countries, including the Slovak Republic, and can be considered a good practice in food redistribution. Hungary can also consider introducing additional tax incentives. This could be in the form of tax credits or enhanced tax deductions of more than 100%, as has been the case in a few EU Member States (see examples in Annex Box 5.A.6). The Czech Republic and France have also introduced mandatory food donations. However, mandatory food donations are not recommended as this may lead to additional logistical challenges, i.e. increased organisational and operational capacities for charitable organisations. For a discussion of the challenges of introducing mandatory donations, see OECD (2022[59]) and European Commission (2020[60]). The EU has also developed guidelines on food donation and redistribution (European Commission, 2017[61]), which can be used by Hungary to better understand how to interpret and apply relevant legislation related to food donations.

Stimulating circular food solutions through green public procurement

Sustainable consumption and production of biomass and food can also be promoted by Green Public Procurement (GPP). The GPP of food and catering services is a well-established intervention, playing an important role within public procurement in the EU. A recent study by the Joint Research Centre analysed the extent of green criteria used in the public purchase of food products and catering services in the EU. It revealed a variety of GPP schemes that target different governance levels (national, regional and local), food products, environmental criteria as well as life cycle phases of public procurement (2017[62]). As in many EU countries, GPP is a voluntary environmental tool in Hungary. Even though Hungary's public procurement law (Act CXLIII of 2015) includes the possibility of incorporating environmental criteria in public procurement tenders, overall, contracting authorities in Hungary considered environmental aspects

in only 9% of the procedures for which information was collected in 2015 (European Commission, 2019[63]). Further, Hungary does not have a national GPP action plan.

To support the sustainable consumption and production of food, Hungary could promote the use of GPP criteria in the procurement of food and catering services. On the one hand, this measure would provide food producers with incentives to decrease the environmental impact of food production, packaging, transportation and waste, and, on the other hand, it would encourage buyers towards more sustainable diets, such as organic and seasonal food products. The GPP of food and catering services in Hungary could be enhanced by increasing the understanding of public authorities on how to implement GPP in this area and by raising awareness about GPP's benefits. This could be done by developing a guidance on GPP methodology or training materials for public authorities, and by using the EU guidance and EU GPP criteria for food, catering services and vending machines (European Commission, 2019[64]) as the basis for these materials. Hungary could also develop a catalogue of good practices to show potential suppliers of food and catering services the options and benefits of supplying sustainably produced food and catering services. Hungary could also consider introducing some form of mandatory GPP criteria in contracts, for example, by focusing on technical specifications or the selection of award criteria. Annex Box 5.A.7 provides some examples of existing GPP schemes for food and catering services.

5.4.4. Improving the management of bio-waste

When food waste and other bio-waste cannot be prevented, or redistributed through food donations, or valorised for feed or other bio-based applications, it needs to be treated or disposed of. Bio-waste can be treated through processes like composting (for compost) and anaerobic digestion (AD) (for digestate and biogas), as these products can be used on soil or as a source of energy. While the use of compost and digestate helps to close the biological cycle of bio-waste through their potential to be introduced back into the soil as a soil improver or fertiliser, the production of biogas contributes to increasing the share of renewable energy in the country and, as such, diverts energy production away from fossil fuels. Bio-waste can also be incinerated for energy recovery. From a circular economy perspective, composting needs to be prioritised over AD, and AD over energy recovery. The EU Landfill Directive requires that biodegradable municipal waste is diverted away from landfills.

The analysis of the Hungarian policy context and the stakeholder consultation led to the identification of three key areas for improvement in the management of bio-waste. First, a separate collection of municipal bio-waste must be improved as it is a crucial pre-condition for bio-waste recycling through processes like composting and AD and for the generation of high-quality compost and digestate for use on agricultural land. Second, the composting capacity for bio-waste will need to be increased to cope with the increased amount of separately collected municipal bio-waste and to produce high quality compost for use in agriculture. Lastly, competing goals of circular economy and bioenergy production need to be reconciled with the cascading principle, which favours material recovery and recycling over energy recovery.

These three areas for improvement are also associated with the requirements of the EU waste legislation obliging all Member States to introduce a mandatory separate collection of municipal bio-waste by the end of 2023 and to recycle or prepare at least 60% of municipal waste for reuse by 2030 (65% by 2035) (Waste Framework Directive). The EU Landfill Directive also introduces a landfill target of 10% or less for municipal waste by 2035. These goals and targets will have important implications for municipalities and the waste management industry in Hungary.

Incentivising separate collection of municipal bio-waste

Hungary has not yet introduced a mandatory separate collection of municipal bio-waste but it is planning to do so by the end of 2023 in line with the EU waste legislation (Ministry for Innovation and Technology, 2021[42]). Municipalities will need to ensure that an adequate infrastructure for the separate collection of bio-waste is in place as well as effective incentives for households to separate their bio-waste. Hungary

had already introduced a ban on landfilling of untreated waste in 2004 and has stepped up investments into mechanical biological treatment (MBT) plants for mixed municipal waste (OECD, 2018[11]). This has ensured that mixed municipal waste is treated prior to disposal, but it also means that municipalities might not be fully motivated to introduce a separate collection of bio-waste as they will need to build additional waste infrastructure, while the existing MBT infrastructure will need to be gradually phased out (as the need for MBT capacity for mixed municipal waste would be less as more bio-waste is separated). There would also be less incentive for municipalities to separate waste if discussions focus on increasing the waste-to-energy capacity in Hungary, as plants compete for bio-waste for the purpose of energy recovery.

To improve the infrastructure for the separate collection of bio-waste, Hungary will need to ensure a regular collection of bio-waste, the provision of properly sized containers and bags, and an appropriate distance to the waste infrastructure or a "door-to-door" collection of bio-waste. The regular collection of bio-waste will limit biodegradation issues (odours, flies or leaks) and preserve the value of the bio-waste, which decreases over time. The provision of small kitchen caddies or bags for each household is relevant, especially for households living in apartment buildings. Additionally, an appropriate distance to the containers (in case of kerbside collection) or a door-to-door collection of bio-waste are all measures that will make it more convenient for households to separate their bio-waste. In particular, Hungary can improve the separate collection of municipal bio-waste by introducing a door-to-door collection system, a proven good practice in the EU, especially in Italy. For example, in the Italian city of Milan, the door-to-door collection of bio-waste, including the provision of kitchen caddies for every household, has succeeded in achieving an almost complete sorting of kitchen waste (see Annex Box 5.A.8). The door-to-door collection can also be limited to certain households. For example, the Slovak Republic is planning to introduce a mandatory door-to-door separate collection for bio-waste for households living in single-family dwellings from 1 January 2023 to further incentivise municipalities and households to separate their waste (amendment to the Ministerial Decree of the Slovak Ministry of Environment No. 371/2015).

Municipalities can also strengthen the use of economic incentives to motivate their residents to better sort their bio-waste. This can be done in the form of gradually increasing the landfill taxes for municipal waste, the cost of which will be reflected in the household waste charges, or, preferably, by expanding the coverage of well-designed "pay-as-you-throw" (PAYT) schemes, where households pay according to the amount of mixed municipal waste they generate. The landfill taxes in Hungary were planned to be linearly increased from HUF 3 000 (EUR 10)[12] per tonne to HUF 12 000 (EUR 39)[13] per tonne (Parliament of Hungary, 2012[43]). However, currently they are frozen at around EUR 15 (HUF 6 000)[14] per tonne for municipal waste, construction and demolition waste, hazardous waste and sludge. For residual waste generated from the use of secondary feedstock that can still be used as feedstock, landfill taxes are set at HUF 4 000 (EUR 13.5) per tonne, and for residual waste that cannot be used as feedstock, landfill taxes are at HUF 3 000 (EUR 10) per tonne. These landfill tax rates are relatively low compared to the landfill tax rates in other EU Member States (Cewep, 2021[65]). The way the proceeds from the landfill taxes are spent also provides an important incentive for municipalities to recycle or landfill. To motivate municipalities to introduce separate collection of bio-waste and to recycle bio-waste rather than sending it for landfilling is to distribute the revenues (or part of them) from the landfill tax back to the municipalities for good performance on bio-waste management. This could take the form of a subsidy for introducing a separate collection of kitchen bio-waste or a door-to-door collection system, or for achieving a high rate of composting, as has been the case in the Slovak Republic (OECD, 2022[59]). The revenues collected from the landfill taxes could also be spent to support municipalities in setting up a PAYT-based scheme.

