Interreg Alpine Space

Co-funded by the European Union

Analyzing the Operating Context for Biomass Conversion Opportunities in Italy, Austria, and Slovenia

Report: D1.4.1

Activity: Context and gap analysis of biomass conversion opportunities for green carbon supply

Interreg Alpine space Alps4GreenC

Biochar and green carbon from biomass residues can make a significant contribution to reduce the energy dependency of the Alpine region further increases and its vulnerability to climate change and the loss of biodiversity. The project Alps4GreenC contributes to the conditions for energy sufficiency and climate protection of the region by setting the scene for a transnational utilisation of biomass residues. Through policy recommendations and the pilot production of green carbon, the project investigates the opportunities for biomass conversion and proposes transnational biochar-based value chains. This first transnational collaboration for the establishment of biochar-production value chain will enable to identify and upgrade the appropriate technologies for biomass conversion and to fully realise the shift to green, post-carbon approaches.

Index

1. Introduction

This report is a culmination of a collaborative effort between the leader of the Activity 1.4. in Alps4GreenC project, Chamber of Commerce and Industry of Štajerska (CCIS), and project partners in Italy, Austria, and Slovenia. The focus of the analysis is to comprehensively assess the operating context within these countries, with a specific emphasis on biomass conversion opportunities for green carbon supply. The foundation of this report lies in the data gathered through two structured questionnaires designed by CCIS, which was responded to by all 6 project partners. Additionaly, CCIS received support from three experts in the field og bio-char in Slovenia and Germany due to absence of best practices in Slovenia.

Objective: The primary objective of this analysis is to leverage the insights derived from the questionnaire responses to illuminate the legal constraints, socio-cultural nuances, political landscapes, economic considerations, and geographic factors influencing the viability and potential success of biomass conversion initiatives. The report aims to provide stakeholders with a nuanced understanding of the current operating environment and to serve as a catalyst for informed decision-making.

Scope: The report's scope extends across the entire Alpine region, covering Italy, Austria, and Slovenia. By harnessing the diverse perspectives of our partners, we aimed to capture a holistic view of the operating context within each country, fostering a comprehensive understanding of the challenges and opportunities unique to each locale. Additionally, a thorough gap analysis has been conducted to compare current performance with desired outcomes, and recommendations for the relevant stakeholders, including policy and investors, are supported by best practice examples from the Alpine region and beyond.

2. Evaluating the Operating Landscape: Comprehensive Analysis of Legal, Socio-Cultural, Political, Economic, and Geographic Factors in Project Partner Countries (Italy, Slovenia and Austria) for Biomass Conversion Opportunities and Green Carbon Supply

Biomass conversion plays a pivotal role in the transition toward sustainable and renewable energy sources, and understanding the multifaceted regulatory and policy landscapes in various countries is paramount for those seeking to participate in the green carbon supply chain. In this in-depth report, we embark on a detailed exploration of the operating contexts in Italy, Austria, and Slovenia, taking into account legal constraints, socio-cultural factors, political dynamics, economic conditions, and geographic influences to provide a holistic understanding of biomass conversion opportunities.

2.1. Legal Framework and Policies

2.1.1. Navigating Regulations: What are the existing regulatory frameworks or policies related to biomass conversion technology in your country?

Italy: Italy's approach to biomass conversion is characterized by a comprehensive and intricate regulatory framework. The Environmental Consolidated Law (Decreto legislativo 3 aprile 2006, n. 152) serves as the cornerstone of Italy's regulations for biomass combustion. This law extends its reach to every facet of biomass conversion, beginning with the origin of biomass, where it essentially permits the use of virgin biomass only. Additionally, it sets forth stringent emission limits and guidelines for the conversion technologies. Another critical legal component is the Decreto Ministeriale 7 novembre 2017, n. 186, which classifies combustion plants based on their size and application, with specific emission limits for each category. Italy's decentralized structure grants substantial authority to its Regions (NUT 1), enabling them to impose additional emissions restrictions, contributing to a mosaic of regional variations in regulations. Importantly, any new biomass conversion plant in Italy is subject to a series of legal aspects that include the acquisition of building authorization, compliance with workplace safety regulations, and adherence to fire-prevention requirements.

Slovenia: Slovenia's regulatory and policy framework for biomass conversion is anchored in a profound commitment to sustainability and renewable energy. Several instrumental strategic documents collectively shape the nation's approach to biomass conversion. The National Energy Program (NEPN) is a comprehensive roadmap that outlines a wide array of measures designed to

promote the sustainable utilization of biomass. This strategic program aligns with broader energy diversification and environmental goals, accentuating the significant role of biomass in the renewable energy sector. The Common Agricultural Policy (CAP) Strategic Plan for 2023–2027 places explicit emphasis on the sustainable utilization of energy resources, with a specific focus on biomass as a primary, natural, and renewable raw material resource. The strategic plan recognizes the crucial role of biomass in enhancing international competitiveness and aligns with broader agricultural and economic objectives. Furthermore, the Slovenian Industry Strategy for 2021-2030 is centered on the imperative of enhancing accessibility to and sustainable utilization of biomass. This natural, renewable resource is viewed as a linchpin in bolstering the international competitiveness of the manufacturing sector. The strategy envisions the initiation of demonstration and pilot projects, aimed at catalyzing the transition away from fossil raw materials and towards sustainable biomass alternatives. By doing so, it seeks to not only drive economic growth but also contribute to environmental sustainability. The "Zakon o spodbujanju rabe obnovljivih virov energije" (ZSROVE), or the Renewable Energy Sources Act, is a crucial component of Slovenia's regulatory framework for promoting the use of renewable energy, including biomass. This legislation outlines a myriad of provisions, incentives, and regulations related to the development and utilization of renewable energy sources within the country.

Austria: Austria boasts a meticulously structured regulatory framework for biomass conversion, focusing on the Waste Incineration Ordinance, known as "Abfallverbrennungsverordnung." This ordinance is a comprehensive document that addresses a multitude of crucial aspects concerning waste incineration. It places specific emphasis on emission limits and feedstock quality requirements. Notably, the ordinance does not encompass gasification or pyrolysis installations if the resulting gases are adequately purified, thereby rendering them no longer classified as waste and ensuring they meet specific limit values. Austria's approach underscores the paramount importance of emissions control and responsible waste management in the context of biomass conversion.

In summary, Italy, Austria, and Slovenia exhibit distinct regulatory and policy frameworks related to biomass conversion technology. Italy's framework is characterized by a complex set of laws covering various aspects of biomass combustion and emissions, while Austria places a strong focus on waste incineration and emissions control. Slovenia stands out with a robust commitment to biomass utilization within its energy and industrial development policies, emphasizing sustainability and competitiveness. These three countries offer unique opportunities and challenges for biomass conversion projects, depending on their respective regulatory landscapes and strategic priorities. Understanding these operating contexts is vital for those seeking to engage in green carbon supply and biomass conversion initiatives in these nations. Each nation represents a unique and dynamic

landscape, and by taking a closer look at the regulatory intricacies, socio-cultural factors, political dynamics, economic conditions, and geographic influences, stakeholders can better tailor their strategies to leverage the abundant biomass conversion opportunities within these countries.

2.1.2. *Permits and Deployment:* Are there any specific permits or licenses required for the development and deployment of biomass conversion technology?

Italy: In Italy, the requirements and limitations for the placement of biomass conversion technology on the market are relatively straightforward:

- **Emission Limits**: Biomass conversion technology in Italy must adhere to specific emission limits. Compliance with these limits is crucial for ensuring that the technology meets environmental standards and minimizes its impact on air quality and the environment.
- **Market Placement Openness**: Other than compliance with emission limits, there are generally no further restrictions or limitations imposed on the placement of biomass conversion technology on the market in Italy. The approach to biomass conversion technology aligns with the principles of the European open market. This approach encourages open competition and the free exchange of technology within the European Union.

In essence, Italy's regulatory framework for biomass conversion technology focuses primarily on emissions control and environmental considerations. Compliance with emission limits is a key requirement to ensure that the technology operates within established environmental standards. The open market approach promotes a competitive and market-driven environment for the development and deployment of biomass conversion technology, facilitating the exchange of technology across European borders.

Slovenia: The development and deployment of biomass conversion technology in Slovenia entail a complex and multifaceted process, often necessitating specific permits and licenses to ensure compliance with environmental, safety, and regulatory standards. The diverse range of permits and licenses required depends on the scale, nature, and specific aspects of the biomass project. Slovenia has developed a comprehensive framework to address these demands and provide clarity to stakeholders in the sector.

- **Environmental Permit** (Okoljevarstveno dovoljenje): One of the cornerstone requirements for large-scale biomass conversion projects, such as power plants and biogas facilities, is the acquisition of an environmental permit. These permits are issued by the Environmental Agency of the Republic of Slovenia (Agencija Republike Slovenije za okolje - ARSO). The

permitting process involves a rigorous environmental impact assessment (EIA) to ensure that the project aligns with environmental regulations and standards. This assessment is crucial in demonstrating the project's commitment to sustainability and responsible resource utilization.

- **Integrated Environmental Permit** (Integrirano okoljevarstveno dovoljenje): Projects that encompass multiple environmental aspects may necessitate an integrated environmental permit. This permit streamlines the various requirements into a consolidated document, simplifying the regulatory process for project developers. It is also issued by ARSO and reflects the country's approach to minimizing bureaucratic complexity while maintaining rigorous environmental standards.
- **Building Permit** (Gradbeno dovoljenje): Biomass projects that involve new construction or significant modifications to existing structures typically require a building permit. This permit is issued by local municipal authorities and ensures that the project adheres to building codes and safety standards. It plays a vital role in guaranteeing the physical integrity of the project.
- **Operational Permit** (Uporabno dovoljenje): Once the construction phase is completed, an operational permit may be necessary to affirm the project's compliance with safety and technical requirements. These permits are issued by local authorities, signifying that the biomass facility has met the prescribed standards and is safe for operation.
- **Forest Management Plan** (Gozdarski načrt): For projects that involve the sustainable harvesting of forest biomass, such as wood chips or firewood, forest owners may need to establish and maintain a valid forest management plan. This plan outlines the sustainable management of forest resources and emphasizes responsible resource utilization, aligning with the principles of sustainable forestry management.
- **Electricity Generation License** (Licenca za proizvodnjo električne energije): In cases where the biomass facility generates electricity for sale, an electricity generation license may be required. These licenses are issued by the Energy Agency of the Republic of Slovenia (Agencija za energijo - AERS) and ensure compliance with national regulations pertaining to electricity generation, distribution, and sale. This authorization is vital for the sale of electricity to the grid.
- **Biofuel Production Authorization** (Dovoljenje za proizvodnjo biogoriv): Facilities engaged in the production of biofuels from biomass may require specific authorizations from relevant authorities. These authorizations can vary based on the type of biofuel being produced, and they underscore Slovenia's commitment to sustainable energy production and reducing greenhouse gas emissions.

- **Waste Management Permit** (Dovoljenje za ravnanje z odpadki): Biomass projects that generate waste materials, whether during processing or as a byproduct, may require a waste management permit. These permits oversee the proper handling, recycling, or disposal of waste products, ensuring adherence to waste management standards and environmental protection.
- **Water Use Permit** (Dovoljenje za odvzem vode): In situations where the biomass project involves water use, such as for cooling systems or steam production, a water use permit may be necessary. These permits are essential to ensure responsible and sustainable water resource management.

