

Insights Report: lab of tomorrow Austria (2021/2022)

Utilization of Biogenic Waste in the Western Balkans

How might we improve the management of waste streams with high biogenic content in Serbia?





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1. Introduction

Globalization has intensified economic and social relations worldwide and has connected the world even more. As a result, topics such as climate change and environmental degradation are issues that can no longer be negotiated or resolved at the national level alone. Interaction and cooperation between different countries and multi-layered stakeholders are becoming increasingly important for solving complex and global challenges. Development (cooperation) and business activities can have a joint effect here: Companies in particular play a key role in finding technical solutions and as solution providers. However, businesses require favorable market conditions in order to get active on a long-term basis. Business activities can also be an important contribution to achieving the United Nations Sustainable Development Goals (SDG). They explicitly call on businesses to make a greater contribution to solving global challenges and emphasize the complementarity between business and development through the right framework conditions. With an estimated market potential of 12 trillion USD (Business & Sustainable Development Commission 2017), the SDG offer a strong business case for private investments in sustainable development.

Waste management is also anchored within the SDG and can act as an important pillar to achieving the Agenda 2030 set by the United Nations. On the one hand, it is about improving the quality of life in general by optimizing waste management and reducing the environmental damage that waste can cause. But there is also great economic potential here: The valorization and utilization as well as further processing of waste is a process that is still happening far too inadequately in many countries and so economic potential remains untapped.



Figure 1: The Sustainable Development Goals

Source: www.wasteaid.org

The Serbian waste management faces numerous challenges along the value chain, starting with waste collection, separation or productive use, for example for energy purposes. In addition to the unused economic potential, there are negative effects on the environment. Particularly in the field of biogenic residues there are great opportunities for improvement: While separate collection and recycling of biogenic residues has a long tradition in Austria and the value chain for these residues is well established, the productive use of biogenic residues in Serbia is not yet implemented. Improving the value chain for biogenic residues is not only a major contribution against climate change, it also creates new income opportunities. It also has potential for scaling effects in the Western Balkans region.

In order to improve the value chain of biogenic waste streams in Serbia and develop innovative approaches with the private sector, **ICEP/corporAID** and the **Cleantech Cluster**, together with its partners, have launched the first Austrian *lab of tomorrow* process ("lot") in 2021. The aim is to support Austrian and Serbian companies to jointly develop innovative solutions and processes in the biogenic waste sector in Serbia and to create profitable business cases that can be brought to market.

An important part of the *lab of tomorrow* process is intensive on-site research. The project team – consisting of corporAID and the Cleantech Cluster – went to Serbia in August 2021 and spent 5 days researching the topic of biogenic residues. The team conducted interviews with various companies, organizations and public utility corporations to learn more about the topic and to better understand the local conditions. The focus was on questions concerning challenges and potential in the field of biogenic residues in Serbia. The information from the interviews was in turn supplemented with desk research to generate a comprehensive overview.

The purpose of this document is to provide an overview of the *lab of tomorrow* Austria as well as to give insights into the topic of biogenic residues in Serbia. Furthermore, research results (from the field trips as well as from desk research) are outlined and potential market opportunities presented.

2. The lab of tomorrow

A *lab of tomorrow* is a business design and incubation program for new sustainable businesses in emerging markets. To this end, the *lab of tomorrow* acts as a catalyst for the development of tailor-made, innovative business solutions for local SDG challenges over a period of 12 months, and facilitates profitable joint ventures owned and driven by the *lab of tomorrow* participants. The *lab of tomorrow* was originally initiated by the German Federal Ministry for Economic Cooperation (BMZ) and is a novel way from the German development cooperation to engage the private sector. For this purpose, the *lab of tomorrow* provides a process and certain tools that enables entrepreneurs and companies from emerging markets and the European Union to jointly seize business potentials.

What is special about a *lab of tomorrow* process is not only the use of design thinking methods to create innovative solutions, but also the strong multi-stakeholder approach, where businesses, academia, non-profits and experts work together.

So far, sixteen *lab of tomorrow* processes have been initiated by the German development cooperation. They include for example the reduction of plastic waste in Thailand or the implementation of easier access to medicines and diagnostics with drones to rural areas in Kenya. An overview of these projects can be found here: https://www.lab-of-tomorrow.com/.

Some key facts about the *lab of tomorrow*:

- The *lab of tomorrow* aims to **create impact** and to help reach the Sustainable Development Goals (SDG) by **economic development**
- The *lab of tomorrow* facilitates a **business development & incubation programme** at the interface between sustainability and business/entrepreneurship
- The venture teams will be **supported throughout** the whole process by development cooperation, design thinking experts, the public sector, civil society, and academia
- The *lab of tomorrow* has **no commercial interest of its own** in the conduction of the innovation process

2.1. The lab of tomorrow Process

As Figure 2 shows, a *lab of tomorrow* process contains five different phases in which participants are enabled to realize profitable business ideas with sustainable impact.





Source: Deutsche Gesellschaft für Internationale Zusammenarbeit

The whole process has a duration of about 12 months. The first step (the grey area) is to form a *lab of tomorrow* project team as well as to identify a specific challenge or unmet need in an emerging economy.

During the second phase the focus lies on user-centered research to deepen the understanding of the challenge, its underlying causes and inherent business potential (marked

in green). Therefore, the main challenge is split into 3-5 different business opportunities, where each business opportunity focuses on another aspect of the main topic. At the same time the aim is to provide information about the *lab of tomorrow* process and to select suitable stakeholders such as companies, institutions, or academia within the application process. Depending on the profile and business focus of the stakeholders, they apply for a suitable business opportunity. For each business opportunity, working teams are created, consisting of approximately 5-7 participants.

Afterwards – at the heart of the process – the selected participants join the process, which happens during the Ideation Sprint (the yellow area). The Ideation Sprint is a four to five-day workshop in the selected country, where all participants come together under the guidance of design thinking coaches, creating innovative solutions for their chosen business opportunity. Each team is supported by experts throughout the process.