While examples of introduced volume and frequency subscription based PAYT schemes exist in Hungary, they do not lead to the desired performance of a separate collection system. This is especially true in densely populated urban areas where household waste charges are split among several households (this is the case of apartment buildings, in particular). Household waste charges should differentiate between recyclables and mixed municipal waste, and make mixed municipal waste more expensive. For example, in Flanders, which has a mandatory PAYT scheme in municipalities, the collection of residual waste is the

most expensive, followed by the collection of household biodegradable waste, in order to encourage separate collection and home composting (OVAM, 2004[66]). Municipalities will also need to be financially supported in their introduction of PAYT schemes (as was the case in Flanders), particularly as the investment costs of such schemes can be burdensome. Providing economic incentives for home composting could also facilitate separate collection of bio-waste by households (see the next section on composting). For example, in Parma (Italy) where both door-to-door collection and PAYT schemes have been introduced, households get a 12% reduction in their waste charges if they compost at home (Ricci, 2020[67]) (see Annex Box 5.A.8). Any introduction of PAYT, as well as increased landfill taxes, will require an effective monitoring and enforcement system to limit illegal waste dumping to avoid the payment of waste charges, preceded by effective awareness-raising campaigns to educate households on the "why and how" of separate collection of bio-waste (see the section "Towards more effective education, awareness raising and skills").

Increasing the recycling capacity for bio-waste

Once bio-waste is separately collected, it will need to be recycled in facilities designed for this purpose. In general, there are two ways to treat separately collected bio-waste: through composting or through AD for biogas and digestate. The increased amount of separately collected bio-waste will require an increased capacity for composting and AD to prevent such waste ending up in landfills. There seems to be a lack of capacity in Hungary at present to process bio-waste into high quality composts. Both the Waste Management Plan 2021-2027 and the National Clean Development Strategy 2020-2050 identify the need to increase (and measure) the actual composting capacity and the level of treatment and recovery of biodegradable and compostable waste. To achieve a high recycling rate of bio-waste, this waste must be treated primarily through composting, after which the product can be used as a soil improver (compost produced in MBT plants, however, cannot typically be used directly on land). In addition to central large-scale composting plants, it is also important to increase local small-scale composting capacities in Hungary.

Hungary can strengthen the financial support for bio-waste recycling facilities to ensure that adequate investments in composting capacities are made. This can be done by allocating more funds to this area within the context of the Operational Programme for 2021-2027 or by simplifying the rules for applying for such funds (e.g. widening the scope of who may apply for funds) especially if available funds are not being fully disbursed. Increasing such capacity would ensure that organic and bio-waste, in particular, (and waste other than food waste) is treated in line with the waste hierarchy (i.e. prevented from ending up in landfill or valorised for other applications before being sent for composting or AD) (OECD, 2022[59]). This will need to be combined with measures supporting the use of compost in agriculture (see the section "The need for a regulatory framework to increase the use of products from bio-waste in agriculture"), as compost that is not used (in agriculture or at home) tends to end up in landfills. Increasing the composting capacity will also help Hungary move away from landfilling of bio-waste and towards increased recycling rates.

The capacity to recycle bio-waste can also be increased by supporting home composting. While the quantities of composted bio-waste at home do not currently count towards the official recycling rates (as home composting is not measured), home composting can decrease the amount of mixed municipal waste generated, which is measured. However, as home compost is typically not sold but used at source for private gardens and plants, generating too much home compost can sometimes end up in mixed municipal waste, which can end up in landfills. Support for home composting therefore needs to be carefully considered and promoted, primarily in homes where it can be used. In other instances, Hungary may want to prioritise industrial composting and the separate collection of bio-waste. Annex Box 5.A.9 provides an example of a successful home composting initiative that relies on the provision of free composter bins and on awareness-raising and educational materials to inform and educate households on home composting.

Redefining the policy approach for bioenergy production in line with the circular economy

Biogas production from agricultural wastes, landfills and wastewater treatment plants, which is then fed into the gas network after purification, may contribute to reducing natural gas imports and CO_2 emissions from natural gas consumption. This can also help meet renewable energy targets and the overall decarbonisation of the Hungarian economy. Even though the generation of renewable energy in Hungary (the major share of which is from biomass) is an important policy goal in the country, supported by relevant policy and targets, the treatment of biodegradable waste needs to follow the waste hierarchy and the cascading principle for the use of biomass and bio-based materials. Composting therefore needs to be prioritised over AD (which produces biogas), and AD over energy recovery. Moreover, a circular bioeconomy can only be achieved if there is a shift in focus from bio-waste treatment towards strategies aimed at higher levels of the waste hierarchy, i.e. bio-waste prevention and reduction, and the bioeconomy (OECD, 2022[59]).

Hungary will need to reconcile and possibly redefine its policy approach for bioenergy production to ensure the transition to a circular bioeconomy (this is also in line with the National Clean Development Strategy 2020-2050). This is because the bioenergy and bioeconomy goals are sometimes conflicting when they compete for the same biomass resources. The use of biomass for energy purposes is currently dominating the Hungarian policy landscape, which is not in line with the EU Circular Economy Action Plan nor with the European Bioeconomy Strategy. The circular bioeconomy may be favoured over bioenergy by setting an ambitious recycling policy or by adopting an integrated policy approach, which considers the interests of relevant sectors such as agriculture, forestry, soil preservation, energy production, nature conservation, and transportation (see the example of German's Ordinance on the generation of electricity from biomass in Annex Box 5.A.10). This redefined policy approach to using biomass needs to favour its use for materials use and recycling over energy use. Only when biomass or bio-waste cannot be used as a resource for bio-based applications or compost may it be used for energy purposes. Introducing such an approach may benefit from the development of a decision process for the use of biomass, which is based on a set of strategic priorities, including those suggested by the OECD on climate change mitigation, protection of the environment, energy security, economic stability and job creation (Philp and Winickoff, 2018[68]). As the integrated policy approach for biomass use involves a variety of different sectors and stakeholders, a coordination mechanism will also need to be in place (see section "Better cross-sectoral and multi-stakeholder cooperation, data collection and measurement").

5.4.5. Horizontal tools for facilitating the transition to a circular bioeconomy

To enable the implementation of identified policy recommendations along the life cycle of biomass and food, Hungary will also need to put in place several measures that cut across the entire biomass and food life cycle. These measures relate to raising awareness on the circular bioeconomy among companies and households, as well as educating citizens and municipalities. However, it also requires improvements in coordination and cooperation among relevant stakeholders, the capacity of business to innovate, and data collection and measurement.

Towards more effective education, awareness raising and skills

An educated, informed and skilled population can spur action towards a circular bioeconomy and help provide solutions to complex and interconnected challenges that are common in the circular economy. While the Hungarian policy framework identifies the need to introduce the basic principles of the circular economy and waste management into the school curricula (Waste Management Act CLXXXV of 2012), to raise awareness about food waste (Agri-Food Economy Strategy 2016-2050 and the National Food Chain Safety Office) and to support such initiatives financially through the EU funds, many challenges remain in this area in Hungary. The key challenges include: i) low awareness and understanding of the concepts around the circular economy and, in particular, the bioeconomy; ii) unsustainable food consumption

patterns and food waste reduction practices; and iii) a shortage of a highly skilled workforce in this area (in particular linked to innovation).

Hungary will need to improve the effectiveness of its education, information and training tools to raise awareness and improve the skills of its citizens, public entities and companies in the area of the circular bioeconomy. Hungary could start by focusing on the food waste generated by restaurants, canteens and mass catering services, which according to one consulted stakeholder, could be greatly reduced by awareness raising and education activities. Raising awareness and education can be done by showcasing successful pilot projects, initiatives and campaigns, but also by implementing targeted consumer campaigns and interactive events, thereby motivating changes in behaviour, attitudes and practices. International good practices provide numerous examples of tools targeting food waste prevention by companies and consumers, and bio-waste management, as well as better sorting of bio-waste by households and the use of date marking or marketing practices. Effective tools use insights from behavioural sciences and involve retail and food services, as well as social media influencers, providing a positive incentive (such as rewards) rather than a penalty. Annex Box 5.A.11 provides some examples of successful initiatives in Hungary and other European countries.