In conclusion, the development and deployment of biomass conversion technology in Slovenia require adherence to a comprehensive system of permits and licenses, ensuring that projects are conducted in an environmentally responsible, safe, and legally compliant manner. The specific permits and licenses needed depend on the project's scope and nature, ranging from environmental permits to building permits, operational permits, and various authorizations for specific activities. Stakeholders involved in biomass conversion projects in Slovenia must establish close communication with the relevant local and national authorities, such as ARSO, the Ministry of Infrastructure, municipal authorities, and AERS, to ascertain the precise permit and licensing requirements for their project and to navigate the evolving regulatory landscape effectively. Staying informed of changing regulations and seeking legal and technical guidance during the project's planning and development phases are integral to the success of biomass conversion initiatives in Slovenia. By adhering to these requirements, biomass conversion projects can contribute to the country's sustainable energy and environmental objectives while ensuring legal compliance and safety standards are met.

Austria: Austria's approach to biomass conversion technology is unique and involves distinct certification requirements:

- **Certification as Pyrolysis**: In Austria, biomass conversion technology that utilizes pyrolysis is not registered as normal combustion but must be certified as a pyrolysis process. This certification is essential for the operation of pyrolysis-based facilities.
- **Emission Requirements**: Pyrolysis-based biomass conversion facilities must adhere to specific emission requirements to minimize the environmental impact and ensure air quality standards are met. Compliance with these requirements is crucial for both environmental sustainability and regulatory approval.

- **Material Requirements for Food/Feed Use**: If the biomass coal produced through pyrolysis is intended for use in the food or feed industry, there are stringent material requirements. Specifically, all components from the coal separation process following pyrolysis must be constructed using stainless steel. This ensures a high level of hygiene and safety for food and feed applications.
- **European Biochar Certificate (EBC):** The European Biochar Certificate is a certifying body that imposes specific requirements for biomass coal production. These requirements include minimum temperatures and residence times during the pyrolysis process. Compliance with EBC standards is necessary for certification and market placement.
- **Polycyclic Aromatic Hydrocarbons (PAH) Requirements**: To place biomass coal on the market, it must meet minimum requirements for Polycyclic Aromatic Hydrocarbons (PAH). Compliance with these requirements is a critical aspect of certification and ensures the safety and quality of the product.
- **REACH Compliance**: The Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH) regulation is a significant consideration. It encompasses the safe use and management of chemicals, including those used in biomass conversion processes. REACH compliance is essential for regulatory approval and environmental protection.

In conclusion, Austria's approach to biomass conversion technology, particularly when it involves pyrolysis, is marked by rigorous certification and regulatory requirements. Facilities utilizing pyrolysis must meet specific emission standards, while those intending to use the resulting biomass coal for food or feed applications must maintain strict material requirements, such as using stainless steel components. Certification from organizations like the European Biochar Certificate (EBC) is a crucial step in the process, as it sets specific criteria for minimum temperatures and residence times during pyrolysis. Additionally, compliance with PAH requirements and adherence to the REACH regulation are vital components of the regulatory framework. Understanding and complying with these unique requirements is essential for the development and deployment of biomass conversion technology in Austria, ensuring both safety and environmental sustainability.

2.1.3. *Legal Boundaries:* Are there any legal restrictions or limitations on the use of certain feedstocks or conversion processes?

Italy: Italy's legal restrictions and limitations regarding biomass feedstocks, particularly woody biomass, focus on the condition and previous use of the biomass, with the primary aim of ensuring environmental sustainability and safety:

- **Condition of Biomass**: The use of woody biomass is subject to restrictions related to its condition. It should not have undergone chemical treatment, emphasizing the importance of using untreated and natural wood as a feedstock. This requirement aligns with principles of sustainability and environmental protection.
- **Prohibition of Waste Biomass**: Another key restriction is that the biomass should not originate from waste materials. This regulation aims to prevent the utilization of waste materials in biomass projects and underscores the importance of using feedstocks with a clear and uncontaminated origin.
- **Environmental Consolidated Law**: The normative reference for these restrictions is the Environmental Consolidated Law (Decreto legislativo 3 aprile 2006, n. 152). In particular, the regulations pertinent to biomass feedstocks are found in Part II, section 4 of the Annex X to Part V of this law. This legal framework serves as the foundation for ensuring the responsible sourcing and use of biomass in Italy.

In summary, Italy's legal framework emphasizes the responsible use of biomass feedstocks, especially woody biomass. These restrictions focus on using untreated and non-chemically treated wood while prohibiting the use of waste biomass. Compliance with the Environmental Consolidated Law is integral to adhering to these regulations and ensuring that biomass projects in Italy meet environmental sustainability and safety standards.

Slovenia: Slovenia has established legal restrictions and limitations to govern the use of specific feedstocks and conversion processes in biomass projects. These regulations are designed to ensure sustainability, protect the environment, and uphold safety standards, aligning with both national and European Union (EU) regulations.

- **Sustainable Feedstock Sourcing**: Slovenia, as an EU member state, is guided by regulations promoting the sustainable sourcing of biomass feedstocks. These regulations likely specify requirements for responsible forestry practices and the production of agricultural biomass, emphasizing the protection of biodiversity. Compliance with sustainability criteria may be necessary to access incentives or subsidies, highlighting the importance of environmentally responsible feedstock procurement.
- **Environmental Impact Assessment (EIA):** Large-scale biomass projects, particularly those with significant impacts on land use or the environment, may necessitate an Environmental Impact Assessment (EIA). The EIA process evaluates potential environmental consequences

and may lead to the imposition of restrictions or the implementation of mitigation measures to minimize adverse effects.

- **Biomass Types and Sources**: Legal restrictions may be in place regarding the types of biomass feedstocks that can be utilized in biomass projects. Regulations might specify the use of particular wood types, crop residues, or waste materials and establish quality standards and requirements for these feedstocks.
- **Air Quality and Emissions**: Biomass conversion processes, including combustion and gasification, can produce emissions that have implications for air quality. Emission limits and air quality standards are likely to be enforced to safeguard public health and the environment. Meeting these standards may necessitate the implementation of emission control technologies.
- **Water Use and Protection**: If a biomass project involves water use or discharges, regulations governing water quality and usage may apply. Compliance with water quality standards and the protection of water resources are typically required to minimize environmental impact and ensure responsible water resource management.
- **Health and Safety Regulations**: Biomass conversion processes come with potential health and safety risks. Regulations related to worker safety and public safety are likely to be in place, requiring adherence to specific safety standards and procedures to mitigate risks.
- **Waste Management**: The handling and disposal of waste materials generated by biomass conversion processes may be subject to waste management regulations. Proper waste management practices and compliance with waste disposal regulations are essential to minimize environmental impact and maintain responsible waste handling.
- **Noise and Land Use Planning**: Large biomass facilities can impact local communities in terms of noise and land use. Land use planning regulations and noise control measures may be enforced to mitigate these effects, ensuring that biomass projects are considerate of their surroundings.

In summary, Slovenia's regulatory framework reflects its commitment to sustainability, environmental protection, and safety in biomass projects. Legal restrictions and limitations span various aspects, encompassing feedstock sourcing, environmental impact assessment, biomass types, air quality and emissions, water use, health and safety, waste management, and considerations related to noise and land use. These regulations are instrumental in safeguarding the environment, public health, and safety while promoting responsible biomass utilization and ensuring compliance with EU directives and national policies.

Austria: Austria has established legal restrictions and limitations pertaining to the use of specific feedstocks and conversion processes in biomass projects. These regulations are designed to safeguard environmental quality and public health, with specific attention to the incineration of waste materials:

- **Abfallverbrennungsverordnung** (Waste Incineration Ordinance): Austria's "Abfallverbrennungsverordnung," or Waste Incineration Ordinance, contains guidelines and restrictions related to the content of metals in waste or residues to be treated in incineration facilities. These limitations are particularly relevant to incineration processes and aim to control and minimize the release of hazardous materials during waste incineration. This ordinance plays a crucial role in maintaining environmental and public health standards in waste management.
- **Exemption for Pyrolysis/Gasification Plants**: It's important to note that these limitations specified in the Waste Incineration Ordinance do not apply to pyrolysis or gasification plants. This distinction reflects Austria's recognition of the differences between incineration and alternative biomass conversion processes and tailors regulations accordingly.

In essence, Austria's legal restrictions and limitations focus primarily on controlling the content of metals in waste materials intended for incineration facilities to prevent the release of hazardous substances into the environment. However, it's crucial to recognize that these restrictions do not extend to pyrolysis or gasification plants, acknowledging the distinctions between these processes and their environmental implications.

2.1.4. *Legislative Dynamics:* Are there any ongoing or proposed legislative changes that could impact biomass conversion technology?

Italy: Italy is experiencing legislative developments that have the potential to influence biomass conversion technology:

- **Floating Material Recovery Legislation**: Italy has introduced legislation that allows for the recovery of floating materials from rivers and lakes by farmers. This legislation primarily aims to address flooding issues. The recovery of floating materials can be relevant to biomass conversion technology, as it provides additional biomass resources. The extent of this impact on biomass availability is still uncertain, and it may depend on the volume of materials that can be recovered.

- **Introduction of Carbon Credits**: Italy is considering the introduction of carbon credits in the foreseeable future. Carbon credits are a form of emissions trading that allows organizations to earn credits for reducing greenhouse gas emissions. These credits can be traded on carbon markets, providing economic incentives for carbon reduction. The introduction of carbon credits can positively impact biochar-related conversion technologies, as they are associated with carbon sequestration and the reduction of greenhouse gas emissions. Such policies may encourage the deployment and growth of biochar-related projects and technologies.

The opening towards the recovery of floating materials aligns with flood prevention efforts and can potentially provide additional feedstocks for biomass conversion. The introduction of carbon credits reflects Italy's focus on carbon reduction and offers new opportunities for technologies that sequester carbon and contribute to environmental sustainability.

In summary, Italy's legislative changes have the potential to influence biomass conversion technology by increasing biomass availability and encouraging the adoption of technologies that contribute to carbon reduction and environmental protection.

Slovenia: Slovenia is currently undergoing legislative changes and updates that have the potential to impact biomass conversion technology:

- **ZVO-3 (Environmental Protection Act Amendment):** The Environmental Protection Act Amendment, known as "ZVO-3," is currently in preparation. This legislative change is likely to introduce modifications and updates to the existing environmental protection regulations. It may affect various aspects of biomass conversion technology, particularly concerning environmental compliance and sustainability.
- **Update of the Law on Soil Improvers**: An update to the Law on Soil Improvers is also being proposed. This update is significant as it can influence the utilization of biomass in soil improvement practices, potentially introducing new guidelines or requirements for the use of biomass-based soil improvers. It reflects the importance of sustainable and responsible soil management in Slovenia.
- **NECP Revision (National Energy and Climate Plan):** The revision of the National Energy and Climate Plan (NECP) is another legislative change that could have implications for biomass conversion technology. As part of the NECP, Slovenia outlines its energy and climate strategies, including its approach to renewable energy sources like biomass. The revision may

introduce new targets or policies that affect the development and deployment of biomass conversion technology in line with national and EU energy and climate objectives.

These ongoing or proposed legislative changes signify Slovenia's commitment to adapting its legal framework to address evolving environmental and energy-related challenges. Biomass conversion technology is likely to be affected by these changes, necessitating compliance with new regulations and aligning with the country's sustainable development goals.

Austria: As of the moment, there are no specific ongoing or proposed legislative changes directly affecting biomass conversion technology. However, it is important to note that Austria is set to hold national elections in 2024. The outcome of these elections and the resulting political landscape may have significant implications for the future development and regulatory framework of biomass conversion technology in the country.