Subsequently, the Incubation Phase starts (blue area). The Incubation Phase consists of two parts: Phase one starts immediately after the Sprint and focuses on the translation of the workshop results into business life. Coaching and consultancy on intercultural teambuilding, funding opportunities and financing is another integral part in the first weeks. The second phase of the incubation contains consultant support for roll-out and investor networking if needed.

Finally, the teams bring their newly developed products successful to the market and contribute at the same time with their sustainable business solutions to the SDG (last section in figure 1).

2.2. The Method of "Design Thinking"

Design thinking is a systematic approach to complex problems from all areas of life. Design thinking methods are used throughout the whole *lab of tomorrow* process: Starting from research and its evaluation as well as during the Ideation Sprint. Design thinking is used where new and innovative solutions are needed: Complex problems need complex thinking and especially different perspectives. Design thinking therefore puts a strong focus on heterogeneous teams. The developers and proponents of design thinking are three Stanford professors who continue to adapt and develop the methodology to this day.

As manifold as design thinking methods are, they are united by a few basic rules: the process always starts with the customer, so the focus is clearly on user-centered research. In contrast to many approaches in science and practice, which start with the technical solvability, user desires and needs as well as user-oriented invention are in the center of the process. Furthermore, the entire method is not linear but iterative. And the primarily multi-disciplinary teams use visualization and creative work to come up with solutions to complex challenges.

The aim of the *lab of tomorrow* process is to find solutions that are convincing from the user's point of view on one hand and market- and product-oriented on the other hand.

The design thinking process is modeled on the work process that designers intuitively follow. It leads teams through five distinct phases in iterative loops:

- 1. **Understanding:** In the understanding phase, the team stakes out the problem space.
- 2. **Observe:** In the observing phase, participants look outwards and build empathy for users and stakeholders.
- 3. **Defining perspective:** This phase is about defining the point of view. Insights gained are compiled and condensed.
- 4. **Finding ideas:** In this phase, the team first develops a variety of possible solutions and then commit to one idea/approach. It is important to focus on one solution.
- 5. **Develop prototypes:** The prototyping that follows is used to develop concrete solutions that can be tested on the appropriate target groups.

Figure 3: Phases of the lab of tomorrow



2.3. The First lab of tomorrow in Austria

The thematic focus of the *lab of tomorrow* is based on competitive knowledge and expertise available in Austria's private sector. For the regional focus, Serbia was chosen because of its present process of transitioning to a more sustainable energy- and waste management system, demanding know-how and partnerships on how to implement these changes and optimize the transition. On the Serbian side, awareness and progress are more and more established in this area, also due to the ongoing accession process to join the European Union, which requires the fulfillment of certain standards and benchmarks in the field of waste management and environmental protection. The biogenic waste fraction (in municipal waste) is rather high with 40-50%, so a lot of potential for further processing of this type of waste is currently unused. A state-of-the-art waste sector can reduce its greenhouse gas emissions from double digit to low single digit shares.

Lastly, the productive use of biogenic waste offers great opportunities for combining foreign trade with international development and it can positively enhance private sector engagement. New solutions in the waste management sector can potentially be scaled up to other regions and countries in the Western Balkans. Additionally, the Serbian market is well-known and long-lasting, established business partnerships provide a solid framework for future cooperation.

Considering all these aspects, the topic of "How might the utilization of waste streams with high biogenic content be improved in Serbia?" was chosen by the project team. To address this challenge, ICEP/corporAID and the Cleantech Cluster in collaboration with the *Austrian Development Agency*, the *Austrian Research Promotion Agency*, the *German Development Cooperation* and the *Ministry of Climate* initiated the first *lab of tomorrow* process in Austria. The pilot program places a particular focus on follow-up funding and multi-stakeholder collaboration. The Austrian *lab of tomorrow* tries to address the issue of unused biogenic waste by promoting and developing new business models in Serbia.

Furthermore, with a strong focus on a multi-stakeholder approach, the aim is to successfully bring together instruments from the field of development cooperation with various funding institutions and companies to generate social and economic added value in Serbia.

2.4. The Implementing Organizations and Partners for the *lab of tomorrow*

ICEP/corporAID

corporAID is the Austrian platform for business, development and global responsibility and was initiated by the Austrian development NGO ICEP. It supports innovative business-oriented development cooperation and corporate responsibility to create new solutions for sustainable global development. corporAID is responsible for the project management and is working closely with the Cleantech Cluster on the implementation of the *lab of tomorrow*.

Cleantech Cluster

Cleantech Cluster is the platform for environmental- and energy technology companies in Upper Austria and contributes to market growth in the field of sustainable environmental and energy technologies along the value chain. Being the second implementing organization, the Cleantech Cluster works closely with corporAID.

Austrian Development Agency

The Austrian Development Agency (ADA) functions as the operational unit of Austrian Development Cooperation. They finance and support development projects internationally on behalf of the Government of Austria. ADA has initiated the first *lab of tomorrow* in Austria and primarily funds the project.

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

The Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) is operating in the field of international development cooperation and international educational work. So far, the GIZ has initiated sixteen *lab of tomorrow* processes. They support the Austrian lab with their extensive expertise, their worldwide contacts and internal and external coaching sessions.

Austrian Research Promotion Agency

The Austrian Research Promotion Agency (FFG) is the national funding agency for industrial research and development in Austria. FFG administers possible follow-up funding after the lab process.

BMK/Climate Ministry

The Climate Ministry (BMK) is the Federal Ministry of the Republic of Austria for Climate Action, Environment, Energy, Mobility, Innovation and Technology. The BMK supports various projects in the field of climate change and renewable energy.

3. Country Profiles

In the previous chapters, the *lab of tomorrow* was introduced while explaining the reasons for choosing the topic of biogenic waste in Serbia. Chapter 3 sets the general framework by providing more information on the two countries of interest (Serbia and Austria) to the reader.

3.1. Serbia

3.1.1. Overview

Located in the West-Central Balkans in the South-Eastern Region of Europe, the Republic of Serbia acts as an important pivotal country in the Balkans region. The country's capital city Belgrade with a population of 1.3 Mio. marks the economic, political and cultural center of the country. Serbia is a member of the United Nations, the Council of Europe, the OSCE and the Central European Free Trade Agreement and is acceding to the World Trade Organization.