Incentivising innovation and circular business models for a circular bioeconomy

Innovation and the application of circular business models play an essential role in the transition to a circular bioeconomy. Innovation helps companies bring bio-based products and services with a higher value added onto the market and helps them compete in global value chains. Circular business models help the economy to reduce the extraction and use of natural resources and the generation of industrial and household wastes (OECD, 2019[69]). Despite various forms of support for innovation in Hungary, the innovation capacity of SMEs has not improved significantly in recent years. Hungarian businesses are characterised by a lack of forward planning and a general reluctancy to innovate, particularly SMEs. They are mostly engaged in low value-adding activities in global value chains, therefore, the share of domestic value added is low in Hungary, especially in manufacturing.[15] Companies involved in the biomass and food value chains face similar challenges.

Hungary will need to step up its innovation efforts in the biomass and food value chains, including the use of circular business models, by increasing the effectiveness of its existing technical and financial support for innovation in this area. The technical support may consist of better communication of information to companies about financing opportunities beyond conventional R&D grants, and helping them develop business plans of a higher quality that would help them secure external funding. According to some of the consulted stakeholders, access to finance and to business support is the key challenge that Hungarian companies face in the country. Business chambers, clusters and other organisations can play an important role in the dissemination and knowledge transfer of financing instruments that are available to SMEs, research organisations and educational institutions. Dissemination of examples of profitable business cases and innovative business models could also be a useful tool to draw the attention of entrepreneurs to the circular bioeconomy, particularly in the aquaculture and forestry sectors. Financial support may consist of a dedicated tax instrument to deduct additional investment costs. For instance, the Netherlands introduced two tax incentive schemes for investing in environmentally friendly technologies, which allow entrepreneurs to deduct additional investment costs on top of the regular investment tax reduction or to decide when to write off a part of the investment costs, which brings liquidity and interest benefits. Circularity indicators may also need to be introduced in the calls for funding to ensure that the funded projects effectively contribute to the transition to a circular bioeconomy.

Better cross-sectoral and multi-stakeholder cooperation, data collection and measurement

Cross-sectoral, cross-value chain and multi-stakeholder cooperation is at the core of a successful circular bioeconomy as actors active at the different stages of the biomass and food value chains need to work

together to meet common goals. Evidence from some European countries show that a common vision and joint actions are needed to build commitment to achieve the overarching goals and targets (OECD, 2022[59]). Monitoring progress towards targets also requires a solid base of evidence on the material flows and waste in the biomass and food area. This can help identify bottlenecks and the areas for improvement that policy makers need to address.

According to some of the consulted stakeholders, the biomass value chain is fragmented in Hungary as the different sectors along the biomass life cycle (primary production, processing, consumption and waste management) do not have a good insight and understanding of each other. Hungary also lacks a dedicated institutional steering and coordination mechanism between the different ministries to steer actors across the sectors and policies towards a circular bioeconomy. A circular economy platform has recently been established, which could support Hungary on its path towards greater cooperation in this area.

For the successful transition to a circular bioeconomy, Hungary needs to consider the establishment of a dedicated institutional steering and coordination mechanism between the different ministries and relevant organisations. The Ministry of Energy, responsible for the development and implementation of the national circular economy strategy, and the Ministry of Agriculture, responsible for developments in the national bioeconomy, should take the initial steps in this process. This entails defining the role of other governmental and non-governmental organisations. The development of a cooperation platform supported by public authorities, while encouraging actors to share good practices, could also lessen the fragmentation that exists in the biomass and food value chain.

With regard to monitoring and measuring materials and waste flows of biomass and food, reliable and more granular data collected for the different types of biodegradable wastes are needed for the efficient valorisation of these types of wastes. As in many other countries, these data are missing from the statistical databases and information systems, including from the National Environmental Information System (OKIR) or data series of the Hungarian Central Statistical Office (HCSO). One reason for their exclusion from official statistics could be the recycling of some of these wastes directly at source in agricultural processes, and thus these recycled wastes is statistically unaccounted for. Another reason is the low granularity of waste categories used for data reporting. For example, wastewater produced in the dairy industry can be very diverse in their chemical composition, pH, suspended solid material content or biochemical oxygen demand (Aleksza, 2018[70]). As a result, different uses or waste management technologies are required to process this waste category. However, statistical databases, including the OKIR database, include only the general waste categories for dairy industry wastes, which do not differentiate between industries. This does not allow for capturing information on the circular use of these wastes. The consulted stakeholders also pointed out that monitoring the volumes of food waste across the entire food production and consumption value chain would be essential for setting up a comprehensive food waste reduction system in Hungary.

Hungary will need to improve the existing monitoring and data collection system for biodegradable wastes. The country can start with monitoring and measuring food waste, as food waste reporting to Eurostat has become mandatory with the first reporting to the EC of 2020 data by mid-2022 (Delegated Decision EC/2019/1597 and Commission Implementing Decision (EU) 2019/2000). The amount of household food waste is precisely known in Hungary as it is monitored by the National Food Chain Safety Office (NÉBIH), including the quantities used for composting or animal feed. Improved data collection of biodegradable wastes can be enhanced by: i) improving reporting methodologies; ii) creating a waste catalogue containing multiple criteria, including waste compositional data, environmental impact and other sustainability indicators; iii) installing a competent authority for the collection, validation and public reporting of data; and iv) stimulating benchmarking, transparency and the levelling of information asymmetries across ministries and the value chain segments (OECD, 2022[59]). Hungary can draw on guidance documents developed by Eurostat on the reporting of data on food waste and food waste prevention (European Commission, 2021[71]) as well as the EU Platform on Food Losses and Food Waste (the sub-group on food waste measurement) (European Commission, 2016[72]).

5.5. Concluding reflections on the key policy recommendations

This chapter analysed the Hungarian policy context in the biomass and food priority area and the different policy instruments that could support its transition to a circular bioeconomy. The analysis identified areas for improvement, leading to a set of key policy recommendations (Table 5.1) that have been further developed into implementation actions (Chapter 8).

The findings show that there is considerable scope for the further development and application of several policy instruments across the biomass and food value chain, including regulatory and economic instruments, as well as information and educational tools to support this transition. In particular, there is a need to:

- Strengthen regulatory instruments to support a wider use of compost and digestate in agriculture and recycling of biodegradable wastes into high quality composts as well as introduce a mandatory separate collection of bio-waste, which is a crucial pre-condition for bio-waste recycling.
- Expand the use of economic instruments to provide economic incentives for innovation and investments in biotechnology and innovative bioeconomy applications for food donations as well as for better sorting of bio-waste.
- Enhance the effectiveness of existing education and awareness-raising tools, as well as skills by using insights from behavioural sciences, and targeted campaigns and training courses.
- Support cross-sectoral, inter-ministerial and multi-stakeholder cooperation to enhance innovation and align conflicting goals associated with the use of biomass according to waste hierarchy principles.

However, to accelerate sustainable consumption and production of biomass and food, the policy efforts in the long term will need to shift focus from waste management and recycling (composting and AD) towards strategies aimed at supporting the use of bio-based resources in agricultural practices and the development of the circular bioeconomy.