The political consequences of the 2024 national elections can influence the direction and priorities of Austria's energy and environmental policies. This may lead to new legislative initiatives, changes in incentives, or shifts in the regulatory environment that could impact biomass conversion technology and its role in Austria's sustainable energy and environmental objectives.

2.2. Socio-Cultural Factors

2.2.1. Public Perception: How is biomass conversion technology perceived by the general public in your region or country?

Italy: The perception of biomass conversion technology in Italy varies significantly depending on the level of technology and the specific geographic area:

- **Urbanized Areas**: In urbanized areas of Italy, where people may have limited contact with forests and agriculture, the public perception of medium to large biomass conversion plants is often negative. These facilities may face opposition from the local population. This resistance could be rooted in concerns related to environmental impact, emissions, or other factors. The disconnection from traditional rural activities and the potentially visible nature of these plants in urban environments can contribute to this skepticism.
- **Rural and Agricultural Areas**: In contrast, the perception of biomass conversion technology may be more positive in rural and agricultural regions. People in these areas may have a closer connection to forestry and agriculture, making them more receptive to technologies that utilize biomass as a resource. These communities may view biomass conversion as a way to promote sustainable practices and generate economic benefits.

Overall, the perception of biomass conversion technology in Italy is shaped by various factors, including the level of technology, geographical location, and the specific concerns and interests of the local population. In urbanized areas, there may be more skepticism and opposition, while rural and agricultural areas may be more accepting of biomass conversion as a means of sustainable resource utilization.

Slovenia: The public perception of biomass conversion technology in Slovenia is characterized by a degree of variability, and it can be influenced by multiple factors:

- **Community-Specific Acceptance**: The degree of local acceptance can vary significantly from one community to another. In certain communities, strong support for biomass projects is evident, indicating a positive perception. However, in other areas, opposition may arise due to various concerns, including issues related to noise, traffic, or land utilization. These localized concerns can shape public opinion about biomass conversion projects.
- **Influence of Biomass Feedstock**: The type of biomass feedstock employed in a project can impact public perception. The utilization of agricultural residues or waste materials tends to receive a more favorable response compared to the use of virgin wood sourced from forests. This preference reflects a general inclination towards resource sustainability and the responsible use of agricultural byproducts and waste materials.
- **Environmental Concerns**: Public perception often centers on concerns related to the environmental impact of biomass conversion. These concerns encompass various aspects, including potential air emissions, habitat disruption, and overall ecological consequences. Addressing these environmental concerns is crucial for gaining public acceptance and support for biomass projects.

In summary, the public perception of biomass conversion technology in Slovenia is not uniform and can vary based on the specific community, the type of feedstock used, and environmental concerns. Successful biomass projects in Slovenia may involve community engagement and clear communication regarding the environmental impact, emphasizing sustainability, and responsible resource utilization.

Austria: In Austria, biomass conversion technology is generally perceived very positively by the general public. Several key factors contribute to this favorable perception:

- **Environmental Awareness**: The Austrian public has a high level of awareness regarding environmental issues, including climate change and the importance of transitioning to renewable energy sources. This awareness aligns with the need for increased use of

renewable energy and local resources, making the public supportive of the use of local residues for renewable energy production.

- **Local Resource Utilization**: The public in Austria recognizes the value of utilizing local biomass residues for energy production. This emphasis on local resource utilization resonates with the principles of sustainability and environmental responsibility.
- **Concerns About Emissions**: While the general perception of biomass conversion is positive, one area of concern is the emissions of pollutants and their potential effects on air quality. This concern is often associated with small-scale biomass combustion in domestic heating systems. It's important to note that these concerns are not directly related to the scope of the Alps4GreenC project, which focuses on larger biomass conversion technologies like pyrolysis and gasification.

To maintain and enhance public acceptance, clear and transparent communication regarding environmental aspects is crucial. This includes emphasizing that emissions from biomass conversion are below legal thresholds and providing explanations about the residue supply chain. Effective communication can help address any misconceptions and ensure that the public has a complete understanding of the environmental benefits associated with biomass conversion.

In summary, Austria's positive public perception of biomass conversion technology is rooted in environmental awareness, support for local resource utilization, and the recognition of renewable energy's importance. Addressing concerns related to emissions through effective communication can further enhance public acceptance of biomass conversion technologies.

2.2.2. *Cultural Acceptance:* Are there any cultural or social factors that could affect the acceptance or adoption of biomass conversion technology?

Italy: The country presents a unique cultural and social environment, where the adoption of biomass conversion technology may depend on several factors. As indicated, a key element is the disconnection of the population from the rural economy. Residents in urbanized areas lack a realistic understanding of the residues generated in agriculture and forestry, contributing to an idealized perception of rural economy.

This aspect could have a dual impact on the acceptance of biomass conversion technology. On the one hand, raising awareness and educating the population about the actual conditions in the agricultural sector could contribute to greater support for the technology, as people would better understand the importance and need for efficient utilization of residues from agricultural and

forestry activities. On the other hand, the existing idealization of rural life might create some reservations or distrust towards technological innovations associated with agricultural practices.

Therefore, it is crucial to emphasize awareness and education in the process of introducing biomass conversion technology in Italy. This approach aims to overcome potential biases and ensure a broader understanding and support for this sustainable technology within the societal context.

Slovenia: In Slovenia, the acceptance and adoption of biomass conversion technology are deeply intertwined with the rural communities' strong ties to farming and forestry. Biomass projects utilizing agricultural leftovers and forest waste align seamlessly with established local practices and, notably, bring about economic opportunities for these regions.

A critical factor influencing the community's receptiveness to such projects is the level of awareness regarding environmental issues. In instances where there is a solid understanding of environmental concerns and their significance, biomass projects tend to garner more support.

The media and public discourse also exert substantial influence. Positive coverage of biomass technology, coupled with open discussions about its advantages and challenges, tends to generate increased public support. Disseminating information and ensuring a comprehensive understanding of the potential of biomass conversion are crucial components in fostering acceptance.

It is noteworthy that, at present, knowledge about biomass conversion in Slovenia is relatively limited. Farmers, deeply entrenched in traditional practices, may exhibit hesitancy towards embracing something novel or unfamiliar. However, this presents a notable opportunity for extensive education and awareness campaigns. By highlighting the advantages of biomass conversion, such initiatives can contribute to greater acceptance and encourage a shift towards more sustainable and economically viable practices in the long term.

Austria: In Austria, the landscape for biomass conversion is already well-established, primarily employing various technologies such as combustion and gasification. Notably, the country has witnessed a growing awareness of utilizing local residues and resources in recent years, reflecting a broader trend throughout the nation.

As of now, cultural and social factors seem to pose minimal barriers to the acceptance of new methods for utilizing residues, particularly through pyrolysis and gasification technologies. The existing prevalence of biomass conversion technologies, coupled with the increasing recognition of the importance of local resources, has created an environment where innovative approaches are likely to be well-received.

The Austrian experience suggests that the cultural and social context is conducive to embracing new advancements in biomass conversion. The established awareness and acceptance of these technologies, combined with a proactive approach towards utilizing local residues, lay a positive foundation for the integration of novel methods like pyrolysis and gasification. This scenario signifies a favorable environment for further development and implementation of biomass conversion projects in Austria.

2.3. Environmental Concerns

2.3.1. *Balancing Act:* Are there any specific social or environmental concerns associated with biomass conversion technology in your area?

Italy: In Italy, the implementation of biomass conversion technology is accompanied by notable environmental concerns, particularly related to particulate emissions, with a focus on the Po Valley region. This area has faced challenges, leading to Italy being subject to an infringement procedure with the European Commission due to the exceeding of emission limits for particulates.

The specific concern arises from the fact that biomass conversion technology contributes to particulate matter emissions. To address this issue, the affected regions in Italy have taken proactive measures by developing region-specific laws. These legislative initiatives aim to promote the adoption of more sustainable technologies in biomass conversion to mitigate the problem of particulate emissions.

The Italian experience highlights the importance of acknowledging and addressing environmental concerns associated with biomass conversion technology. The development of region-specific regulations underscores the commitment to finding sustainable solutions and ensuring compliance with European environmental standards. It also emphasizes the need for a nuanced and context-specific approach when implementing biomass conversion projects to strike a balance between technological advancement and environmental preservation.

Slovenia: In Slovenia, the adoption of biomass conversion technology is accompanied by significant concerns, particularly regarding the sustainable sourcing of biomass feedstocks. The emphasis is placed on ensuring that practices are environmentally responsible, as unsustainable methods could deplete resources, harm ecosystems, and compromise the long-term viability of biomass as a renewable energy source.

A crucial challenge identified in Slovenia is the low level of public awareness and understanding of biomass conversion technology, including its potential benefits and challenges. This lack of awareness

poses a potential obstacle to the widespread acceptance and support for biomass conversion projects. Without a comprehensive understanding of the technology and its implications, there is a risk that public sentiment may be hesitant or resistant.

Addressing this challenge requires targeted efforts to enhance public awareness and education regarding biomass conversion technology. Initiatives aimed at informing the public about the sustainable practices associated with biomass sourcing and the broader benefits and challenges of conversion technology can contribute to building a supportive environment. This, in turn, can facilitate the responsible and sustainable development of biomass conversion projects in Slovenia.

Austria: In Austria, the adoption of biomass conversion technology is generally free from significant social concerns. However, there are noteworthy environmental considerations that have been identified. These concerns revolve around emissions, as previously discussed, and are particularly relevant to the general public. Emission-related worries underscore the importance of addressing air quality and minimizing the environmental impact of biomass conversion processes.

Additionally, a key environmental concern in Austria centers on the sustainability of the residue supply chain. The preference and, in some cases, the requirement for utilizing local residues in biomass conversion projects is a critical aspect. The local emphasis stems from the recognition that the transportation of residues over long distances to reach conversion plants may raise environmental concerns. This is not only an issue of resource efficiency but also a factor that can be of concern to both the general public and policymakers.

Acknowledging and proactively addressing these environmental considerations are crucial for sustaining the positive trajectory of biomass conversion technology in Austria. By focusing on emissions control and promoting a sustainable residue supply chain, the country can continue to foster public and policymaker confidence in the environmental responsibility of biomass conversion projects.

2.4. Political Landscape

2.4.1. *Government's Stand:* What is the government's stance on renewable energy and biomass utilization?

Italy: In Italy, the government's stance on renewable energy and biomass utilization is predominantly positive and aligns with European perspectives. The overarching support for renewable energy sources, including biomass, reflects a commitment to sustainable and environmentally friendly energy practices.

However, it is noteworthy that there is a lingering concern related to air quality. This concern suggests a nuanced approach, emphasizing the importance of balancing renewable energy goals with the need to maintain high air quality standards. It indicates a recognition of potential environmental challenges associated with biomass utilization, particularly in the context of emissions.

Slovenia: The Slovenian government demonstrates a strong commitment to renewable energy and maximizing biomass resources. Clear policies are in place, accompanied by specific targets that underline the importance of sustainable biomass utilization. This commitment not only aligns with EU guidelines and climate objectives but also facilitates the reduction of greenhouse gas emissions, contributing to broader environmental goals. However, Slovenia currently lacks a comprehensive strategy for its bioeconomy. The absence of such a strategy is a notable gap in the overall approach. A comprehensive bioeconomy strategy could offer a more organized and effective framework for fully realizing the potential of biomass resources. Such a strategy would not only benefit the environment but also provide a structured path for leveraging biomass's economic potential, aligning with Slovenia's commitment to renewable energy and sustainability.