With a GDP per capita of EUR 7.794, Serbia can be categorized as a middle-income country. Despite good economic progress within the last years and a constant upward trend in GDP per capita, Serbia is considered an eligible recipient country for Official Development Assistance (ODA). With this status, it is one of the most important countries for development assistance in the Southeastern part of Europe and a crucial partner for political stability in the Balkans area (German-Serbian Chamber of Commerce, 2019).

Serbia is characterized by a turbulent political history and a high diversity of ethnic groups, that all enjoy equal rights. Ethnic Serbians make up about 80% of the population, while Bulgarians, Hungarians and Roma account for the largest minorities in the country. Considering Serbia's ranking on the Human Development Index – an indicator to measure the development status of countries – the country ranks on position 64 of 189. The rank is shared with Kuwait and the value of 0.8 indicates a very high degree of human development progress (UNDP, 2020).

Serbia is striving to achieve the Sustainable Development Goals, which are also an integral part for the EU accession process. The Republic of Serbia has committed to harmonizing national with international standards as well as to define key areas that demand particular attention such as agriculture, environmental protection, and climate change. There is also continued effort on implementing new waste-processing infrastructure as well as improving energy efficiency (United Nations, 2022).

3.1.2. Economy

With five million hectares of agricultural land available, Serbia's economy is characterized by a high relevance of the agricultural sector. Due to the countries' favorable climate and the substantial availability of land, the country produces an oversupply of agricultural goods that act as a primary source for exports. In addition to agricultural products, Serbia is a main supplier of cars and automotive parts, energy, as well as metal products used for industrial machinery. Within recent years, the IT-, finance- and service sector are increasing in relevance.

The economic performance of Serbia relies on strong household consumption as well as ongoing investments as key drivers of economic growth. In 2022, growth rates are expected to reach pre-pandemic levels, showing the strong resilience of the Serbian economy, which is somewhat independent of particularly severely affected sectors such as tourism (Erste Group Research, 2021). In terms of trade, the EU remains Serbia's most important partner, with Germany and Italy being the top individual trading partners.

Serbia was equally hit by the COVID-pandemic as other European countries, however, due to extensive public spending and an effective vaccination program in 2021, Serbia managed to recover quite well from the economic downturn caused by the pandemic. In 2020, it was among the best performing countries with a decline in GDP of just about -1%, the main reasons being a strong pre-pandemic economic momentum, decisive fiscal measures, low dependency on economic sectors such as tourism as well as short-term containment measures (European Commission, 2021).

As with other European countries, economic transformation towards climate neutral technologies, reducing greenhouse gases as well as transferring to green energy sources will be the main pillars to secure future growth and job creation. In addition, these measures can help in closing the gap to other European countries (The World Bank, 2022). Programs such as the *lab of tomorrow* can help in kickstarting this process.

3.1.3. Politics

Serbia is divided in 30 districts with 108 municipalities in central Serbia as well as 54 in Vojvodina. Due to the turbulent history of Serbia, relations and ongoing negotiations between Serbia and Kosovo are a traditional source of political discussion and turmoil. International efforts to mediate between the two continue, and they are a pillar for the ongoing negotiations for joining the European Union.

The latest elections in 2022 were won with a substantial 58% by the currently ruling Serbian Progressive Party (SNS) which, policy-wise, follows a pro-European center-right path. 2022 is expected to be a politically tense year with multiple elections ahead on the presidential, parliamentary- and local level. Support for the ruling party is expected to be intact but the opposition is gaining momentum from recent public protests revolving around the potential Rio Tinto Lithium-mining operation. In addition, overall pollution levels in Serbia are increasingly regarded as problematic by the civil society, resulting in increased tensions and opposition (Erste Group Research, 2021).

Association Status for the European Union

Serbia is following a pro-European path since 2000. In March 2012, the European Council officially granted Serbia the status of a "candidate country" and negotiations started in 2014. As of now, 18 of 35 chapters have been opened and are subject for negotiations (European Commission, 2021). The Serbian government declares the European integration as high priority and continues to pursue it as a strategic goal in the coming years. Reforms required by the European Union are high on the political agenda, accompanied with continued financial support from the EU e.g., with grants and funds from the EU Solidarity Fund to purchase vaccines during the COVID-pandemic.

Some reform measures include privatizations, adaption of fees and energy prices to market prices, a reduction of the informal economy as well as continuous delegation of responsibilities to local districts and municipalities. This includes in particular the distribution of tax revenues. Nevertheless, the political climate regarding the EU-accession is still polarized with harsh language being used against political opponents. The accession process gained new momentum in December 2021, with representatives from the Serbian government and the EU meeting in Brussels for further negotiations. The ongoing convergence between EU and Serbia is likely to further improve business environment.

3.2. Austria

3.2.1. Overview

Austria is located centrally in Europe with a population of 9 million. Vienna as the capital city is an important administrative, cultural, and political center which is pivotal for the country.

Since 1995, Austria is an EU member state which significantly impacted its political and economic development and convergence with other European states. It is a member of numerous international organizations such as the WTO, WHO, IMF, OECD, World Bank Group, OSZE and the United Nations. The capital city Vienna accommodates representations for a range of international organizations such as the OSZE, the IAEA and other United Nations institutions in the Vienna International Centre.

With a GDP per capita of 48.635 USD, Austria is placed among other high-income nations.

3.2.2. Economy

Austria's economy is dominated by small- and medium-sized businesses. Some of the most important industry sectors include the food- and beverage industry, machinery and steel production, chemical industry as well as the wood- and paper industry. Tourism is another main source of income.

The economy is highly export-oriented and 50% of total GDP value are exported. In addition, every second job is directly or indirectly connected to exporting activities. The network of trading partners spans all over the world, with the most significant being countries from the

European Union (67,6%), Asia (8,8%) and North America (8,1%) (Austrian Chamber of Commerce, 2021).