Table 5.1. Overview of gaps and policy recommendations by life cycle stage

Life cycle stage	Gaps	Policy recommendations
Primary production	Natural bio-based solutions for soil (i.e. compost and digestate produced from bio-waste and sewage sludge) are not sufficiently used in agriculture	Develop a regulatory framework to support the use of products from bio-waste (compost and digestate) in agriculture, with a focus on the quality assurance system for compost and digestate
		Investigate the potential to enhance the use of sewage sludges on agricultural land
	Initiatives for alternative protein production to animal protein production are not sufficiently supported	Consider policy support for alternative initiatives in the field of innovative protein production
Industrial processing and distribution	Lack of targeted support for research and innovation of the bioeconomy, including for the development of biorefineries and biotechnology as well as multi-stakeholder cooperation	Develop a dedicated bioeconomy research and innovation programme with associated funding and technical support to support the development of industrial biotechnology and biorefineries
Consumption	Lack of a supportive regulatory framework and economic incentives for food donations	Consider allowing food donations after food's "best before" date for food under specific conditions that is safe for consumers but cannot be sold, and consider introducing additional tax incentives
	GPP of food and catering services is not sufficiently supported	Promote GPP of food and catering services by developing a catalogue of good practices and guidance on GPP methodology or training materials for public authorities
		Consider implementing a form of mandatory use of GPP criteria in contracts
End-of-life	Separate collection of bio-waste is not sufficiently effective and in place	Provide additional incentives for the separate collection of municipal bio-waste through improving the waste collection infrastructure
		Provide additional economic incentives for the separate collection

Life cycle stage	Gaps	Policy recommendations
		of municipal bio-waste by supporting PAYT schemes and by increasing landfill taxes
	Insufficient recycling capacity for bio-waste	Strengthen financial support for bio-waste processing and recycling facilities to ensure adequate investments into recycling capacities
	Limited application of the cascading use of biomass, priority focus on bioenergy	Redefine the policy approach for bioenergy production to ensure its coherence with the transition to a circular bioeconomy
Horizontal tools	A low awareness and understanding among the Hungarian population about circular bioeconomy and its opportunities	Strengthen education, information and training tools to raise awareness and skills in Hungary in the area of circular bioeconomy
	Lack of interest in innovation and a lack of adequate technical and financial support for Hungarian companies	Improve the innovation capacity, particularly of SMEs, by making the existing technical and financial support more effective
	Lack of cross-sectoral and multi-stakeholder cooperation and data on material flows and waste in the biomass and food area that is more granular	Support cross-sectoral, inter-ministerial and multi-stakeholder co-operation across the entire biomass and food life cycle (e.g. by forming a dedicated institutional steering and coordination mechanism and by creating a platform to share good practices)
	No data on bio-based wastes that would provide sufficiently granular information	Improve the existing monitoring and data collection system for bio-based wastes to produce a highly granular understanding of these wastes

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Annex 5.A. Supplementary information

Annex Box 5.A.1. Concepts related to the circular bioeconomy

Green economy

The green economy is an umbrella concept that emphasises the lowering of environmental risks and ecological scarcities. The concept applies to low carbon, resource-efficient and socially inclusive economies.

Bioeconomy

The bioeconomy is part of the green economy. The bioeconomy relates to promoting global economic growth and technological development for primary production and industry, especially where advanced life sciences are applied to the conversion of biomass into materials, rather than focusing on limits to growth due to resource scarcity, depletion and population growth.

Bio-based economy

The bio-based economy is part of the bioeconomy and relates to converting biological resources into products and materials. Food and feed production usually involves processing agricultural goods, which enters into the bio-based economy.

Circular economy

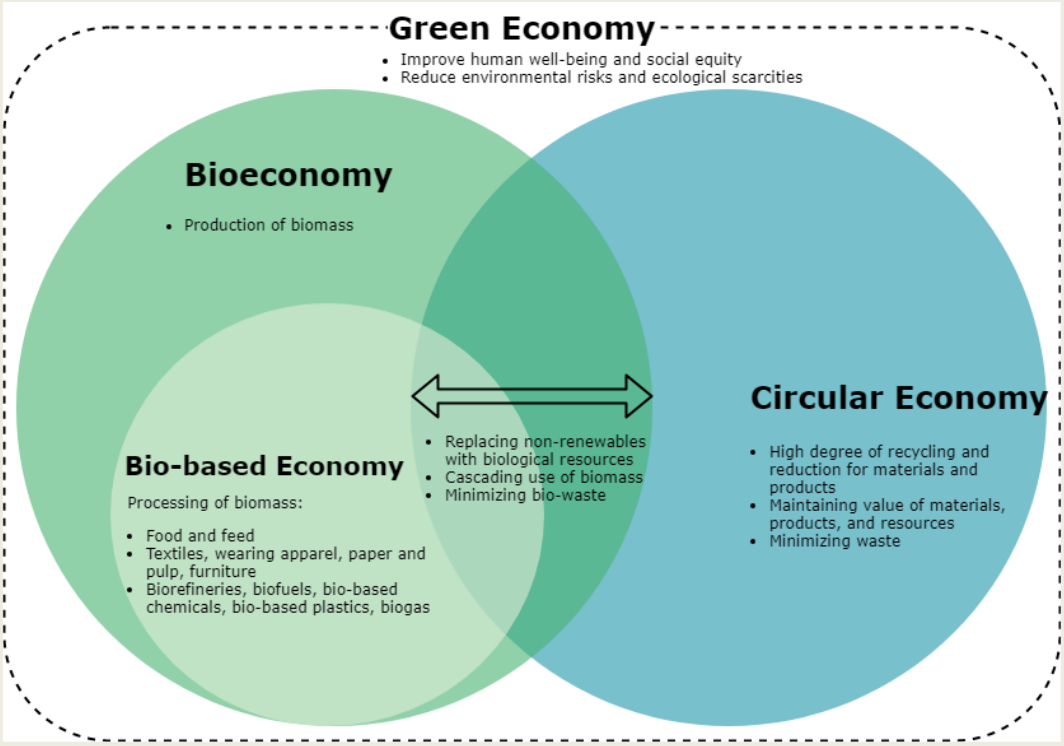
The circular economy relates to the use of products and materials that show the highest degree of recycling and lowest waste. That is, the linear production model "take, make and dispose" is replaced by a circular model in which waste products (disposed of in a linear model) are kept within the system. In this way, waste materials are drastically reduced, recycled and remanufactured. The concept of circular economy can be complementary to the bioeconomy.

Circular bioeconomy

The circular bioeconomy builds on the concepts of bioeconomy and circular economy. The circular bioeconomy refers to the economic activities in which biotechnology contributes centrally to primary production and industry. At the same time, waste materials are drastically reduced, and wastes are recycled and remanufactured and kept in the system for as long as possible.

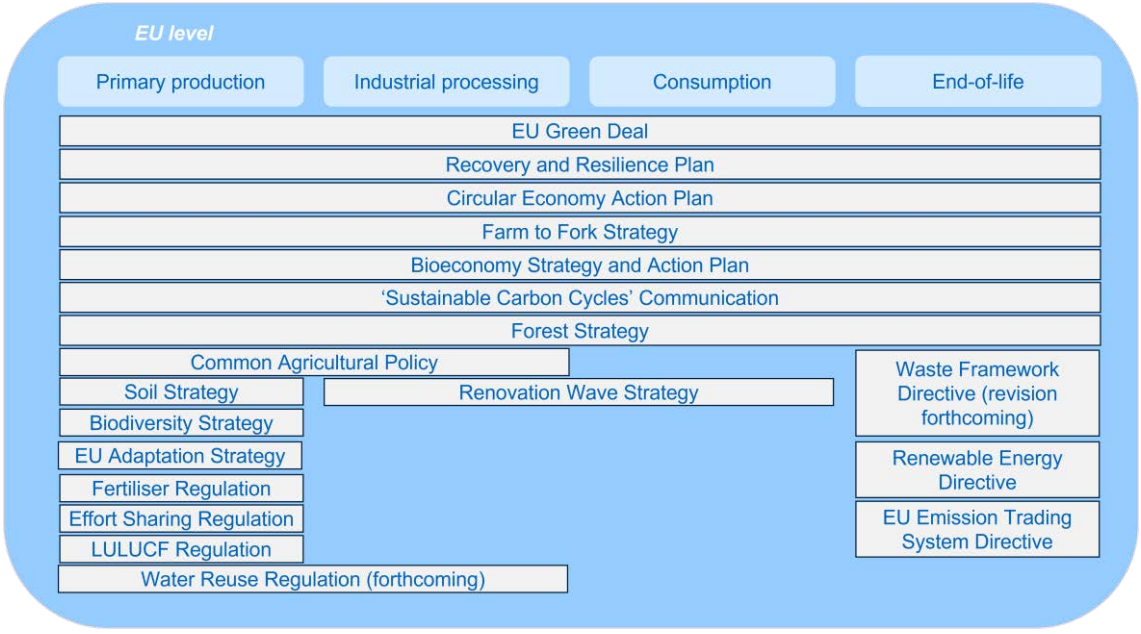
Source: Adapted from Kardung et al. (2021[73]) and Philp and Winickoff (2018[68]).