Austria: Over the past two decades, regardless of political orientation, all Austrian governments have consistently supported the increased use of renewable energy. This sustained commitment is evident in the current share of renewable energy in gross energy consumption, which stands at approximately 36.4%. Austria has set ambitious goals for the future, aiming to achieve carbon neutrality by 2040.

By 2030, Austria targets generating 100% of the country's electricity from renewable sources, including solar, wind, hydropower, and biomass. This comprehensive strategy aligns with the country's commitment to a climate-neutral transformation and sustainable development.

The use of renewable energy, including biomass, has shown a consistent upward trajectory over the past two decades. This trend reflects Austria's dedication to transitioning towards cleaner and more sustainable energy sources. The cited sources, including the Austrian Recovery Resilience Plan and data from the International Energy Agency (IEA), underscore the country's proactive approach and provide a comprehensive overview of Austria's progress in the realm of renewable energy.

2.4.2. *Initiatives and Incentives:* Are there any government initiatives or incentives to promote the development and deployment of biomass conversion technology?

Italy: Italy has implemented various government initiatives and incentives to promote the development and deployment of biomass conversion technology. Notably, financial support is

available, as outlined in specific programs. Additionally, the Rural Development Policy (RDP) plays a crucial role in supporting rural areas by allocating funds for logistics and facilities related to biomass conversion projects.

These initiatives signify a concerted effort by the Italian government to stimulate the growth of biomass conversion technology. Financial support mechanisms provide a direct incentive for businesses and organizations involved in biomass projects, while the Rural Development Policy contributes to the overall infrastructure and logistical support in rural areas, fostering a conducive environment for the deployment of biomass conversion technology.

Slovenia: Slovenia has implemented initiatives, such as:

Slovenian Environmental Public Fund (Eco Fund): established in 1993 with a primary focus on promoting development in environmental protection.

- Its main tools for achieving these goals include offering financial incentives such as soft loans and grants for various environmental investment projects.

The public call https://www.ekosklad.si/gospodarstvo/pridobite-spodbudo/seznam-spodbud/demonstracijski-projekti-nove-tehnologije/demonstracijski-projekti-nove-tehnologije-kredit for loans from Eko sklad for environmental investments or defined phases of investments related to the following measures:

- Reduction of greenhouse gas emissions.
- Reduction of air pollution (excluding the reduction of greenhouse gas emissions).
- Waste management.
- Protection of water and efficient water use.
- Wastewater treatment or supply of drinking water.
- Initial investments in environmental technologies.

Eligible Entities: Entities eligible for the loan include:

- Legal entities, sole proprietors, and other individuals performing registered activities, all registered in the business register in the Republic of Slovenia, excluding their branches abroad.
- Public law legal entities that own real property, excluding direct users of the state budget.

Furthermore, Slovenia's initiatives also involves collaboration between the Ministry of Higher Education, Science, and Innovation and the Public Agency for Research Activities. The financial resources for these initiatives are derived from the European Union's Recovery and Resilience Fund, managed by the Office of the Republic of Slovenia for Recovery and Resilience. The purpose of these initiatives is aligned with the National Recovery and Resilience Plan (NOO), focusing on "Smart, Sustainable, and Inclusive Growth." The specific aim is to support Research, Development, and Innovation (RDI) programs that contribute to the green transition and digitalization. However, the strategic goals are underlined by the requirement for supported programs to demonstrate scientific and technological excellence, market potential in global networks, commitment to investing their own resources, and the sustainability of RDI programs beyond the funding period. The overall objective is to encourage private investments in research and development, enhance socio-environmental responsibility, and boost the productivity and competitiveness of the economy globally. The success of these programs will be evaluated based on achieved results within TRL 3-6 activities and their potential for further commercialization and broader societal use.

Austria: Austria actively supports the development of biomass conversion technology, particularly in the realms of pyrolysis and gasification. Companies and research institutions can avail themselves of various funding opportunities available at different levels:

- **EU Funding**: Opportunities exist through programs such as Horizon Europe (HE), LIFE, INTERREG, and other EU initiatives.National Level Funding: In Austria, the Austrian Research Promotion Agency (FFG) administers national funding programs, including COMET, Innovationschek, Basis Programm, and others. Additionally, initiatives may be funded by the Austrian Science Fund (FWF) and individual ministries, such as the Ministry of Climate Protection, Environment, Energy, Mobility, Innovation, and Technology (BMK).
- **Regional Funding**: Various regions within Austria offer additional funding to support biomass conversion technology initiatives.

2.4.3. *Political Influences:* Are there any political factors or influences that could affect the growth or implementation of biomass conversion technology?

Italy: In Italy, political factors crucially hinge on citizen awareness of the circular economy. The government recognizes that informing the public is vital for garnering support. Policies are expected to align with a common position, emphasizing the importance of cohesive strategies for sustainable practices, including the implementation of biomass conversion technology.

Slovenia: In Slovenia, political factors influencing biomass conversion technology are intertwined with the broader green transition. The closure of coal mines aligns with a shift towards cleaner energy sources, including biomass. The high demand for electricity, coupled with the necessity to address environmental concerns, may drive policies favoring sustainable alternatives. However, the potential for higher electricity prices could pose challenges and influence the political landscape concerning the adoption and growth of biomass conversion technology.

Austria: At present, there are no significant political factors impeding the growth of biomass conversion technology in Austria. The country's political landscape, while anticipating national elections in 2024, maintains a strong and consistent support for renewables, including biomass. This backing is expected to persist until Austria achieves carbon neutrality. Current government campaigns advocating the replacement of fossil heating systems with climate-friendly technologies, especially the promotion of biomass-based heating systems like pellet boilers, highlight the proactive stance towards sustainable practices. The Ukrainian crisis has further catalyzed this shift, contributing to a notable increase in the sales figures for biomass-based heating systems.

As reflected in the sales data, the consumption of final energy from solid biofuels has steadily increased, reaching record levels in 2022. This surge, particularly in pellet boiler sales, exemplifies Austria's commitment to biomass utilization. Looking ahead, discussions on optimizing biomass use, considering both material and energy applications, may emerge as Austria continues its trajectory towards a renewable-based energy mix.

2.5. Economic Considerations

2.5.1. *Financial Incentives:* What are the current economic incentives or subsidies available for biomass conversion technology?

Italy: Italy provides various economic incentives and subsidies specifically targeted at biomass conversion technology, primarily focused on heat generation. The notable initiatives include:

- **Conto Termico**: This subsidy is primarily associated with enhancing energy efficiency and encompasses installations up to 2 MW. It specifically supports the replacement of old appliances with more efficient biomass-based technologies.
- **White Certificates** (Energy Efficiency Certificates): These certificates offer incentives for replacing fossil fuel appliances with renewable technologies, further encouraging the adoption of biomass conversion for heat generation. Renewable Energy Communities Subsidy: While not exclusively for biomass-based electric production, this subsidy supports renewable

energy communities. It provides integration opportunities for electric generation using biomass within the broader context of community-based renewable energy initiatives.

These subsidies reflect Italy's commitment to promoting biomass conversion technology, particularly in the context of heat generation, and contribute to the country's broader goals of achieving energy efficiency and transitioning to renewable energy sources.

Slovenia: In Slovenia, economic incentives for biomass conversion technology are accessible through various programs, as outlined by the Slovenian Environmental Public Fund (Eko Sklad). The specific initiative relevant to the adoption of environmental technologies, including biomass conversion, can be found in the list of incentives provided by Eko Sklad.

One notable program is the "Začetne naložbe v okoljske tehnologije" (Initial Investments in Environmental Technologies). This program is designed to support businesses and organizations in making initial investments in environmental technologies, potentially encompassing biomass conversion solutions.

For detailed information on the specific incentives, eligibility criteria, and application processes, individuals and entities interested in biomass conversion technology in Slovenia are encouraged to refer to the official list of incentives on the Eko Sklad website: Eko Sklad - Seznam Spodbud.

Austria: Austria offers various economic incentives to support investments in pyrolysis and gasification plants, particularly through the Klima- und Umweltschutzförderungen des Bundes (KPC) - Federal Climate and Environmental Protection Funding. The main opportunities for funding in this context are as follows:

1. **Funding for Companies:**
    - Biomass Cogeneration and Wood Gasification: funding opportunities for companies engaged in biomass cogeneration and wood gasification, emphasizing the generation of heat from renewable resources.
    - Energetic Utilization of Biogenic Raw and Residual Materials: funding for companies involved in the energetic utilization of biogenic raw and residual materials, particularly focusing on the generation of heat from renewable sources.
    - Resource Management: Companies engaged in resource management, especially those related to renewable resources, can find funding opportunities through this link.
2. **Funding for Municipalities and Regions:**

- Funding Opportunities for Municipalities and Regions: various funding opportunities available to support sustainable and environmentally friendly initiatives in their respective areas.

3. **Feed-in Premiums for Electricity from Pyrolysis/Gasification Plants:**
    - Feed-in Premiums for Electricity: feed-in premiums for electricity generated by pyrolysis and gasification plants, especially for those selling electricity to the grid.
4. **CO2 Certificates:**
    - Austrian Economic Chambers - CO2 Certificates: CO2 certificates as a funding mechanism for projects related to carbon emissions reduction and environmental sustainability.

2.5.2. *Funding Opportunities:* Are there any existing financial support programs or funding opportunities for biomass conversion projects?

Italy: In Italy, financial support programs for biomass conversion projects are primarily associated with the Rural Development Policy (RDP). The RDP plays a crucial role in providing funding opportunities and support for initiatives related to rural development, including projects involving biomass conversion.

Slovenia: In Slovenia, there are several financial support programs and funding opportunities available for biomass conversion projects. These initiatives play a key role in promoting sustainable development, especially in the context of a just transition towards cleaner energy sources. The notable programs include:

1. **Just Transition Fund:**
    - The Just Transition Fund is designed to support regions that are particularly affected by the transition towards a green economy. It provides financial assistance for projects aiming to mitigate the social and economic impact of this transition, making it a relevant source for biomass conversion projects.
2. **Cohesion Funds:**
    - Cohesion funds, a part of the European Structural and Investment Funds, contribute to reducing economic and social disparities among EU regions. These funds can be utilized for various projects, including those focusing on renewable energy and biomass conversion.
3. **Plan for Resilience and Recovery:**

- The Plan for Resilience and Recovery encompasses financial support mechanisms to enhance economic recovery and resilience. Biomass conversion projects aligning with sustainability and green energy objectives may find support through this initiative.

4. **Green Credits:**
    - Green credits, or green financing mechanisms, provide financial support specifically for environmentally sustainable projects. Biomass conversion projects meeting green criteria may be eligible for green credits to facilitate their implementation.
5. **Impact Investors:**
    - Impact investors are private or institutional investors who prioritize projects with positive environmental and social impacts. Biomass conversion projects aligning with sustainability goals may attract investment from impact investors, contributing to their financial viability.

Austria: Building on the previous response, Austria provides financial support for biomass conversion projects through the Klima- und Umweltschutzförderungen des Bundes (KPC) - Federal Climate and Environmental Protection Funding. This funding is specifically earmarked for the construction of pyrolysis and gasification plants, emphasizing the government's commitment to advancing technologies that contribute to climate and environmental protection.

For detailed information on accessing these funds and eligibility criteria, interested parties are encouraged to refer to the official website of KPC: KPC Funds for Plant Construction.