3.2.3. Politics

Austria is a parliamentary republic organized through two chambers – the National Assembly (Nationalrat) and the Federal Council (Bundesrat). The current government consist of a coalition formed by the *Austrian Peoples Party* (ÖVP) and *The Greens – The Green Alternative* ("*Die Grünen*"), the latter being in power for the first time since their foundation. On the political spectrum, The *Austrian Peoples Party* is considered to be conservative, while *The Greens – The Green Alternative* follow more progressive views.

As other European countries, Austria is engaged with international development initiatives which are managed by the operational agency for development cooperation – the Austrian Development Agency. With its' strategic focus on *business & development*, it provides state aid to businesses engaging in development projects (Advantage Austria, 2022). As an example, in 2017, the Austrian Development Agency in cooperation with multiple other stakeholders such as the *GIZ* and the *Austrian Chamber of Commerce* set up a project for dual vocational training in Serbia.

Austria's central location in Europe and its proximity to eastern and southern countries provide a solid framework bilateral cooperation. Especially relations to the Western Balkans are strong and built on long partnerships.

4. Relations between Serbia and Austria

Relations between Serbia and Austria have a long tradition and the Serbian community in Austria is large. More than 150.000 individuals with Serbian nationality currently live in Austria and it is estimated that well over 300.000 people have Serbian roots (Austrian Integration Fund, 2014).

In terms of economic relations, Austria is strongly intertwined with most regions in Southeastern Europe and in particular with Serbia. In the Western Balkans region, Serbia is the top recipient for direct investments and a substantial trading partner for Austrian imports and exports. With an investment volume of 2.48 billion, Austria is the second largest investor in Serbia, right after the Netherlands. More than 400 Austrian companies have some form of presence in Serbia, providing 22.300 jobs. In 2020, exports of EUR 686,7 Mio. with imports of EUR 563,7 Mio. were traded between the two partners (Austrian Chamber of Commerce Belgrade, 2021).

Considering the waste management sector in particular, there are also a handful of Austrian businesses operating already in the industry, the largest being a joint venture between *PORR Umwelttechnik* in cooperation with *Werner & Weber. Brantner – Green Solutions* is collecting waste in four locations in northern Serbia (CMS, 2021).

In the past decades, there has been continuous cooperation and exchange between the two countries, offering a solid basis for future engagement. The geographical proximity between Vienna and Belgrade as well as good connectivity with multiple airports and highways are beneficial for intensifying ties between Austria and Serbia.

5. Serbian Waste Management

The following chapter 5 gives an overview of the Serbian waste management (and chapter 6 on the Austrian system), its shortcomings but also potentials for engagement. Comprehensive knowledge about the Serbian market is necessary to provide business-driven solutions, as is the goal with the *lab of tomorrow*.

5.1. Biogenic Waste in Serbia

Biogenic waste basically sources from the following categories:

- Municipal waste/commercial waste
- Agricultural waste

5.1.1. Municipial Waste

According to the *Serbian Environmental Protection Agency* (SEPA), the total volume of waste generated in Serbia in 2018 was around 11.6 million tons, while the share of municipal waste is around 20 percent. However, the data is incomplete, as only some of the relevant agencies collect data consistently. In Serbia's largest cities, Belgrade, Novi Sad and Nis, no disposal facilities are available for further treatment of waste and municipal waste is primarily dumped in landfills, resulting in toxic effects on the environment. There are first initiatives to introduce recycling systems for households with extra bins, but these are very small pilot projects. Landfilling of untreated municipal waste is a major challenge, especially considering greenhouse gas emissions, the cost of future soil remediation and other environmental impacts which result from unsecured landfilling (German Trade & Invest, 2020).

The composition of municipal waste is quite diverse, and it is comprised of non-toxic, solid waste from industrial, commercial and public institutions. The following table shows the composition of municipal waste in Serbia (G. Vujić, 2009):

Table 1: Composition of Municipal Waste in Ser
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Type of Waste	% of Total	Examples	
Other biodegradable waste	31,10%	Food waste (bread, meat, vegetables, fruit, etc.)	hissoniawasta
Garden waste	14,58%	Mowed grass, weeds, flowers, twigs, branches, leaves	
Fine components	9,54%	Dust, ash, sand, broken glass	
Plastic bags	6,42%	Plastic bags for waste, groceries	
Cardboard	6,28%	Boxes for food packaging, cardboard, beer boxes, cookie jars	
Paper	5,90%	Envelopes, old mail, posters, books, bus tickets tickets, bills, letters	
Textiles	5,30%	Natural fibers (cotton, wool, linen) and synthetic fibers (pants, socks, cloth bags, linen)	
Glasses	4,70%	Bottles, glass jars, flat glass, light bulbs, mirrors	
Solid plastic	4,19%	Rulers, pens, toilet lids, toothbrushes, plastic, boxes, buckets, sinks, sunglasses	
Diapers	4,17%	Diapers for babies, sanitary diapers	
Plastic packaging	3,60%	Plastic bottles for water, juices, beer	
Metal packaging	1,43%	Cans, tools	
Waxed cardboard	0,85%	Boxes for yoghurt, milk, juices	
Carboard with aluminum	0,77%	Boxes for yoghurt, milk, juices	
Leather	0,67%	Wallets, belts, leather, shoes, bags	
Aluminum packaging	0,30%	Beverage cans	

Source: G. Vujić (2009)

As Table 1 shows, around 45% of municipal waste is biogenic, however, it is not properly separated yet due to a multitude of reasons, leaving a lot of potential untouched. Infrastructure for efficient separation at the place of occurrence such as bins and transport vehicles is not implemented yet. Moreover, there are no landfill taxes, so there are no incentive systems for waste separation or recycling at all. In addition, limited awareness for the value of biogenic waste further hinders the productive use of biogenic residues.

Data on food waste on a country-wide level is hard to come by, however, a recent study in the capital city Belgrade shows that each citizen throws away 27.7 kg of edible and 80.4 kg of inedible food annually. Overall, this amounts to 165.000 tons of edible and non-edible food waste per year only in Belgrade. Similar results can be expected across the country. On a positive note, the study also shows that more than 70% of respondents expressed their readiness to separate food waste from other waste fractions if there is an appropriate separation system in place (United Nations Serbia, 2021).