Annex Figure 5.A.1. Relations and overlaps between the concepts of green economy, bioeconomy, bio-based economy and circular economy



Source: Kardung et al. (2021[73])

Annex Figure 5.A.2. Overview of EU strategies, policies and legislative documents relevant to the biomass and food priority area



Annex Box 5.A.2. Examples of regulatory frameworks to support the use of compost and digestate

According to the EEA analysis, of the countries surveyed, 24 have national standards for compost quality, set either in legislation, stand-alone standards or are under development, while a few countries/regions have also developed quality standards for digestate (e.g. Denmark, Flanders [Belgium], Germany, Sweden and the United Kingdom) (European Environment Agency, 2020[47]).

Austrian waste legislation on compost products

Since 1995, Austria's Bio-waste Ordinance (FLG No 68/1992) requires the source separation and biological treatment of organic waste (primarily through composting and anaerobic digestion). The Compost Ordinance (FLG II No 292/2001) established the end-of-waste regulation for compost produced from defined organic wastes, as well as monitoring and external quality assurance obligations. In Austria, the aim has been to avoid recommending the imposition of excessive technical obligations to preserve the well-established decentralised, mostly on-farm composting systems. Since the early 1990s, this has been widely recognised as a sustainable bio-waste recycling system. Compost can be classified and marketed as a product in Austria, provided it meets certain quality criteria and has been processed from specific input ingredients. The minimum organic matter level of 20% (m/m) is one of the most important requirements, compared to artificial or dredged soils having substantially lower organic matter concentrations (Austrian Ministry for Agriculture and Forestry, 2009[74]).

A practical example of composting is the case of Freistadt (Austria), a town that set up a project in which local farmers can separately collect bio-waste from local towns, including both kitchen and canteen waste, as well as wood, tree and bush cuttings (EY et al., 2020[75]). This waste is then composted in simple composting facilities on their farms, with the farmers using the compost for their own use or sale. Key success factors include the supportive legal framework (e.g. mandatory training and requirement of a contract with the municipality) and the involvement of local stakeholders. This set up provides a new source of income for farmers through community activities in the services sector, promotes awareness in the public process and strengthens the regional employment situation. Reported data show a collection rate of 149 kg per capita per year, with 80% of the produced compost used in agriculture and 20% is sold to private customers.

Slovenian Decree on the treatment of biodegradable waste and the use of compost or digestate

Slovenia became one of the first countries to have introduced compulsory operations in the treatment of biodegradable waste and conditions for its use, as well conditions for placing treated biodegradable waste on the market (European Commission, n.d.[76]). The legislation on the recovery of biodegradable waste and the use of compost and digestate lays down the conditions for designing and operating biogas plants (e.g. applying for an environmental permit), the types of biodegradable waste that can be treated (listed in annex 1), the specific requirements for composting and anaerobic digestion, and the quality control (1st or 2nd quality class in accordance with annex 4) of compost and digestate, among others. The regulation prescribes that digestate must be further composted following anaerobic degradation (article 12), and that a quality control of the compost or digestate must be carried out by a company, public institution or private individual (article 14).

Germany's quality assurance system for compost and digestate

Since 1989, Germany has successfully run a quality assurance system (QAS) for compost and digestate made from bio-waste, which comprises a body (the Bundesgütegemeinschaft Kompost e.V., BGK) qualified to oversee the quality of compost and digestate and award a quality label. This quality

assurance organisation (QAO) was founded by composting plant operators in 1989 following the increasing uptake of separate bio-waste collection by German municipalities throughout the 1980s. BGK is an independent association that participates in the European Compost Network (ECN) and one of four national QAOs in the EU to have been awarded the ECN-QAS conformity label. It implements the quality standards which are set at national level by the German Institute for Quality Assurance and Certification (RAL). The costs of running such a QAS, including the process of on-site audits and sample analyses for quality assurance, are indirectly financed by waste management fees (Dollhofer and Zettl, 2018[77]).

Source: Adapted from OECD (2022[59]), European Commission (2021[78]) and other sources mentioned in the box.

Annex Box 5.A.3. Regulating the use of sewage sludge in agriculture – examples of practices

As part of the open public consultation on the evaluation of the Sewage Sludge Directive (86/278/EEC) from the end of 2020, the definition of "biosolids" has been proposed (i.e. treated sewage sludge-product, which underwent appropriate treatment processes, such as anaerobic digestion or composting, and meets high quality standards) as opposed to (untreated) "sewage sludge". The application of biosolids to agricultural soils represents a circular economy measure that helps counteract climate change and soil degradation while improving nutrient self-sufficiency. A system of quality assurance, including the regular review of limit values for pollutant and contaminant loads, is crucial for the use of biosolids in agriculture. Some respondents to this public consultation considered that quality standards should be harmonised across the EU . Emerging issues, which might require measures to address them at source, include risks associated with contamination from microplastics, hormonally active agents and pharmaceutical waste (ECN, n.d.[79]).

Germany

Germany is one of the largest producers of sewage sludge-derived compost in the EU. A decree (Klärschlammverordnung, AbfKlärV) passed by the German government in 2017 requires all wastewater treatment plants (WWTPs), the size of up to 100 000 population equivalent (and up to 50 000 in 2032), to recover phosphorus from sewage sludge and its ashes by 2029 (except if the phosphorus concentration is less than 2%). The regulation does not impose any technological requirement for nutrient recovery, leaving ample room for innovation. At the same time, the AbfKlärV aims to prevent pollutant leakage into the soil, tightening the conditions for the application of sewage sludge in agriculture and significantly reducing associated land use (Hudcová, Vymazal and Rozkošný, 2019[49]). However, overly strict regulations for the use of sewage sludge in agriculture may be less efficient in preventing soil pollution than removing obstacles to nutrients recycling (QDR, 2020[80]).

Austria

In Austria, the soil protection laws of the relevant federal state must be followed when using sewage sludge for agricultural purposes. For instance, the Lower Austrian Soil Protection Act and the Lower Austrian Sewage Sludge Directive both govern how sewage sludge is used in Lower Austria, where only quality classifications I and II (having low levels of heavy metal content) may be applied to soils. Sewage sludge can otherwise be turned into compost through biological treatment, which is regulated by the Austrian Compost Directive. The directive, which includes end-of-life criteria, distinguishes between high-quality sewage sludge compost that is approved for use in agriculture and sewage sludge compost, which may only be used for landscaping applications. Moreover, a certificate of origin is

required to attest the suitability of raw materials and product quality (Stürmer et al., 2021[81]). Nevertheless, the Federal Waste Management Plan draft of 2017 envisions the direct application to soil or composting of sewage sludge from wastewater treatment plants (WWTPs) with a size of 20 000 population equivalent or more to be discontinued. The draft legislation equally requires such plants to either recycle phosphorus on the spot (if the content is higher than 2%) or to recover it from sewage sludge ashes following mono-incineration (Hudcová, Vymazal and Rozkošný, 2019[49]).

Sweden

In July 2018, the Swedish government conducted an inquiry to formulate proposals for a ban on applying sewage sludge to soils. The main concern was to prevent hazardous substances, such as pharmaceutical waste and microplastics, from entering the environment. The 2018 inquiry also sought to replace the use of sewage sludge on land with alternative technologies for nutrient recycling. The inquiry's main proposal was a complete ban on sewage sludge land use and the requirement to recover at least 60% of phosphorus from WWTPs greater than 20 000 population equivalent (Forssell, 2020[82]). A complete ban on land use, however, would imply a significant shift in Sweden, where nearly one-third of the sewage sludge produced is used in agriculture. In early 2020, the inquiry's committee finalised the report and proposed that high-quality sludge be exceptionally allowed on agricultural land (Ekman Burgman, 2022[83]).

At the same time, a voluntary certification system for the use of sewage sludge in agriculture was developed thanks to the initiative of wastewater operators, farmers and the food industry. The REVAQ system, which started in 2002, provides stakeholders with information regarding the composition and end-use of sewage sludge, and sets guidelines for continuous quality improvements, such as by setting limits for the accumulation rate of trace metals in agricultural soil. After less than a decade, 65% of the sewage sludge applied to land and about 50% of the total sludge produced in Sweden originated from REVAQ certified plants (L'ons et al., n.d.[84]).