2.5.3. *Cost Competitiveness:* What is the cost competitiveness of biomass conversion technology compared to other energy generation methods in your region?

Italy: In Italy, the cost competitiveness of biomass conversion technology varies depending on the application. For electrical production, it is noted to be less competitive unless associated with heat valorization. On the other hand, when it comes to heat generation using wood chips, it emerges as a cost-effective option.

1. **Electrical Production:**
    - Biomass conversion for electrical production is mentioned to be less competitive, implying that it may require additional support or integration with heat valorization to enhance its economic viability.
2. **Heat Generation with Wood Chips:**

- Heat generation using wood chips is highlighted as the most cost-effective technology. The cost is reported to range from 35 to 50 €/MWh, making it a compelling option. This cost is notably lower, accounting for approximately 50% of the cost of natural gas (ranging from 75 to 120 €/MWh) and, depending on the area, about one-third of the price of diesel or propane.

These insights underline the significance of considering the specific application and the economic context when evaluating the cost competitiveness of biomass conversion technology in Italy. The focus on heat generation with wood chips, given its favorable cost dynamics, suggests a promising avenue for biomass utilization in the region, especially in comparison to traditional fossil fuel alternatives.

Slovenia: In Slovenia, the competitiveness of biomass conversion technology is subject to several influential factors. Key determinants include:

1. **Availability and Cost of Biomass Feedstocks:**
    - The cost competitiveness is significantly influenced by the accessibility and affordability of biomass feedstocks. The availability of biomass resources, such as agricultural residues or forest waste, plays a crucial role in determining the overall cost-effectiveness of biomass conversion technology.
2. **Efficiency of Conversion Technologies:**
    - The efficiency of the conversion technologies employed is a critical factor. High-efficiency processes contribute to lowering production costs and enhancing the competitiveness of biomass conversion technology against alternative energy generation methods.
3. **Economic Context and Government Support:**
    - The broader economic context and any governmental support, subsidies, or incentives for biomass conversion projects can impact their competitiveness. Supportive policies can help level the playing field and enhance the economic viability of biomass technologies.

Considering these factors, Slovenia's approach to biomass conversion technology competitiveness is likely to involve optimizing the efficiency of conversion processes and addressing feedstock

availability and costs. The economic and policy landscape will play a crucial role in shaping the overall competitiveness of biomass conversion technology within the country.

Austria: In Austria, the cost competitiveness of biomass conversion technology, particularly pyrolysis and gasification, involves various factors, and specific data on tariffs for energy generation from these methods is not readily available. However, there are insights into the broader energy landscape in Austria that can provide context:

1. **Electricity Generation:**
    - **Role of Biomass in Electricity Generation:** Biomass plays a minor role in electricity generation compared to hydropower and photovoltaics, which are the main sources of renewable electricity in Austria.
    - **Electricity Prices:** The current electricity prices for domestic customers are around 24.84 Cent/kWh (as of June 2024), according to Verbund, a major energy provider. This price is for renewable-based electricity. However, the overall electricity cost in Austria is estimated to be in the range of 24-35 Cent/kWh.

2. **Heating Generation:**
    - **Biomass in Heating Generation:** Biomass contributes significantly to heating generation in Austria, encompassing domestic-scale applications like boilers and stoves, as well as larger-scale plants using combustion, combined heat and power (CHP), and biogas.
    - **Comparison with Other Fuels:** Pellet prices, a form of biomass, are currently at 0.43 Cent/kg, resulting in approximately 0.09 Cent/kWh, making them competitive with other heating sources. This has led to a sales boom in pellet boilers.
    - **Impact of Ukraine Crisis:** The crisis in Ukraine has led to increased prices for all energy carriers, including both fossil fuels and biomass fuels. This has created a dynamic and unpredictable pricing environment.

3. **Overall Considerations:**
    - **Market Dynamics:** The pricing dynamics for energy sources, including biomass, are experiencing significant changes due to geopolitical events and market fluctuations.

- **Uncertainty:** The uncertainty in predicting future developments is acknowledged, given the current volatile market conditions.

These factors collectively highlight the complexity of the energy market in Austria and the challenges in assessing the precise cost competitiveness of biomass conversion technology. The influence of geopolitical events and the interplay between different energy sources contribute to the intricate landscape of energy pricing in the region.

2.6. Geographic and Logistical Factors

2.6.1. *Environmental Impact:* Are there any geographical or climatic factors that could impact the efficiency or viability of biomass conversion technology?

Italy: In Italy, the efficiency and viability of biomass conversion technology are influenced by various geographical and climatic factors. Specifically:

1. **Technological Efficiency:**
    - **Limited Impact***:* Geographical and climatic factors have a minimal direct impact on the technological efficiency of biomass conversion. The efficiency of the conversion process itself is primarily determined by the technology and equipment used.
2. **Supply Chain Efficiency (Life Cycle Assessment - LCA):**
    - **Geographical Impact***:* Geographical factors, however, play a significant role in the overall efficiency of the biomass supply chain, especially concerning Life Cycle Assessment (LCA).
    - **Transport Emissions***:* The efficiency of the supply chain is influenced by transport emissions. The geographical distribution of biomass resources and the distance they need to travel to reach the conversion plant can affect the environmental footprint of the entire process.
    - *Local Sourcing Advantages:* Locally sourced biomass may have lower transport emissions and contribute to a more sustainable supply chain.
3. **Climatic Considerations:**

- **Biomass Availability***:* Climatic conditions impact the availability of biomass resources. Different regions may have varying levels of biomass productivity based on factors such as temperature, precipitation, and soil quality.
- **Seasonal Variability***:* Seasonal changes can influence the availability of certain types of biomass, impacting the planning and operation of biomass conversion facilities.

Overall Implications:

- **Balancing Local Sourcing:** While technological efficiency is less affected, optimizing the supply chain for biomass conversion involves balancing the benefits of local sourcing against potential variations in biomass availability.
- **Environmental Sustainability:** Considering transport emissions in the LCA is crucial for ensuring the overall environmental sustainability of biomass conversion projects.

Slovenia: In Slovenia, the efficiency and viability of biomass conversion technology are intricately connected to the country's distinct geographical and climatic characteristics. Key considerations include:

1. **Distinct Seasons:**
   - *Biomass Availability:* Slovenia experiences marked seasons, impacting the availability of specific biomass feedstocks. The cyclic nature of seasons can influence the types and quantities of biomass resources accessible for conversion.
   - *Energy Demand Patterns:* Seasonal changes also influence energy demand patterns, particularly for heating. The demand for biomass-based heating solutions may vary based on climatic conditions, with increased usage during colder seasons.
2. **Diverse Landscape:**
   - *Variability in Biomass Resources:* Slovenia's diverse landscape, encompassing mountains, plateaus, and lowlands, contributes to varying biomass resource availability. Different regions may offer different types of biomass, influencing the choice of feedstocks for conversion projects.

- *Accessibility Challenges:* The geographical diversity may pose challenges related to the accessibility of biomass resources. Transportation and logistics considerations become important factors in determining the feasibility and cost-effectiveness of biomass projects.

3. **Regional Differences:**

    - *Feasibility and Cost-Effectiveness:* Regional disparities in biomass resource availability and accessibility can significantly impact the feasibility and cost-effectiveness of biomass conversion projects. Understanding and navigating these regional differences are essential for successful project planning and implementation.

Overall Implications:

- **Adaptation to Seasonal Variations:** Biomass conversion projects in Slovenia need to adapt to seasonal variations in biomass availability and energy demand, especially for heating applications.
- **Logistics Planning:** Given the diverse landscape, careful logistics planning is crucial to address accessibility challenges and optimize the transportation of biomass feedstocks to conversion facilities.
- **Tailored Regional Approaches:** Considering the regional differences in biomass availability and accessibility, a tailored approach for each area may be necessary to maximize the efficiency and economic viability of biomass conversion projects.

In summary, Slovenia's geographical and climatic factors contribute to the dynamic nature of biomass resources and energy demand. Successful implementation of biomass conversion technology requires a nuanced understanding of these factors and strategic planning to adapt to the seasonal and regional variations in resource availability.

Austria: In Austria, the efficiency and viability of biomass conversion technology are influenced by various geographical, climatic, and other factors. Key considerations include:

1. **Geographical Factors:**

- *High Residue Availability:* Austria maintains a high availability of residues from forestry and agriculture. Residues from sectors like food production and pulp & paper are widespread, providing a consistent and reliable source for biomass conversion.
- *Industry Residues:* The presence of industries generating residues, such as food production and pulp & paper, contributes to the stability and availability of biomass feedstocks.

2. **Climatic Factors:**

- *Climate Change Impact:* In the medium to long term, climate change may influence the availability of biomass feedstocks. Changes in climate could lead to variations in the types of crops grown in agriculture and impact the distribution of species in forests.
- *Wood Fuel Changes:* The report highlights that climate change, affecting water availability, may lead to changes in the range of wood fuels. For example, certain tree species like Spruces may only reach cutting maturity at higher altitudes in the future.
- *Short-Term Challenges:* Short-term challenges include occurrences of large amounts of damaged wood, often caused by factors like bark beetles, windthrow, fungal infections, snow, and ice breakage. These events contribute to fluctuations in biomass availability.

3. **Other Factors:**

- *Supply Chain Disruptions:* External events such as the pandemic and the war in Ukraine have revealed vulnerabilities in the biomass industry's supply chains. Disruptions can lead to rising costs and potential production failures, underscoring the importance of supply chain resilience.
- *Price Fluctuations:* The current prices of wood and pellets are reported to be very high, reflecting the impact of supply chain disruptions and other external factors.

Overall Implications:

- **Flexibility in Supply Materials:** Changes in the availability of wood assortments due to climate change necessitate flexibility in supply materials. This adaptability is crucial to ensuring a broad and reliable raw material base for biomass conversion.
- **Risk Mitigation:** The biomass industry must actively manage and mitigate risks associated with supply chain disruptions to maintain stable production and manage costs.
- **Sustainable Planning:** As climate change impacts become more pronounced, sustainable planning and strategies for biomass conversion technology will be essential for long-term viability.

In summary, Austria's geographical and climatic factors, coupled with external disruptions, contribute to the dynamic nature of biomass feedstock availability. Strategic planning, adaptability, and risk management are key considerations for the sustainable development of biomass conversion technology in the country.

2.6.2. *Logistical Challenges:* Are there any logistical challenges or considerations related to the transportation of biomass feedstocks or by-products?

Italy: In Italy, the transportation of biomass feedstocks or by-products faces significant logistical challenges, primarily related to the forest road system. Key considerations include:

1. **Outdated Forest Road System:**
    - *Limited Infrastructure:* Italy's forests predominantly feature an outdated road system, and in some cases, there may be a lack of proper infrastructure altogether.
    - *High Transport Costs:* The outdated road system contributes to high transport costs, impacting the overall economics of biomass transportation. Inefficient road infrastructure can lead to longer transportation times and increased expenses.
2. **Economic Viability of Transport:**
    - *Cost-Profit Imbalance:* The challenge lies in the fact that the cost of transporting biomass residues may surpass their economic value. This creates a situation where the transportation of residues becomes economically challenging or unsustainable.

- *Economic Considerations:* The economic viability of biomass projects is intricately linked to the ability to manage and mitigate high transportation costs, ensuring that the overall value chain remains financially sustainable.