Annually, about 770.000 tons of food waste occur in Serbia with 90% ending up on landfills. The food service industry generates about 40,000 tons of waste per year, primarily consisting

of non-recyclable kitchen waste and food scraps. Estimates suggest that 580 kg of CO2 per ton of biowaste could be saved if food waste would be diverted from landfills and instead used productively in biogas or biomass facilities. Large consumers of food such as restaurants, hotels and the retail sector leave a lot of the potential of food waste unused (Ministry of Agriculture, Nature and Food Quality, 2022).

There is a multitude of reasons why food waste is not yet processed on a larger scale. Substantial producers and consumers of food like caterers, hotels and hospitals argue that they are willing to engage in the recycling and productive use of biogenic waste. However, they require appropriate infrastructure to separate food waste from other wastes, a legal binding framework as well as new incentives for proper waste management such as tax-reductions (Ministry of Agriculture, Nature and Food Quality, 2022). All of these measures are currently either not or very inconsistently available. New recycling initiatives certainly have to go hand in hand with accompanying legal standards and the implementation of new infrastructure.

5.1.2. Agricultural waste

Besides municipal waste, large amounts of biogenic waste accumulate in the agricultural sector. The volume of agricultural waste aggregates to about 13 million tons annually, including wood waste, residues from agriculture, arable farming and manure. In Serbia, a total of 260.300 cows are kept, producing 5.270 m³ of manure, while the amount of manure from pigs is slightly lower at 4.560 m³. Waste management on farms is inadequate since there are no facilities for wastewater treatment or slurry storage, resulting in pollution of waterways with nutrients (Ilic & Nikolic, 2016).

An important resource in the agricultural waste sector is liquid manure, which also acts as a sourcing material for producing biogas. However, Serbian livestock farming is characterized by small farms and so far, there have hardly been any initiatives to use liquid manure for energy generation on a larger scale. Exceptions are *Global Seed*, an organic farming corporation from Čurug as well as the *Lazar* dairy. The latter uses a combination of manure and whey to produce biogas. There are also some other initiatives e.g., in the sugar industry by using wastewater for biogas production. One example is *MK Group* – a producer of sugar beets – who set up a biogas plant with 2.4 megawatts in Vrbas. Table 2 gives an overview of the real energy potential in tonnes for biowaste in Serbia.

Type of Biowaste	Real energy potential (in tonnes)
Farming/harvesting residues	1.036.828
Fruit- and wine plantation residues	133.602
Bio fules	142.770
Slurry	176.526
Biogenic waste from municipal waste	42.910
Total	1.532.636

Table 2: Energy Potential of Biowaste

Source: German-Serbian Chamber of Commerce (2019)

5.2. Key Actors

Public Sector and Ministries

The main actors in the management of municipal waste are public utility companies with the largest being *Gradska čistoća* with 2,000 employees in Belgrade. (CMS, 2021).

The institutional framework in the field of waste management is established by the Ministry of Environmental Protection. The Environmental Protection Agency is a part of the ministry. The tasks of the Ministry of Environmental Protection include issuing permits for waste management. According to the latest data, waste management companies have issued 1,973 permits for the collection, transport, storage, treatment, and disposal of waste (Flanders Investment & Trade, 2017).

Private Sector

Along with the public sector, there are also some key private players engaged in municipal waste management. *FCC Environment CEE* (part of the Spanish *FCC Group*) collects waste in 9 municipalities and operates two landfills in Kikinda and Lapovo.

PWW, a joint venture of *Porr* and *Werner & Weber* also operates two landfills in Leskovac and Jagodina. Another Austrian player is the company *Brantner* which is engaged in waste collection at four locations in the northern parts of Serbia. Some other key companies are *Čistoća* and *Beo Cista Energija*.

In addition to these most significant companies mentioned above, there is a large number of additional private players with international connections to Japan, Germany or France (CMS, 2021).

5.3. Current State of Waste Disposal

Serbian waste management faces numerous challenges along its value chain and business driven solutions could significantly improve the current condition of the waste management system. Some major challenges are the following:

Substantial Waste Dumping

Officially, the value chain for municipal waste management includes all essential steps: waste collection, separation, transport and final use (landfilling, recycling, etc.). However, waste dumping and landfilling still remain the predominant method for waste disposal, especially in rural areas which are poorly connected to public waste management systems. Landfilling has substantial downsides and heavily pollutes the environment, especially if landfills are illegal and hence unsecured and unsanitary, as is often the case. The major problem is also that there are no landfill taxes. Therefore, no incentives to separate or recycle waste are given.

Roughly 85% of all accumulated waste in Serbia is dumped in landfills. In comparison, EU countries reuse 45% of solid municipal waste, 27% is burned in waste incineration plants and 28% are dumped on landfills. Germany is in the top position with 64% of reused solid municipal waste (German RETech Partnership, 2017).

Currently, there are 164 landfills for waste disposal (Serbian Environmental Protection Agency, 2021). Most of them do not meet security standards and due to a lack of resources, sufficient maintenance is not always possible, resulting in environmental damage e.g. through the leakage of toxic liquids (Reuters, 2021). In addition to these 164 officially registered dumping sites, there are numerous illegal landfills in more rural areas that heavily pollute the environment. The spread of illegal landfills is exacerbated by the fact that the capacity of official landfills is exceeded in most municipalities, which further encourages illegal dumping. Lastly, 97,6% of landfills have not developed any form of waste recycling yet. Comparing data in Serbia with EU-countries, waste generation in Serbia is high and combined with a low recycling rate (European Environment Agency, 2021).

Especially in landfills that do not meet the latest technical requirements, the toxins produced during decomposition can lead to severe pollution, e.g. soil and groundwater contamination. The major pollutants emitted from landfills are nitrogen and sulfur oxides, dust and heavy metals, landfill gas, about 50% of which is methane, and leachate. This not only leads to severe environmental pollution and greenhouse gas emissions but also wasted economic potential, as the biogenic fraction remains largely unused in Serbia (Tosic & Vasovic 2020).