Ireland

In Ireland, the Sewage Sludge Directive was transposed into national law by the Waste Management (Use of Sewage Sludge in Agriculture) Regulations 1998, amended by S.I. 267 in 2001. Article 3 of the law restricts the use of untreated sewage sludge on agricultural land under specific circumstances. The Department of the Environment, Heritage and Local Government (DEHLG) "Codes of Good Practice for the use of Biosolids in Agriculture" contains best practices for the treatment and management of sewage sludge (FSAI, 2008[85]). These codes have no statutory basis, yet many local authorities follow them in practice (Cré, 2013[86]). For example, the requirement to provide a certificate of analysis ensures the traceability and quality of biosolid products (Kyne, 2021[87]). Furthermore, the National Wastewater Sludge Management Plan (NWSMP), published in 2016, includes measures covering, among others, the development of a quality assurance system and Standard Operating Procedures (SOPs), such as requirements for use on land, for sewage sludge and biosolids (Irish Water, 2016[88]).

Although most of the sewage sludge in Ireland is treated and used on agricultural land, Ireland's Environmental Protection Agency (EPA) expressed concerns about heavy metal accumulation in soils as well as emerging risks, such as microplastics and antimicrobial resistance development. The EPA thus advised that the revised Sewage Sludge Directive takes such aspects into account and ensures that appropriate legal requirements, monitoring and reporting systems be implemented (Derham, 2020[89]).

Source: Adapted from Hudcová, Vymazal and Rozkošný (2019[49]) and sources specified in the box.

Annex Box 5.A.4. Government promotion of sustainable food production in the Netherlands

The Dutch government promotes sustainable food production by encouraging food producers to take environmental and climate change impacts into account and by introducing two national policy agendas to accelerate the protein transition in the Netherlands (Geurts, Loenen and van Gelder, 2021[90]):

- The 2018 Transitie-agenda Circulaire Economie - Biomassa en Voedsel [Transition Agenda for Biomass and Food].
- The 2020 Nationale Eiwitstrategie [National Protein Strategy].

While the Transition Agenda for Biomass and Food focuses on significantly reducing animal protein consumption in the Netherlands, the National Protein Strategy has a more strategic ambition of reducing the Dutch livestock sector's dependency on animal feed imports.

In the Transition Agenda for Biomass and Food, the Dutch government set the targets to reduce the share of animal protein to 50%, and to reverse the current ratio to 40% animal protein and 60% plant protein in the longer term. Defining clear and long-term objectives for a protein transition creates a favourable investment environment for financial and other actors in the food supply chain, and helps them understand the direction and pace of the transition.

The National Protein Strategy proposes several concepts to support the advancement of a protein transition, including incentives for the development of alternative protein sources for food and feed production, such as microbial proteins, cultured meat or insects. According to the Dutch Ministry of Agriculture, Nature and Food Quality (MANFQ), 10% of proteins in livestock feed and 20% of proteins in human food could be replaced by insect proteins in the Netherlands by 2025 (Selten and Flach, 2021[91]).

As one of the main lines of action, the 2018 Transition Agenda states the importance of circular protein measures to be financed, scaled up and commercially implemented. For example, the agenda suggests that funding for such initiatives and the start of pilots for scaling-up and behavioural change come from banks, investors and multinationals working with start-ups. Collaborative funding initiatives between researchers, primary producers, companies and potential investors could stimulate innovation to help drive the protein transition. This example highlights the programme of the Regio FoodValley, a "Hub for Insect Knowledge" created by the government, in which eight municipalities in Gelderland work together with local partners in the food supply chain, from primary producers to local retailers, to facilitate the uptake of insect proteins for food and feed production.

Annex Box 5.A.5. Incentives for the bioeconomy

Support for the bioeconomy in the Netherlands

The Netherlands is one of the frontrunners in promoting the bioeconomy, having adopted its first "Government vision on the biobased economy in the energy transition" in 2007. The Dutch government offers support in the form of grants, tax benefits and credits to innovative businesses in the agri-food, life-sciences, health, energy and chemical industries. It primarily serves as a facilitator in networks of commercial and non-governmental organisations and provides R&D funding, mostly through labour-related tax reductions, for the development of biorefineries and associated technology (Langeveld, Meesters and Breure, 2016[92]). In particular, innovation and market development are supported by platforms such as TKI Biobased Economy (TKI-BBE), which provides financial assistance to initiatives (TKI-BBE, n.d.[93]), or so-called "Green Deals" for the bioeconomy, in which government supports innovative projects through the removal of non-technical barriers, such as those posed by legislation or a lack of market incentives (Government of the Netherlands, 2016[94]). Many regional schemes in support of bio-based industries have also emerged and mostly focus on the final stages of the innovation cycle and regional market development (Langeveld, Meesters and Breure, 2016[92]).

German bioeconomy strategy

With the National Bioeconomy Strategy adopted in January 2020, the Federal Government of Germany defined the guidelines and goals of its bioeconomy policy and specific measures for its implementation. The overarching goal is to transition from an economy predominantly based on fossil raw materials to a sustainable, circular bio-based economy (Federal Government of Germany, 2020[95]). Research and development are recognised as key drivers for tapping into and exploiting the potential of a sustainable bioeconomy. Small and medium-sized enterprises (SMEs), in particular, play an important role for new biological knowledge and advanced technologies. In order to strengthen their innovation potential, the Federal Ministry of Education and Research (BMBF) launched the KMU-innovativ: Bioökonomie funding scheme in May 2020. The scheme supports SMEs carrying out technologically demanding, high-risk projects that combine biological knowledge with innovative solutions (Projektträger Jülich, 2020[96]). Overall, within the National Bioeconomy Strategy framework, a total of six federal ministries supports the development of a bio-based economy in Germany. There are also numerous funding opportunities at European level, as well as research funding offered by federal states, all of which are listed on a dedicated government website (bioökonomie.de, n.d.[97]).

Italy's Bioeconomy Strategy and Implementation Action Plan

With an annual turnover of EUR 345 billion and 2 million employees, the Italian bioeconomy is the third largest in Europe after Germany and France. In 2017, the Italian government promoted the development of a national Bioeconomy Strategy (BIT), revised in 2019 (BIT II), to better integrate different sectors, policies and investments relevant to the bioeconomy, and to increase coordination between national and regional authorities. The Implementation Action Plan (IAP) (2020-2025) for Italy's Bioeconomy Strategy envisions specific actions to realise the national bioeconomy's potential, including measures aimed at strengthening the public-private partnerships that sustain it. Examples of priority actions include the launching of pilot projects to promote circular bioeconomy development at the local level and the identification (through stakeholder consultation within thematic "National Technology Clusters") of flagship investments, such as for the reconversion of oil refineries and industrial sites into new and advanced biorefineries, and their integration within regional agricultural and bio-based value chains. This could mobilise a total of EUR 2 billion in the short term. Finally, the IAP includes an analysis of regulatory bottlenecks and proposals to overcome the bottlenecks, which is a necessary step to support initiatives for the bioeconomy in the country (CNBBSV, 2021[98]).

Support through the EU funds in the Netherlands

As part of the European Regional Development Fund (ERDF) Operational Programme West Netherlands 2014-2020 (European Commission, n.d.[99]), a sub-ceiling of EUR 451 750 has been set for the Bio-based Industries Incentive Scheme. It is a voucher-based scheme aimed at supporting innovative SMEs, with a specific focus on industrial biotechnology and bio-based industries to further develop and scale up their products and production processes.

Three different types of vouchers are available and can be applied for separately or in combination:

- The establishment voucher, which can be used to pay rent or to set up an office or lab.
- The growth voucher, used to receive support for growing a bio-based business case, including research to address techno-economic bottlenecks or support in pre- and piloting phases.
- The pilot voucher, used to scale up a bio-based business case.

Applications are open to SMEs (based in an EU Member State) that intend to establish themselves at Planet B.io (a foundation that works to attract innovative companies, mainly start-ups and scale-ups, by placing them in an open innovation hub) or the Bioprocess Pilot Facility (an independent public pilot facility), both of which are located in Delft at the Biotech Campus Delft, an innovative business park focused on industrial biotechnology and bio-based industry (Municipality of Rotterdam, 2021[100]).