Overall Implications:

- **Transportation Efficiency:** Improving the efficiency of the forest road system is critical to addressing logistical challenges. Investments in modernizing or expanding road infrastructure can enhance transportation efficiency and reduce costs.
- **Economic Assessment:** Biomass projects need to conduct a thorough economic assessment, taking into account the specific logistical challenges related to transportation. This includes evaluating the balance between transport costs and the economic value of the biomass.
- **Collaborative Solutions:** Collaboration between stakeholders, including government bodies, forestry management, and biomass industry players, is essential to develop solutions that address the logistical challenges. This may involve joint efforts to improve infrastructure or explore alternative transportation methods.

In summary, the outdated forest road system in Italy poses a significant logistical challenge for the transportation of biomass feedstocks or by-products. Addressing these challenges requires a strategic and collaborative approach to enhance transportation efficiency and ensure the economic viability of biomass projects in the region.

Slovenia: In Slovenia, the transportation of biomass feedstocks or by-products involves several logistical challenges, reflecting the diverse geographical and climatic conditions. Key considerations include:

1. **Geographical Distribution of Biomass Resources:**
    - **Spatial Variation**: Biomass resources are spread unevenly across Slovenia, leading to varying distances between resource locations and processing facilities.
    - **Transport Complexity**: The disparate distribution of biomass resources introduces complexity in transportation logistics. Some resources may be located a considerable distance away from processing sites.
2. **Road Conditions and Terrain:**

- **Challenging Roads**: The condition of roads, particularly in hilly and mountainous areas, can pose challenges for transporting biomass efficiently. Steep and winding roads may require special equipment for handling.
- **Winter Challenges**: During winter, heavy snowfall adds an additional layer of complexity. Snow and ice on the roads can slow down transportation, leading to potential delays.

3. **Weather Impact:**
    - **Seasonal Challenges**: Weather conditions, especially during winter, can significantly impact transportation efficiency. Heavy snowfall and icy roads can create obstacles and affect the overall logistics timeline.
4. **Storage Requirements:**
    - **Pre-Conversion Storage**: Biomass often needs to be stored before conversion into energy. Ensuring good storage facilities at both the biomass source locations and processing sites is crucial to prevent spoilage or quality degradation during transportation.

Overall Implications:

- **Specialized Equipment:** Specialized equipment may be necessary to navigate challenging terrains, particularly in mountainous regions with steep and winding roads.
- **Weather Preparedness:** Developing strategies for weather-related challenges, such as heavy snowfall, is essential. This may involve seasonal planning and contingency measures to minimize transportation disruptions.
- **Strategic Storage Planning:** Robust storage facilities play a vital role in maintaining biomass quality during transportation delays. Strategic planning for pre-conversion storage is necessary to mitigate the risk of spoilage.
- **Collaboration and Coordination:** Collaboration between stakeholders, including biomass producers, transporters, and processing facilities, is crucial for effective coordination and addressing the diverse logistical challenges across Slovenia.

In summary, Slovenia's geographical and climatic diversity introduces unique challenges in the transportation of biomass. Overcoming these challenges requires a comprehensive approach that considers road conditions, weather variations, and strategic storage solutions to ensure the efficient and reliable supply of biomass feedstocks for conversion.

Austria: In Austria, the transportation of biomass feedstocks or products encounters relatively few logistical challenges. Key considerations include:

1. **Feedstock Storability:**
    - **Storage Requirements***:* The storability of feedstocks is a general consideration. Depending on seasonal availability, ample storage areas must be allocated to accommodate varying quantities of feedstocks.
    - **Seasonal Planning***:* Feedstock storage planning is influenced by seasonal variations, requiring adjustments to storage capacities based on the availability of biomass resources.
2. **Transport Economics:**
    - **Economic Efficiency***:* To maintain economic viability, transport costs and distances of feedstocks must be kept relatively short. Ensuring cost-effective transportation is crucial for the overall economic feasibility of biomass projects.
3. **Transport Modes:**
    - **Road Transport***:* Truck transportation is a viable option, leveraging the well-maintained road infrastructure in Austria. The extensive network of highways covers the entire country, ensuring efficient connectivity.
    - **Rail Transport***:* Austria's railway network is also well-developed, offering an alternative for transporting biomass residues and products. Key routes, especially from Vienna to Linz-Wels and further to Germany, are well-established.
    - **Upcoming Infrastructure Improvements***:* Future developments, such as the construction of new tunnels like the Brenner Base Tunnel and Semmering Tunnel south of Vienna, aim to enhance transportation efficiency. These projects are expected to facilitate both passenger and goods transport within Austria and to other countries.

- **Alternative Transport Modes**: While not explicitly mentioned as prominent for biomass transport, Austria's accessibility by air and its connection to the Danube via shipping offer additional possibilities.

Overall Implications:

- **Integrated Transport Network:** Austria benefits from an integrated and well-connected transport network, allowing for efficient movement of biomass by road and rail.
- **Infrastructure Investments:** Anticipated improvements in infrastructure, such as new tunnels, signal a commitment to reinforcing Austria's transportation capabilities, contributing to smoother logistics for biomass projects.
- **Diverse Transport Options:** The availability of multiple transport modes, including road, rail, air, and potentially water, provides flexibility for biomass transport, allowing for adaptability based on project requirements.

In summary, Austria's logistical considerations for biomass transport highlight a well-established infrastructure and ongoing efforts to enhance connectivity. Efficient transportation planning and integration of various modes contribute to the overall success of biomass projects in the country.

3. Gap analysis to compare current performance with desired and provide recommendations for the relevant stakeholders (policy, investors)

In the second part of the report, 'Analyzing the Operating Context for Biomass Conversion Opportunities in Italy, Austria, and Slovenia,' the focus was on conducting a thorough gap analysis within the context of biomass utilization in the regions of Austria, Italy, and Slovenia. The primary objective was to assess the current state of biochar production. By undertaking this analysis, our aim was to provide informed recommendations tailored for key stakeholders, particularly policymakers and investors. Our approach involved not only identifying gaps but also proposing strategies to bridge them effectively. To enhance the credibility and applicability of our policy recommendations, we drew upon best practices not only from the local Alpine region but also from a broader European perspective, with a keen emphasis on EU-wide success stories in the field of biochar utilization. In this phase, we also conducted a detailed gap analysis on biochar production in Austria, Italy, and Slovenia. Utilizing a tailored questionnaire, we gathered key insights to assess the current state of

performance. Our report presents these findings, alongside informed recommendations for policymakers and investors. This inclusive approach ensures our insights are grounded in both theoretical considerations and practical industry perspectives.

3.1. Assessment of Legal Framework for Biochar Usage

3.1.1. Are the existing laws or regulations in your country clear and supportive of biochar development and usage?

Italy: In Italy, there are not supportive regulations for biochar development and utilization. Currrently, there are mainly loopholes, and there is not a clear pathway for the valorization of products such as biochar.

The existing laws and regulations appear to lack clarity and support, leaving room for ambiguities and impeding the effective valorization of biochar products. This insight underscores a potential barrier to the growth of the biochar sector in Italy, signaling the need for targeted policy improvements and a more defined regulatory pathway. In the subsequent sections of this report, we will further explore such challenges and propose strategic recommendations to address them, fostering a more conducive environment for biochar development and utilization.

Slovenia: As of now, Slovenia is yet to officially recognize biochar as a soil improvement agent within its agricultural practices. In contrast to the European Union's proactive approach, exemplified by the implementation of Regulation (EU) 2019/2164 in December 2019, which categorized biochar as a pyrolytic product derived from various organic plant materials. This categorization aligned biochar with Regulation (EC) No 834/2007, placing it in Annex I of the current EU Regulation (EC) No 889/2008 under the category of fertilizers, soil improvers, and nutrients as an approved fertilizer. This regulatory move eliminated one of the significant barriers to biochar market entry – the restrictions imposed by the prescribed biomass composition.

However, in Slovenian agricultural practices, the production of biochar is yet to commence officially, awaiting recognition as a soil improvement substance. The initiation of this process involves calculating the greenhouse gas emissions balance of biochar, a prerequisite for acknowledging it as a method for reducing carbon footprints. Simultaneously, defining threshold values and appropriate biochar properties falls under the purview of the Slovenian Forestry and Agricultural Institute. Slovenian farmers presently procure biochar from neighboring countries where legislation has already been established. Additionally, Slovenia currently lacks widespread pyrolysis furnaces, except for a few prototypes. The official recognition and integration of biochar into Slovenian agricultural

practices will depend on concerted efforts by experts, the Ministry of Agriculture, Forestry, and Food, and the involved institutes to establish regulatory frameworks, standards, and practices.

Austria: Austria's doesn't have any specific legal constraints inhibiting the utilization of biochar for industrial or agricultural purposes within the country. Notably, Austria possesses legislation enabling and regulating biochar usage, exemplified by the Weinverordnung from 1999 (Document identifier NOR12143922). This regulation permits and oversees the application of biochar in wine refining processes, where it functions as an adsorbent for unwanted odor or taste molecules.

However, the broader application of biochar appears to be subject to regulations at the European Union level, implying a reliance on EU-wide directives rather than exclusive Austrian statutes. While Austria demonstrates a proactive stance in regulating specific biochar applications, such as within the winemaking industry, the overarching utilization of biochar aligns with EU-level regulations rather than distinct national laws. This indicates a need for alignment with EU directives concerning the general application of biochar outside specific industries, urging compliance and synchronization with broader EU standards and guidelines.

3.2. Regulatory Permits and Legislative Gaps for Biochar Production and Use

3.2.1. Are specific permits/licenses/certificates required for the production and use of biochar in your country?

Italy: Italy provides a nuanced perspective on the regulatory requirements for biochar production and use. The necessity for specific permits, licenses, or certificates hinges on the intended application and the raw materials employed in the biochar production process. Notably, for biochar use as a fertilizer, certification in line with Regulation (EU) 1009/2019 and approval in accordance with national D.lgs 75/2010 are imperative.

Moreover, Italy highlights the contextual nature of regulation by emphasizing that if biochar results as a byproduct of electricity or heat generation, adherence to laws governing byproducts is essential to secure exemption from waste regulations. This insight underscores the importance of understanding the dual influence of the final application and the production process on the requisite permits and certifications.

Slovenia: Slovenia has a current regulatory void regarding biochar production and use. Unlike some European counterparts with established frameworks, Slovenia, at this juncture, lacks specific mandates, permits, licenses, or certificates governing biochar-related activities. This absence of regulatory requirements may pose both challenges and opportunities.

On the one hand, it highlights a potential area for development, as establishing a regulatory framework could provide clarity, set quality standards, and ensure environmentally responsible practices. On the other hand, it underscores the need for proactive efforts by stakeholders, including governmental bodies and industry experts, to collaboratively shape a regulatory landscape that supports the sustainable integration of biochar practices in Slovenia. As the biochar sector evolves globally, Slovenia has the chance to craft regulations that align with its unique context and contribute to the responsible growth of the industry within its borders.

Austria: Austria outlines a comprehensive regulatory framework for biochar production and usage. The European Biochar Certificate (EBC) stands as a pivotal quality standard, encompassing biomass, production technology, biochar properties, and application. Nationally, ÖNORM S2211 specifies parameters for biochar production from plant-based raw materials, emphasizing suitability for agricultural use and delineating residue sources.

The Federal Ministry's 2018 decree defines specific applications, restricting biochar usage to farm fertilizers, compost, soil additives, and plant aids. Additional regulations, such as the Weinverordnung, address specialized applications like biochar use in wine refining. Notably, Austria emphasizes compliance with food regulations for biochar as a feed additive, including specific limits, such as Polycyclic Aromatic Hydrocarbons (PAH), restricting certain biochar types in soil amendment technology. This comprehensive regulatory overview reflects Austria's commitment to ensuring the quality, safety, and application precision of biochar within its borders.