Collection and separation of waste

Serbia has a total of 2.200 registered waste management and recycling facilities, most of them from the private sector (German RETech Partnership, 2017). Most private companies in Serbia are exclusively engaged in the collection, transportation, and storage of waste. Organized collection of municipal waste is carried out only on 80% of Serbian territory, leaving 20% uncovered with any form of systematic waste transport and -management. In addition, those companies that have permits for the collection, transport and storage of waste are more focused on the collection of waste that can be recycled on a strictly commercial basis, i.e. metal, plastic, paper, rubber or end-of-life vehicles.

Only 160 of 2.200 registered waste management and recycling facilities are licensed to treat biodegradable waste, which is a rather small number considering that Serbia produces about 1.300.000 tons of biodegradable municipal and industrial waste annually (Flanders Investment & Trade, 2017). Apart from some low-capacity facilities which are installed directly at companies that generate biodegradable waste, no public or private company entrusted with the collection and treatment of municipal waste currently processes biodegradable waste in Serbia.

Lack of separation at the source

One major challenge is the persisting lack of infrastructure for appropriate separation of waste at the source. Separate bins/disposal systems for biogenic waste and other municipal waste are an important precondition to use biogenic residues productively.

Incentives and public/political awareness

One of the main reasons for the persisting waste problem is the lack of awareness of waste on a political, but also on an individual level. Apart from a reduction in landfilling by introducing new recycling systems, it also seems necessary to devote resources to increasing public and political awareness for the problem. While progress was made in the past few years – also due to recommendations from international organizations – there is still room for improvement and awareness setting should be seen as a significant lever to improve the persisting issues related to waste accumulation.

Next to improving public/political awareness by making the recycling value and the possibilities for productive use visible, incentives have to be adapted as well. The waste management system in Serbia shows some sub-optimal incentives e.g. for determining waste disposal fees. Currently, the fees for waste disposal are calculated based on the square meters of a building – the larger the building, the higher the fee, disconnected of the actual amount of waste being produced. Even if businesses are eager to reduce waste, there is no financial incentive to do so because they still pay the same amount of fees.

Lastly, public and political awareness is primarily focused on reducing plastic waste despite the fact that uncontrolled degradation of biogenic waste in landfills (which are the main disposal method in Serbia) is highly toxic for the environment.

5.4. Recent Developments

The following chapters intend to give an overview of recent, positive developments that support initiatives such as the *lab of tomorrow*.

5.4.1. New Strategic Frameworks for Waste Management

National Waste Management Strategy 2020-2025

In 2020, the Serbian government – in collaboration with the Austrian Environmental Agency, the Serbian Ministry of Environmental Protection and several other EU members states – published the "National Waste Management Strategy 2020-2025". This strategic framework is key to achieving the standards required for EU membership and for paving the way towards more sustainable development (Environment Agency Austria, 2020). While the previous strategy emphasized a conservative approach by constructing more landfills, the new strategy envisages smaller waste centers with subsequent productive use of waste fractions. Waste will be treated, recycled and stored there. According to current estimates, about 5 percent of total waste will be sent to treatment (German Trade & Invest, 2020).

European Waste Management Program 2022-2031

In 2022, Serbia has adopted the Waste Management Program for 2022-2031 as part of Chapter 27 of the EU accession process. The program's key target is to harmonize the existing waste system with the objectives set by the EU. It frames a foundation for future improvements in the waste management sector, particularly for better separation of waste at the source, the construction of missing infrastructure as well as increased recycling efforts.

The Waste Management Program includes revamped incentives, such as the "Polluter Pays Principle" or the "Pay As You Throw" scheme (households can reduce the amount of waste fees depending on their level of separation, home composting, etc.), and an adaption of deposit and waste fees which will increase from 0.5% to 1.5% of household income to finance new infrastructure.

Additionally, it includes new commitments for using biodegradable waste. Beginning in 2022, regions that collect more than 85.000 tons of municipal waste have to prepare feasibility studies that develop concepts to deal with the separation and treatment of biowaste.

Necessary capacities must be installed by 2037. Regarding the separation of biodegradable waste at the place of occurrence, "Home Composting" is another pillar in the Waste Management Program. It includes policies to equip all households in rural areas with home composting kits to reduce the amount of biowaste ending up in landfills (eKapija, 2022).

The new Waste Management Program 2022-2031 is certainly beneficial for Serbia's transformation to a more sustainable waste management system and shows the great momentum for new solutions in this sector.

5.4.2. Business-Driven Solutions for Climate Change

Climate change is increasingly showing its adverse effects and global efforts are necessary to mitigate the detrimental consequences as best as possible. Transitioning to renewable energies, implementing proper waste management systems, increasing recycling rates and using waste productively are some measures that can help in combating global warming. Capturing methane emissions from uncontrolled landfills is another measure to reduce global emissions. Due to the global scale of this challenge, there is great momentum to get active and businesses can provide innovative solutions.

5.4.3. New Incentives and Social Awareness

Currently, incentives for individuals and corporations to reduce their waste volume are not ideal. One major reason being that the fee for waste disposal is based on the number of people per household or square meters in case of businesses. Reducing or separating waste has no financial benefit yet, which is counterproductive when trying to implement new methods for waste management. The new Waste Management Program seeks to revamp this system of incentives.

In addition to achievements from a regulatory perspective, public awareness for environmental issues is increasing as well. This boosted awareness can be attributed to intensified activities from civil society organizations and multiple protests against highly controversial projects such as the Rio Tinto Lithium mining, which faced strong opposition in public (Erste Group Research, 2021). Litter pollution is more and more perceived as problematic, especially plastics in the environment. While social awareness is expected to intensify, there is still a long way ahead.

5.4.4. EU-Membership

Environmental issues and the harmonization of waste management systems with EU objectives are a subject of Serbia's ongoing accession negotiations with the EU. Under the premise of a possible EU membership by 2025, Belgrade proposed to meet EU standards for the waste sector by 2036 (Balkan Green Energy News, 2017). Legislation is already being adapted, however, its implementation poses great difficulties. Above all, it requires considerable investment, with experts estimating around 4 billion euros (CMS 2021). One major project already exists: international development banks are financing the Vinca waste center near Belgrade, which will cost nearly 350 million euros (German Trade & Invest, 2020).