Annex Box 5.A.6. Supporting food donations

Economic incentives for food donations in Italy

Italy has a long history of economic incentives for food donations. Food donations are among value added tax (VAT) exempted activities and can be partly deducted from taxable income (Busetti, 2019[101]). In addition, the Good Samaritan Law states that non-profit food rescue organisations are responsible for the safety of donated food, which has freed donors from liabilities after their donations (European Commission, 2020[60]). Donors had remained responsible for the production and manufacturing phases and had to donate safe products, but they were legally protected if the non-profit organisations misused their donations. Further, this law eliminated several bureaucratic burdens for non-profit organisations, as they were considered as consumers rather than professionals in terms of food donation activities. Most notably, two measures (the streamlining of bureaucratic procedures and the possibility of donating food after the “best before” date) are often mentioned as fundamental improvements to the food donations process.

In 2018, Milan implemented a tax deduction (set at 20%) on food donations made to redistribution organisations. The businesses benefitting from this tax deduction must report to the municipality on the amounts of donated food. The action involved different departments of the municipality, creating a multi-sectoral working group. The measure also supported the mapping, strengthening and spreading of ongoing initiatives on food donations in the city, led by non-profit organisations.

Economic incentives for food donations in some EU Member States

Some countries (e.g. Austria, Denmark, Germany, Italy and Slovenia) consider the monetary value of donated food to be close to its “best before/use by” date and thus has low or zero value, equating to a very low or no VAT payable on the donated food (irrespective of the original value of the food product).

Some countries offer corporate tax credits on food donations (e.g. 60% in France and 35% in Spain of the net book value of donated food can be claimed as a corporate tax credit that can be deducted from the corporate revenue tax).

Others offer an enhanced tax deduction where donors can deduct more than 100% of the value of the food at the time of donation (e.g. Portugal has in place an enhanced tax deduction of up to 140% if the food is used for a social purpose, limited to 0.008% of the donor's turnover).

Source: Adapted from OECD (2022[59]), European Commission (2017[61]) and EU Platform on Food Losses and Food Waste (2019[102]).

Annex Box 5.A.7. Examples of Green Public Procurement practices in the provision of food and catering services

Green Public Procurement (GPP) for sustainable diets in Scotland

East Ayrshire Council in Scotland used the GPP of food and catering services to shift food consumption towards more sustainable diets in schools (European Commission, 2012[103]). The objectives of introducing GPP were to transform the menus on offer to reduce processed food, use fresh ingredients and ensure good nutritional standards.

The procurement included technical specifications around the supply of food products and services, including the need to provide organic certification, to comply with animal welfare standards and hazard analysis and critical control points (HACCP) systems, or to provide clear details of food sourcing and production and transport arrangements. Bidders were then awarded based on multiple criteria, including the net price, the ability to supply by the deadline, the quality and range of food products, food handling arrangements and facilities, and the use of resources (e.g. the supplier's reduction in environmental impacts or waste, recycling and composting, etc.).

As a result of applying these GPP criteria, 90% of food used was unprocessed and fresh and 30% was organic. In addition, research into the "social" return on investment indicated that for every GBP 1 spent, up to GBP 6 returned to the local community through employment and environmental, health and social benefits. At least 70% of the food supplied was sourced locally, although this was not a requirement under the tender. The uptake of school meals also increased in the council area since the GPP was introduced in school canteens, while the national trend has been the opposite.

GPP for organic food in Denmark

The conversion to organic food in Danish public kitchens started in childcare centres and schools (IFOAM, 2020[104]). Currently, it covers all types of public institutions, ranging from hospitals, senior homes and city halls to ministry canteens, military barracks and prisons. A key turning point came in 2012 when the Danish Government launched a new "organic public procurement" strategy. The goal of the strategy was to improve the quality of meals, reduce climate emissions and increase the organic farming area.

The success of the initiative was based on four public policy initiatives (procurement goals, financing, labelling, and NGO capacity building) and three "organic" sector initiatives (supply chain collaboration, "organic" schools for food services, and education for kitchen workers). The goal of the national government was to achieve a 60% use of organic food in all public institution kitchens ("public kitchens"). In addition, the government provided EUR 4 million annually to finance education in the public kitchens. Education was needed because the shift towards organic food was not only a replacement of

conventional food with organic food but a complete change in purchasing, food preparation, meal planning and waste reduction. Furthermore, capacity building in the "organic" sector was also financed by public funds, which allowed for intensive collaboration with the food service industry as well as with trade unions representing kitchen workers and other stakeholders.

The development of the Danish label for organic cuisine was a key motivation for kitchens, as acquiring this label was considered a "point of pride", which was highly motivating for workers and leaders interested in branding. The labelling model has now also been adopted in Norway and Germany.

As a result of organic public procurement, sales of organic food have increased in private food services, such as restaurants, hotels, catering and canteens serving private employers. This has resulted in a five-fold increase in sales of organic food in the food services sector over a period of 10 years. This market signal, and value chain collaboration on sourcing of organic products in Denmark, has been a significant contributing factor to the 70% increase in organic farming area in this same period. Active organic policy, and the positive influence on private food services, has rapidly expanded uptake for the national Organic Cuisine Labels, which are available for 30%, 60% and 90% total share of organic food. Today, more than 3 300 kitchens have labels for organic cuisine.

Barriers, such as a potential violation of EU rules, or costly and bureaucratic paperwork, were addressed and removed. In the first case, a mobile public procurement team assisted procurement managers at all levels. The costly and bureaucratic paperwork was resolved by introducing a national exemption from all fees for the inspection of the Organic Cuisine Label and by providing kitchens with a tool to calculate the percentage of organic food used, which is required for the organic label.

Annex Box 5.A.8. Door-to-door collection systems for bio-waste in Italy

Door-to-door collection in Milan

In 2011, Milan (Italy) introduced the separate collection of municipal food waste for composting and anaerobic digestion, covering 1.4 million inhabitants (European Commission, 2020[105]). Brown bins and compostable bags are used for collection, while small 10-litre kitchen bins (with a special airy structure to minimise the inconvenience of odours and liquids) are used in apartments. Collection frequency is twice a week (Circular Economy Europa, n.d.[106]).

Milan's waste management system is increasingly a door-to-door system. The introduction of this system has been the main driver, pushing up the overall recycling rate for municipal waste from 35% in 2011 to 52.5% by January 2015 (European Commission, 2021[78]).

In addition to providing convenient infrastructure, other success factors include the comprehensive communication to citizens (before and after implementation of the door-to-door collection for food waste) and the focus on the quality of the collected streams, i.e. a transparent bag to help inspect the contents of residual waste, quality controls by 24 trained staff, and sanctions in case of irregularities (European Commission, 2020[105]). The customer satisfaction survey in 2014 showed that 79% of the citizens had found the organic waste collection to be efficient.

Door-to-door collection and the pay-as-you-throw (PAYT) scheme in Parma

In 2012, the Italian city of Parma collected waste separately through large roadside containers (Ricci, 2020[67]). Since 2014, the inhabitants of Parma have had their waste collected door-to-door. In addition, a PAYT scheme was introduced. The fee for every household is composed of two main elements: a fixed part based on the number of household members and the size of apartment, and a variable part

that essentially depends on the amount of residual waste generated and home composting. The fixed part already covers a minimum number of collections of residual waste per household, which is intended to cover the fixed costs of managing the system and, concurrently, to prevent dumping and littering. In terms of positive incentives, households get a 12% reduction in their fee if they do home composting.

Following the introduction of the door-to-door collection and the PAYT scheme, sorting has doubled, to almost 100 kg per capita. This figure also includes kitchen bio-waste from restaurants and canteens, which represents about 20%. In addition, the level of contamination fell from 8.3% to 3.3%.

Annex Box 5.A.9. Supporting home composting

Home composting programme in Spain

Vázquez and Soto (2017) analysed the efficiency of home composting programmes in eight rural areas in three councils in Spain (2017[107]). The study evaluated the quality of the produced compost, carrying out home composting programmes (up to 880 composting bins) for all household bio-waste, including meat and fish leftovers. The efficiency was evaluated in terms of reduction of organic waste collected by the municipal services.

The programme included the initial provision of composter bins to households for free. Furthermore, the programme was accompanied by awareness campaigns and training programmes. In addition to the composter bin, a small home composting manual was given to the users, which recommends composting all bio-waste, including the remains of fish and meat. The educational manual explained both the composting process and the management of waste in general, as well as the related ecological and environmental aspects.