3.2.2. Are there any existing legislative gaps that affect the production or use of biochar in your country?

Italy: There are two major gaps identified:

Alignment of D.lgs. 75/2010 with Regulation (EU) 1009/2019: The identified legislative gap underscores the need for synchronization between the Italian national legislation, D.lgs. 75/2010, and the EU-wide Regulation (EU) 1009/2019. While D.lgs. 75/2010 likely addresses various aspects of biochar production and use, its coherence with the EU regulation is essential for a harmonized, consistent, and legally sound framework. The misalignment could lead to regulatory ambiguities, hindering the effective implementation of biochar practices. Addressing this gap would not only enhance regulatory clarity, but also contribute to Italy's compliance with broader European standards.

Application of D.Lgs. 152/06 to Small-Scale, Agricultural Self-Production: The second legislative gap highlights a potential complexity in the regulatory landscape for small-scale, agricultural self-production of biochar. Although covered by the comprehensive environmental protection law, D.Lgs. 152/06, there is an additional requirement for adherence to Regulation (EU) 1009/2019. This dual compliance could pose challenges for smaller producers, introducing administrative burdens and potential barriers to entry. Resolving this gap is crucial for ensuring that environmental protection laws are effectively integrated into the biochar regulatory context, with due consideration for the unique challenges faced by smaller-scale producers.

Slovenia: The regulatory landscape surrounding the production and utilization of biochar in Slovenia faces significant challenges, with a notable void in dedicated legislation. This gap not only raises concerns about the potential lack of guidance and oversight but also underscores a broader issue of limited awareness and understanding of the biochar domain. The nascent nature of biochar technology necessitates a comprehensive understanding to establish effective regulatory frameworks. The current lack of dedicated regulations may impede the promotion of environmentally sustainable and responsible biochar practices. Addressing this dual challenge of regulatory gaps and a need for enhanced awareness requires collaborative efforts among governmental bodies, industry experts, and academia. Initiatives to bridge the knowledge gap and formulate comprehensive guidelines will be instrumental in fostering a regulatory environment that supports the growth of the biochar sector while ensuring its sustainable and responsible integration into Slovenian practices.

Austria: The input residues (mainly originating from food, wood, or paper production) for biochar are regulated in ÖNORM S2211. The use of non-listed residues is therefore not regulated. The use of biochar in agriculture as an additive to fertilizer and compost, as a soil additive, and as a plant aid is regulated. Other areas of application are not (yet) regulated.

Regulation of Input Residues in ÖNORM S2211: Austria demonstrates a proactive stance in regulating input residues for biochar production. ÖNORM S2211 specifies the residues allowed for biochar production, predominantly sourced from food, wood, or paper production. However, the absence of regulations for non-listed residues implies a potential gap in oversight. Addressing this gap may involve periodic updates to include emerging residue sources, ensuring the continued relevance of the regulatory framework.

3.3. Public Awareness of Biochar Technologies

3.3.1. Is there public awareness of biochar technologies in your country? If not, please explain what measures can be taken to raise awareness.

Italy: Italy identifies a significant lack of public awareness regarding biochar technologies, attributing it primarily to regulatory and market-related challenges. The historical lack of robust regulations at both the national and European levels has contributed to this issue. Until 2021, biochar was not well-regulated at the European level, creating loopholes and fostering a predominant practice of biochar production as a by-product of electric energy generation.

The limited number of dedicated biochar production plants in Europe, including one in Italy and one in Austria, emphasizes the niche nature of the industry. The crucial need for market expansion and supportive policies from policymakers is highlighted as essential to enhancing public awareness and fostering the growth of biochar technologies in Italy. The identified regulatory gaps and the historical reliance on biochar as an electricity generation by-product underscore the urgency for comprehensive regulatory frameworks and strategic awareness campaigns to promote the benefits and applications of biochar in Italy.

Slovenia: Slovenia indicates a lack of public awareness regarding biochar technologies, attributing it to unclear economic benefits. The response suggests that farmers in Slovenia are hesitant to implement biochar technologies due to perceived uncertainties in the economic advantages associated with its adoption. This highlights a key barrier to the widespread acceptance and utilization of biochar in the agricultural sector.

To address this challenge, targeted awareness campaigns and educational initiatives can be instrumental. Providing farmers with clear and evidence-based information on the economic benefits of biochar, including potential improvements in soil fertility, crop yields, and long-term sustainability, could be an effective strategy. Collaborative efforts between governmental bodies, agricultural organizations, and research institutions can play a pivotal role in disseminating information, conducting field trials, and showcasing successful case studies to build confidence and encourage the adoption of biochar technologies among farmers in Slovenia.

Austria: Biochar is recognized in Austria, but primarily in the context of traditional charcoal production, leading to a perception of it as a dated and insignificant technology. There is a prevailing misunderstanding, with many individuals equating biochar with fossil fuels, particularly hard coal. The lack of awareness extends to newer biochar technologies and the diverse feedstocks available

for biochar production. In the agricultural sector, while biochar is known, direct benefits are challenging to measure, resulting in some reservations among practitioners.

Raising public awareness for biochar technologies involves addressing these misconceptions and providing clear information about the technology's contemporary applications and environmental benefits. The agricultural sector, a key stakeholder, presents a challenge due to difficulties in directly quantifying the benefits of biochar.

Proposed Measures to Raise Awareness:

- Educational Campaigns: Develop educational materials to explain biochar, its production, and potential environmental benefits. Collaborate with educational institutions for curriculum integration.
- Workshops and Seminars: Conduct hands-on workshops and seminars for practical demonstrations of biochar production and application.
- Public Events: Organize or participate in public events to showcase biochar technologies through interactive displays and demonstrations.
- Media Engagement: Work with media outlets for features, articles, and interviews about biochar technologies, leveraging both traditional and online platforms.
- Online Presence: Establish a strong online presence with a dedicated website and active engagement on social media, sharing updates and success stories.
- Partnerships and Collaborations: Collaborate with environmental organizations, NGOs, and community groups to amplify outreach efforts and enhance credibility.
- Government Involvement: Engage with government agencies and policymakers to include biochar technologies in relevant policy discussions and advocate for supportive policies.
- Demonstration Projects: Implement biochar demonstration projects in communities to provide tangible examples of the technology's benefits.
- Public Speaking Engagements: Arrange for experts to speak at conferences, community meetings, and public forums to communicate the importance and potential of biochar.
- Networking and Advocacy: Connect with individuals and organizations passionate about sustainable technologies, engaging in advocacy efforts and lobbying for increased support.
- Incentives and Subsidies: Advocate for government incentives or subsidies to encourage the adoption of biochar technologies.

- Public Involvement in Scientific Process: Involve the public in the scientific process through citizen science projects, exhibitions, and knowledge dissemination through social media and public journals.

Implementing these measures collectively will contribute to raising public awareness, dispelling misconceptions, and fostering a better understanding of biochar technologies in Austria. The proposed strategies aim to bridge the existing knowledge gap, encouraging the adoption of biochar for sustainable and environmentally friendly practices across various sectors.

3.4. Financial Incentives and Measures for Increased Uptake of Biochar Development

3.4.1. Do existing financial incentives or subsidies sufficiently support biochar development in your country?

Italy: Italy highlights a critical gap in the existing financial incentives and subsidies for biochar development. The absence of specific support dedicated to biochar is notable, with most existing plants having received support primarily as electrical energy producers. This implies that the current financial mechanisms are not tailored to address the unique challenges and potential of the biochar sector. Italy emphasizes the necessity for specific support for biochar development. This recognition underscores the importance of creating targeted financial incentives and subsidies to foster the growth of the biochar sector independently.

Recommendations:

- Dedicated Financial Incentives: Advocate for the establishment of dedicated financial incentives and subsidies specifically tailored to support biochar development. This could include grants, tax incentives, or subsidies aimed at promoting the production and application of biochar.
- Policy Alignment: Work towards aligning national policies with the unique needs of the biochar sector. This involves engaging with policymakers to create a regulatory environment that encourages investment and development in biochar technologies.
- Public-Private Partnerships: Foster collaborations between public and private entities to develop funding mechanisms that support biochar research, production, and application. Public-private partnerships can leverage resources effectively to drive sustainable growth in the biochar industry.
- Awareness Campaigns for Policymakers: Launch targeted awareness campaigns to educate policymakers about the potential benefits and applications of biochar. This understanding is crucial for garnering support and crafting effective policies.

- International Best Practices: Explore and implement best practices from countries with successful biochar development support systems. International benchmarks can offer valuable insights for designing effective financial incentives.

Slovenia: Slovenia indicates a lack of existing financial incentives or subsidies that sufficiently support biochar development. This response suggests that the current financial mechanisms in the country are not structured to address the specific needs and challenges of the biochar sector.

Limited Financial Support: The absence of dedicated financial incentives or subsidies implies a potential challenge for the growth and development of the biochar industry in Slovenia. Without specific financial support, the biochar sector may face obstacles in realizing its full potential, limiting innovation, research, and widespread adoption of biochar technologies.

Recommendations:

- Advocacy for Biochar-Specific Incentives: Advocate for the introduction of biochar-specific financial incentives or subsidies. Collaborate with relevant stakeholders to highlight the unique benefits and applications of biochar, emphasizing its potential contributions to sustainable agriculture and environmental conservation.
- Policy Dialogue: Engage in policy dialogue with governmental bodies to discuss the need for tailored financial support for biochar development. Highlight the positive environmental impacts and economic benefits associated with biochar technologies.
- Public-Private Partnerships: Explore opportunities for public-private partnerships to fund biochar research, production, and application. Leveraging combined resources can accelerate the growth of the biochar sector.
- Capacity Building: Invest in capacity-building initiatives to educate policymakers, investors, and industry stakeholders about the biochar sector's potential. Enhancing awareness can contribute to the creation of more supportive financial policies.
- International Collaboration: Collaborate with international organizations and countries with successful biochar development models. Learning from best practices and adapting successful strategies can provide valuable insights for shaping effective financial incentives.

Austria: Research subsidies are granted on a regular basis for biochar research projects in Austria. For example, the Nutricoal project coordinated by BEST - Bioenergy and Sustainable Technologies

GmbH from 2018-2021, looking into the conversion of slaughterhouse wastes to biochar. Another example would be the BC4I project coordinated by BIOS BIOENERGIESYSTEME GmbH set to last from 2021-2024, investigating the suitability of biochar for metallurgical applications. In total, the Austrian Research Promotion Agency FFG lists 15 different projects related to "Pyrolyse", "Biokohle" or "Pflanzenkohle that it subsidized and all of which started in the last ten years. There are no economic subsidies in the shape of bonuses, tax reliefs or similar things that encourage biochar application. Whether the existing research subsidies are sufficient to develop biochar as a technology in Austria on the long run can't be said, but they are certainly not enough for a rapid and widespread establishment of this technology.

Recommendations:

- Advocacy for Economic Incentives: Collaborate with stakeholders to advocate for the introduction of economic incentives, such as bonuses or tax reliefs, to encourage the widespread application of biochar technologies.
- Continued Research Support: Sustain the support for biochar research projects, ensuring a continuous exploration of its potential applications, benefits, and challenges.
- Public-Private Partnerships: Foster collaborations between research institutions, private companies, and government bodies to maximize resources and accelerate the development of biochar technologies.
- Monitoring Effectiveness: Regularly assess the effectiveness of existing subsidies and incentives in achieving biochar development goals. Adjust policies as needed to ensure alignment with evolving industry needs.