However, the attainment of EU candidate status in 2012 and the government's reform program, which was largely shaped by the loan agreement with the International Monetary Fund in 2014, were important stimuli for structural reforms, the consolidation of the state budget and the recovery of the private sector (German Trade & Invest, 2020). All in all, the EU accession process – albeit progressing slowly – unlocks substantial new financial resources and improves conditions for private investors and companies to enter the Serbian market.

6. Austrian Waste Management

6.1. Biogenic Waste in Austria

Austria has a long tradition in the productive use of waste, especially in the biogenic fraction, both in terms of technological developments as well as market implementation.

Considering the biogenic sector in particular, Austria has an established system of collection, separation and usage of biogenic waste for energy production. Good separation infrastructure at the source (households, hotels, catering, etc.) leads to a high purity of biowaste, which can be used for further processing. Due to the high carbon and nitrogen content, this raw material is mainly utilized in Austria energetically through biological methanization or materially through composting.

The overall waste volume in Austria aggregates to roughly 62 Mio. tons annually and is composed as follows (Ministry for Sustainability and Tourism, 2018):



Figure 4: Composition of Total Waste in Austria (2016)

The total share of biogenic waste, which in the diagram is composed of biogenic waste and part of municipal waste, in total waste generation is relatively small, but of great importance, especially for bioenergy production.

Source: Ministry for Sustainability and Tourism (2018)

As can be seen in Table 3, biowaste fractions in municipal waste are separated efficiently, with separation rates of 85%. Austria ranks first amongst the EEA member states (European Environment Agency, 2020).

Table 3: Biowaste collected separately as a Share of Biowaste generated by Country (32 EEA

 Member and cooperating Countries)



Source: European Environment Agency (2020)

6.2. Relevance of Biowaste in Austria

Austria also has a well-functioning and established waste management system for biogenic waste. Depending on the type and origin of the waste, it is collected in separate garbage cans and transported to the recycling facility by transport companies. The following types can be distinguished:

Separately collected biogenic waste from households and similar establishments

This waste consists of green waste from gardens and green areas, such as grass cuttings, tree and shrub cuttings, flowers, leaves and also waste from the preparation of food and leftovers. In 2019, around 1 million tons of biogenic waste from households and similar establishments were collected separately and recycled in agricultural, municipal or commercial composting as well as biogas plants. The majority of biogenic waste from households is collected via the organic waste garbage can, which is mostly disposed of in the collection system. In contrast, greenery and shrub cuttings from household gardens are also taken to existing collection points or directly to composting plants. The compost is subsequently used for agricultural purposes, for fertilizing public green spaces such as parks, cemeteries, sports facilities, etc., for distribution to the general public, or for use in gardening and landscaping. The biogas produced in biogas plants is used to generate energy and heat. The digestate is composted or used in agriculture.

Individual and community composting in home gardens

In individual or home garden composting, the residents of a single-family home or apartment building recycle their biogenic materials on their own green or garden areas. This has a high value, especially in rural areas, because in addition to their own labor costs, no fees are incurred and the resulting compost is in turn used on their own garden areas. It is estimated that 1.5 million tons of biogenic materials were recycled in this way across Austria in 2019 via individual and community composting in compost silos or in containers made of wooden or wire mesh.

Biogenic waste from green areas

This chapter describes those biogenic wastes generated on public and semi-public areas from municipal garden and park waste, cemetery waste and roadside greenery.

Municipal garden and park wastes are plant residues from green spaces, parks and sports facilities. This includes mown grass, leaves, tree and shrub cuttings. Cemetery waste is predominantly biogenic waste generated by the maintenance of graves and cemetery grounds. It consists of flowers, wreaths, soil, etc. In 2019, around 500,000 tons of biogenic waste was generated nationwide from green spaces, most of which is collected in bulk, some of which is chipped and recycled in green waste composting plants or together with biowaste. A not insignificant part of the municipal garden and park waste as well as of the roadside greenery remains at the place of occurrence and decomposes without being brought to treatment plants. This proportion is not included in the total waste volume.

The composts produced from biogenic waste from green spaces are used to fertilize public green spaces in sports facilities and parks, gardens and cemeteries, recycled for agricultural purposes or used in private gardens and landscaping.

Commercial kitchen and food waste

Kitchen and food waste is food residue that comes from food service establishments, food wholesalers, and commercial kitchens such as those in hospitals, dining halls, and military barracks. These are vegetable and animal wastes from the sale and preparation of food, as well as residues from the consumption of food.

For the most part, these are collected through commercial disposal companies and mostly recycled in biogas and composting plants. In 2019, around 135,000 t of kitchen and food waste was generated (Ministry for Climate, Environment, Energy, Mobility, Innovation and Technology, 2021).

6.3. Core Competencies in the Austrian Waste Management System

Technological Expertise

The combustion of biomass is an established technology in Austria and technological expertise is available all over the country. Applications range from smaller household boilers fired with wood chips or log wood up to large scale biomass facilities providing heat to households and corporations. Expertise is available for heating and cooling, electricity generation as well as the production of biofuels. In the field of biogenic waste, Austrian companies can rely on many years of expertise. Along the value chain, from waste collection and separation to productive use such as composting or fermentation, there are numerous companies that have specialized in this industry and sell their products globally.

High recycling rate

According to the European Environment Agency, Austria is among the top 5 countries with the highest recycling rates for municipal waste in Europe at around 60% (European Environment Agency, 2021). Again, know-how in this sector is widely available in Austria and there is a long tradition with separating municipal waste and providing infrastructure for it.

Industry clusters

Austria has a network of corporate clusters with the two most prominent and relevant being the Cleantech Cluster (Upper Austria) and the Greentech Cluster (Styria). Around 500 companies are members of these two industry clusters. They are engaged in the development of new technologies for energy production, environmental technology or concepts for a circular economy. Companies within the cluster bundle their expertise, share information, and can improve their competitiveness and visibility, while also creating new innovations which are underpinned by scientific expertise provided by universities and research institutions who are also active members of the cluster.