An efficiency of 77% on average was obtained, corresponding to 126 kg of bio-waste per person per year. High quality compost was obtained, as indicated by the low carbon to nitrogen (C/N) ratio, low contaminants, low heavy metal content and high nutrient content.

Annex Box 5.A.10. Ordinance on the Generation of Electricity from Biomass in Germany

In Germany, biomass use in bioelectricity is regulated through the Ordinance on the Generation of Electricity from Biomass (Wageningen Research, Bay Zoltan, AKI, 2020[108]). The ordinance helps prevent conflicts between bioenergy generation, food security and biodiversity by classifying energy crops, such as maize and sugar beets, in the group of substances with a lower tariff, thereby stimulating the processing of non-food substances.

The policy package in Germany, and not only the biomass ordinance, is a good example of how a regulation can evolve in time from overall wide support to bioenergy production without insisting on very strict requirements on efficiency and type of biomass use. Instead, stricter requirements are put in place for energy efficiency and higher feed-in premium support for the bioenergy and heat produced from more sustainable biomass types, particularly those with no or low indirect land use change impacts.

Annex Box 5.A.11. Examples of education, information and training tools

Practices to improve education about the circular bioeconomy

- The Green-Schools programme in Ireland works with primary and secondary schools across the country. It is operated and coordinated by the Environmental Education Unit of An Taisce (an independent charitable voice for the environment and for heritage issues) (Green-Schools, n.d.[109]).
- The first national Environmental Education (EE) act in the Netherlands was passed in 1988 and the first multi-year environmental education action programme was initiated in 1992 (GEEP, n.d.[110]). The Netherlands released two separate policies: one for EE and one for Education for Sustainable Development (ESD). National policy also supports new forms of monitoring and evaluation for the country's prominent EE programmes, such as Groen Gelinkt (GroenGelinkt, n.d.[111]), an online search system that allows educators from primary and secondary schools and afterschool programmes to locate EE resources by topic and audience. The "Duurzame PABO", a nationwide sustainability network, offers support for schools in initiating sustainability projects and also supports environmental educators by offering professional learning opportunities through conferences, lectures and workshops, newsletters with tips and activities, and online resources.

Awareness-raising practices

- Campaigns launched by large food retailers to save "ugly food" (Tesco, 2022[112]).
- The "money thrown in the window" [Ablakon Bedobott Pénz] programme in Hungary was launched in 2002 by KÖVET, an association of environment-focused consulting companies, to encourage the dissemination of good practices through an award for environmental performance, including on waste management and resource efficiency. Its aim is to prove that environmental measures and the economy are mutually beneficial (OECD, 2018[11]).
- The Italian city of Treviso introduced a PAYT scheme in 2014 (Zero Waste Europe, 2018[113]). When adopting the PAYT scheme, the city also prepared a well-developed and targeted communication campaign for residents (Bucciol, Montinari and Piovesan, 2011[114]). The communication campaign included emotive and engaging posters displayed in public spaces and shops, technical and specific leaflets and booklets for households explaining the new waste collection system in detail, and public events and meetings with residents in order to respond to questions and concerns.
- In the Italian region of Apulia, the door-to-door collection system is widely used in municipalities, achieving sorting rates of more than 80%. The implementation of this system was preceded by an information campaign on television and social media as well as physical events to explain the meaning and functioning of the system to the inhabitants. In the city of Altamura, a survey was designed to evaluate the effectiveness of the systems from the citizen's point of view (Laurieri et al., 2020[115]). The results of the study showed that citizens are more motivated to collect separate waste fractions when they have information about subsequent environmental benefits and the outcomes of the fractions collected, and when there are greater controls on the quality of the sorted waste fractions.
- In the Swedish city of Malmö (Beyon Food Waste, 2018[116]), the introduction of separate collection of kitchen bio-waste was accompanied by an information campaign. First, the target audience was analysed and then their messages were displayed on buses, at the cinema, and in ads and newspapers. In terms of activities, several owners of multi-family properties were personally visited and given advice. In 2018, the average amount of sorted food waste

amounted to 51 kg per person per year, accounting for a 47% rate of waste separation. The collected food waste is then treated in the biogas plant and used as fuel for the city's buses and garbage trucks.

Improving skills

- Training and workshops are offered by several networks, partnerships and research projects (e.g. the European Bioeconomy Network [EuBioNet] or the European Bioeconomy University within the context of the Erasmus+ programme).
- Covar 14, a public waste management company in Piemonte (Italy), has promoted home composting in rural areas through awareness campaigns, compost training courses and a financial discount of 20% on waste taxes for families joining the composting programme.

Notes

[1] "Food" shall not include: (a) feed; (b) live animals unless they are prepared for placing on the market for human consumption; (c) plants prior to harvesting; (d) medicinal products; (e) cosmetics; (f) tobacco and tobacco products; (g) narcotic or psychotropic substances; (h) residues and contaminants (EC/2002/178) (European Parliament and the Council, 2002[2]).

[2] Latest available data corresponds to the latest data available from each sector: 2019 for agriculture, 2016 for fisheries and aquaculture and 2017 for forestry (European Commission – Joint Research Centre, n.d.[12]).

[3] The share of biomass use excludes biomass losses across biomass flows, for which a specific use cannot be estimated in the current statistical system.

[4] The Hungarian food industry's most relevant segments include meat processing and preservation; mineral water, soft drinks and other beverages; pet food and feed production; milk processing and dairy products; sweets, snacks, convenience and other foods; and fruit and vegetable processing and preservation (Hunyadi Borbélyné et al., 2020[120]).

[5] According to the national accounts employment data by industry, the percentage of the total workforce employed in 2020 in the country in economic activities called "manufacture of food products, beverages and tobacco products" and "manufacture of wood and of products of wood and cork, except furniture" was 2.7%, and 0.4% in "manufacture of articles of straw and plaiting materials" (Eurostat, n.d.[27]).

[6] There is no reliable and sufficiently detailed data about the different types of bio-based wastes broken down by their origin in Hungary, nor are there sector-specific industrial data about food and food industry wastes.

[7] Hungary is currently developing a bioeconomy policy strategy.

[8] According to Decree 23/2003 (XII. 29.), bio-waste reused for recultivation purposes cannot exceed 500 tonne/hectare of stabilised dry-matter. This decree also provides the list of wastes that can be used for composting as well as their respective waste codes.

[9] According to the Government Decree 50/2001 (IV. 3), which regulates the agricultural applications of wastewaters and sewage sludge, untreated wastewater and sludge cannot be put to agricultural uses. Sludge cannot be used for growing fruit (that grows close to the ground) and vegetables nor can it be used if the concentration of toxic materials is above a certain percentage (see annex 1 and 2 of the Decree).

[10] Composting and anaerobic digestion (AD) may be carried out as mutually exclusive processes. AD produces biogas alongside digestate, which can be directly used as organic fertiliser. However, to further enhance benefits to the soil, the residue from AD may be composted through aerobic post stabilisation (Gilbert, Ricci-Jürgensen and Ramola, 2020[117]). Some European countries (e.g. Austria, Italy) introduced mandatory post-treatment requirements for the application of digestate on land (International Solid Waste Association, n.d.[119]). A range of technologies has been developed for digestate processing and full-scale implementation, proving the ability to produce marketable end products, although further technical development is required to minimise operational costs (European Environment Agency, 2020[47]). The term "compost" thus often refers to both compost produced directly from aerobic bio-waste treatment and composted digestate from AD (Commission of the European Communities, 2008[118]).

[11] Using an average conversion rate of HUF 319 to EUR 1 in 2018 reported by the Hungarian National Bank.

[12] Using an average conversion rate of HUF 296 to EUR 1 in 2013 reported by the Hungarian National Bank.

[13] Using an average conversion rate of HUF 311 to EUR 1 in 2016 reported by the Hungarian National Bank.

[14] Using a conversion rate of HUF 399 to EUR 1 in September 2022 reported by the Hungarian National Bank.

[15] The National Smart Specialisation Strategy (S3) 2021-2027 uses the OECD "Trade in Value Added" (TiVA) indicator, measuring the value added of countries in their external trade, to present Hungary's position in global value chains. Based on this indicator, the domestic value added in total Hungarian exports fluctuated between 52% and 56% between 2005 and 2016, which is lower than in the Czech Republic, for example, where the rate was above 60% in this period.