International cooperation

Through the IEA Bioenergy Technology Collaboration program, national experts and stakeholders from politics, the corporate and research sector continuously engage in cross-country research. Activities include the initiation, coordination and promotion of international research, development and demonstration projects. Currently, 22 countries in Europe participate in this international cooperation program (Federal Ministry of Transport, Innovation and Technology, 2019).

Network of research institutions and universities

The technological expertise in Austria is backed up by a large network of research institutions and universities who deliver scientific input to implement new and optimize existing technologies.

7. Solutions to Explore

The last chapter 7 aims to put the existing pieces of information into practical business opportunities so that they can provide adequate solutions that combine market expansion with sustainable development. These business opportunities are the main pillar for the *lab of tomorrow* process, and they break down the overall challenge into more operational topics.

As presented in the previous chapters, the Serbian waste management sector faces numerous challenges along its value chain, from waste collection to the productive use of waste. Large proportions of waste are currently dumped on landfills and there is no wide-spread separation or recycling system in place, which leads to substantial environmental damages in the surrounding areas.

There are various possible approaches for improving the value chain of biogenic waste. What all the concepts have in common, is that they create a considerable need for investment. When waste is no longer simply dumped, it has to be separated, recycled, processed or destroyed.

Biogenic waste from forestry was excluded in our lab process. This is due to the fact that the entire forestry industry is heavily regulated by the state and therefore does not show any business case potential.

Based on the findings of on-site visits in Belgrade as well as desk research, the following business opportunities have been defined by the project team, each focusing on a separate aspect of the value chain:



Figure 5: The four Business Opportunities

7.1. Storage and Collection of Biogenic Waste

How might we develop an efficient solution for the storage and collection of biogenic waste for different customer groups?

Background

The appropriate storage and collection of biogenic residues is an important point in the improvement of the value chain. It is crucial for the subsequent utilization of biogenic waste and to gain value from it, e.g., in biogas plants, compost systems or other products. First, it is

about collection at the point of accrue, since hardly any value or further processing can be generated from biogenic residues if they are mixed with interfering materials. Separate collection often also requires separate storage, which should be as simple and odor-free as possible. Separated biogenic residues can either be processed at the place of occurance or be transported to a centralized processing facility. This collection is not carried out comprehensively at state level in Serbia.

Business Opportunity

The challenge here is to recover the waste as purely as possible as well as to minimize negative impacts (e.g. odors, hygienic issues) generated during storage. Furthermore, the high-water content and the resulting dead volume and weight is a challenge especially for transport. Decentralized use-cases may therefore be advantageous or even required. In addition, different processes require precise specifications concerning purity or homogeneity of the biowaste – smart collection can improve the composition and hence positively influence its useability for further processes. Seasonal fluctuations of biogenic residues must be considered as well.

Possible Business Cases/Business potential

- devices/machines that enable separate collection and storage
- hygienic and smell-free containers (e.g., for restaurants and hotels as well as private households)
- local hygienic storage/local solution, if biogenic residues are further utilized on site (e.g., supermarkets, industries, big farms)
- improvement of regular and pure collection
- savings in terms of cost-efficiency within the current budget
- equipment/machinery/vehicles that remove water from biogenic waste
- smart vehicles/containers to collect biogenic residues (frugal innovation)

Possible audience/customers

Public Utility Companies, restaurants & hotels, farmers, public institutions, food retail, food processing companies, biogas plant operator, compost plant operator, buyers/processors of biogenic material

7.2. Decentralized Uses of Biogenic Residues

How might we use biogenic waste productively at the place of accrue?

Background

An efficient way to improve the use of biogenic waste is to process and use it directly where it is generated. One of the reasons for this is that biogenic waste is difficult to transport due to its high-water content and must be treated quickly due to hygienic issues and the rapid formation of odors. As a result, biogenic waste often is not integrated into the value chain at all in Serbia. Wherever larger quantities of organic waste are generated or can be collected and stored, decentralized use is a possibility. This might be interesting for producers, intermediaries, and retailers to collect and recycle biogenic residues on the place of accrue.

Business Opportunity

A challenge here is to develop a space-saving collection and hygienic storage as well as rapid processing. Furthermore, it is about the question of heterogeneous composition and homogenization as well as conditioning of the biogenic residues in the spot. In addition, the urgent question about the reduction of negative value needs to be addressed as well as a possibility of local value creation. The proper disposal of possible residues needs to be solved as well.

Possible Business Cases/Business potential

- local energetic use (electricity and/or process heat/cold)
- local composting
- local dehydration
- local storage and/or fractionation and/or homogenization and/or conditioning
- controlling and automatization of small-scale installations

Possible audience/customers:

Local compost plants, local biogas plants, food production/trade/retail, farms, livestock processing factories

7.3. Separation and Homogenization of Biogenic Waste

How might we provide an efficient solution for the separation and homogenization of biogenic waste for further use?

Background

To use biogenic waste productively, for example for energy production, it has to meet certain requirements in terms of composition and contamination etc.. Composting and biogas plants require different types of biogenic waste. This business opportunity therefore focuses on how biogenic waste can be appropriately processed in order to increase overall quality and thus productivity for further use.

Business Opportunity

The challenge here is the develop an efficient and hygienic storage system for the different customer needs. Furthermore, it is about establishing the process of homogenisation.

Possible Business Cases/Business potential:

- storage solutions
- homogenization solutions
- pyrolysis/coal
- energy technology

Possible audience/customers:

Compost/biogas plants, treatment companies, companies that generate products from biogenic residues

7.4. Value-added Products from Biogenic Waste

How might we create value-added products from biogenic waste for different customer groups?

Background

Products from biogenic waste have a wide range: from special soap, to pellets and compostable packaging. They can thus be used and reused in various processes and for new products.

Business Opportunity

The business opportunity here is to process the biogenic waste into products that are marketable and that customers buy. Therefore, the biogenic waste must be processed and conditioned.

Possible Business Cases/Business potential

- compost-based fertilizer
- cosmetic products like soaps, peelings etc.
- pellets
- packaging
- conditioning solutions

Possible audience/customers

Farmers, industry sectors, processing companies, cosmetics industry

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