3.4.2. What measures or changes do you think would contribute to an increased uptake of biochar in your country?

Italy: Italian partners identified key areas for improvement to foster the increased uptake of biochar technologies. The focus is on regulatory enhancements, targeted incentives for the agricultural sector, and the establishment of a positive political framework to support smaller entities engaged in biochar production.

- Regulation Improvement: The regulation needs to be improved to address criticalities and create a more conducive environment for the adoption of biochar technologies.

- Incentives for Farmers: Incentives should be provided to farmers who use biochar as a substitution for mineral fertilizers. Financial support or other advantages can encourage the agricultural sector to embrace biochar applications.
- Positive Political Framework: Establishing a positive political framework is crucial to support small-scale farms or forestry companies in producing biochar and utilizing the resulting heat for various processes.

Recommendations:

- Collaboration with Stakeholders: Engage in collaborative efforts with regulatory bodies, agricultural associations, and policymakers to actively contribute to the improvement of regulations governing biochar production and application.
- Designing Targeted Incentive Programs: Work with relevant authorities to design and implement incentive programs specifically tailored to farmers adopting biochar. These incentives can include financial support, tax benefits, or other advantages to encourage the transition.
- Advocacy for Supportive Policies: Advocate for the development and implementation of policies that create a positive political framework for small-scale farms and forestry companies involved in biochar production. This involves highlighting the socio-economic and environmental benefits associated with biochar technologies.

Slovenia: Slovenian partners have identified that positive examples of biochar can serve as encouraging instances of successful application. These examples would showcase the versatility and benefits of biochar across various sectors, contributing to sustainable practices and environmental conservation.

- Agricultural Applications: Positive instances of biochar use in agriculture would demonstrate its potential to enhance soil fertility, water retention, and nutrient availability. Farmers incorporating biochar into their practices would potentially observed improvements in crop yields and overall soil health. These success stories would serve as valuable examples for promoting biochar adoption among the agricultural community.
- Carbon Sequestration Initiatives: Slovenia should recognized the role of biochar in carbon sequestration, contributing to efforts aimed at mitigating climate change. Projects focused on carbon capture and utilization, where biochar would play a pivotal role, would demonstrate the positive environmental impact of biochar

technologies. These initiatives would serve as models for integrating biochar into broader sustainability and climate action plans.

- Waste Valorization and Circular Economy: Positive examples of biochar use in waste valorization would highlighed its potential to convert organic waste into a valuable resource. Biochar production from agricultural residues, forestry waste, or organic byproducts can contribute to the circular economy by creating a sustainable and beneficial product. Such examples would showcase biochar as a solution for managing organic waste while producing a valuable soil amendment.
- Collaborative Research and Demonstration Projects: Collaborative research and demonstration projects involving biochar would demonstrate its real-world applicability and benefits. Projects that showcase biochar's effectiveness in addressing specific environmental challenges, such as soil degradation or water quality improvement, would serve as inspiring models for further research and implementation.

Recommendations:

- Knowledge Sharing and Outreach: Encourage knowledge sharing and outreach programs to disseminate information about successful biochar applications. Highlighting positive examples can inspire other stakeholders, including farmers, policymakers, and industries, to explore biochar's potential in their respective domains.
- Demonstration Farms and Pilot Projects: Establish demonstration farms and pilot projects that showcase biochar use in different agricultural settings. These hands-on initiatives provide tangible evidence of biochar's benefits, allowing farmers to witness its impact firsthand and consider its incorporation into their practices.
- Partnerships with Industry and Research: Foster partnerships between industry players, research institutions, and government bodies to support collaborative projects that demonstrate biochar's efficacy. These partnerships can facilitate the implementation of biochar technologies across diverse sectors, from agriculture to waste management.
- Policy Support for Biochar Initiatives: Advocate for policies that support and incentivize biochar initiatives. Providing policy frameworks that encourage the

adoption of biochar in various applications, along with possible financial incentives, can further promote its positive impact.

Austria: Austrian partners are proposing a multifaceted approach to increase the uptake of biochar technologies. The focus is on integrating biochar into a CO2 certificate economy, fostering market development through utilization strategies and financial incentives, and promoting soil health through the implementation of a soil charter.

- Integration into CO2 Certificate Economy: Implementing biochar in a CO2 certificate economy, where biochar application ensuring carbon sequestration is accounted for as negative CO2 equivalent, would provide a significant financial incentive for widespread adoption. The impact, however, depends on the success of CO2 trading.
- Market Development: The development of a market for biochar necessitates utilization strategies, business cases, and potentially financial incentives, such as political subsidies, to encourage its widespread use. Creating awareness among the population and industries about the benefits of biochar, particularly its carbon storage capabilities as one of the 6 NET (Negative Emission Technologies), is crucial.
- Soil Charter for Improved Soil Health: The introduction of a soil charter with clear goals and mandatory measurements to enhance soil health and humus formation is essential. While biochar alone cannot achieve this task, it can play a significant role as one piece of the puzzle.

Recommendations:

- Advocacy for CO2 Certificate Integration: Collaborate with stakeholders to advocate for the integration of biochar into a CO2 certificate economy, emphasizing its role in carbon sequestration.
- Market Development Strategies: Work with industry partners and policymakers to develop utilization strategies and business cases for biochar. Explore and advocate for financial incentives, including political subsidies, to drive market development.
- Awareness Campaigns: Launch targeted awareness campaigns to educate the population and industries about the benefits of biochar, positioning it as a crucial element in carbon sequestration and soil health improvement.
- Support for Soil Charter Implementation: Collaborate with relevant authorities to support the implementation of a soil charter with clear goals and mandatory measurements. Emphasize the role of biochar as a contributing factor to overall soil health objectives.

3.4.3. What do you perceive as the most significant challenge hindering the development of biochar in your country?

Italy: Italian partners underscored two interconnected challenges—market development and the absence of affordable and reliable small-scale production technologies. These challenges are pivotal in determining the growth trajectory of the biochar sector within the country.

- Market Development: The challenge of market development is identified as a significant hurdle. This suggests that creating a viable and robust market for biochar products is a key concern.
- Absence of Affordable and Reliable Solutions (Technologies) for Small-Scale Production: the absence of affordable and reliable solutions, particularly technologies for small-scale biochar production is as a critical challenge. This indicates a need for accessible and efficient production methods tailored to smaller operations.

Recommendations:

- Market Awareness Campaigns: Launch targeted awareness campaigns to educate potential consumers, industries, and stakeholders about the benefits and applications of biochar. This can stimulate demand and contribute to market development.
- Industry Collaboration: Foster collaboration between biochar producers, industries, and research institutions to develop and implement efficient market strategies. Building networks within relevant sectors can create opportunities for biochar integration.
- Research and Development for Small-Scale Technologies: Invest in research and development focused on designing affordable and reliable small-scale biochar production technologies. This could involve adapting existing technologies or creating new solutions tailored to the needs of smaller operations.
- Policy Support for Small-Scale Producers: Advocate for policies that specifically support small-scale biochar producers. This could include financial incentives, streamlined regulatory processes, and targeted support programs to encourage the entry of smaller players into the biochar market.

Slovenia: Slovenian partners recognized the importance of building a community of positive examples to overcome challenges and foster the development of biochar within the country.

Recommendations:

- Establish Community Platforms: Create dedicated online platforms, forums, or communities where biochar enthusiasts can connect, share experiences, and discuss challenges and opportunities.
- Organize Collaborative Events: Facilitate events, workshops, and seminars that bring together stakeholders from different sectors to exchange ideas and build a shared vision for biochar development.
- Document and Share Success Stories: Actively document and share success stories through various channels, including websites, publications, and social media, to reach a wider audience and inspire others.
- Engage in Policy Dialogues: Use success stories as powerful advocacy tools in policy dialogues. Engage with policymakers, presenting evidence of the positive impact of biochar applications to shape supportive regulations and incentives.
- Encourage Knowledge Transfer: Promote knowledge transfer within the community by encouraging mentorship, collaborative research, and the sharing of technical expertise.

Austria: Austrian partners identified market-related challenges as the primary hindrance to the development of biochar within the country. The key issues revolve around market awareness, financial incentives, and the need for real-life examples showcasing the benefits of biochar application.

- Ignorance and Limited Awareness: Austria acknowledges that the perception of biochar is often limited to traditional wood-based biochar produced in charcoal piles and retorts. There is a lack of awareness regarding biochar as a versatile industrial resource that can be derived from various feedstocks. Overcoming this limited perspective is crucial for expanding the application of biochar in diverse sectors.
- Insufficient Financial Incentives: The financial incentives for transitioning from established fossil carbon sources, such as hard coal, to renewable alternatives like biochar are perceived as inadequate. This poses a significant challenge, especially for large-scale investments. Without compelling financial motivations, industries may be reluctant to make the shift to biochar, hindering its industrial application.
- Need for Biochar Advocates: Austria recognizes the absence of biochar advocates as a contributing factor to the challenges. Having advocates who actively promote and

endorse the benefits of biochar could positively influence perceptions and drive interest among industries, policymakers, and the public.

- Lack of Real-Life Examples in Agriculture: The challenges include a shortage of real-life examples demonstrating the practical benefits of biochar application in agriculture. The absence of tangible success stories makes it difficult to quantify the advantages, hindering broader acceptance and adoption.

Recommendations:

- Comprehensive Awareness Campaigns: Launch campaigns that comprehensively educate industries, policymakers, and the public about the diverse applications and benefits of biochar.
- Advocacy Programs: Initiate advocacy programs involving key stakeholders to champion the cause of biochar. Engage with industry leaders, researchers, and influencers to become advocates for biochar technologies.
- Policy Dialogues: Engage in dialogues with policymakers to advocate for stronger financial incentives and supportive policies that promote the transition to biochar.
- Case Study Development: Encourage and support the development of case studies highlighting successful biochar applications, particularly in agriculture. These case studies serve as valuable references for potential adopters.

4. Examples of Best Practice in Biochar production in Alpine Space

Italy: In Italy, the biochar landscape is evolving, and while there is limited visibility, one noteworthy company has emerged as a pioneer in producing biochar as its primary product, rather than as a byproduct of electrical energy production. Unfortunately, due to the limited information available and the nascent stage of the industry, specific details about the company, including its name and webpage, are not disclosed.

This company represents a positive example as it signifies a shift in the Italian biochar sector towards dedicated biochar production. By prioritizing biochar as the main product, the company is likely to focus on optimizing production processes, ensuring the quality of biochar, and exploring diverse applications beyond energy production byproducts. While the industry is in its early stages, the existence of such a company showcases a commitment to advancing biochar as a standalone and valuable resource.

Slovenia: In Slovenia, there is currently no identified or publicly available information regarding a specific company or project that can be recognized as a positive example of best practice in biochar production or utilization.

Due to a lack of established best practices in Slovenia, we identified a noteworthy approach and conducted an interview with Technologie- und Förderzentrum im Kompetenzzentrum fur Nachwachsende Rohstoffe (TFZ) in Bavaria. TFZ is actively coordinating the DemoPyro funding initiative. The interview with TFZ allowed us to gain insights into their successful practices and the coordination efforts involved in supporting the construction of pyrolysis demonstration plants for biochar production.

The DemoPyro funding initiative aims to support the establishment of pyrolysis demonstration plants dedicated to producing biochar. These systems play a crucial role in long-term carbon storage, making a significant contribution to climate protection, particularly in agriculture and forestry. The supported projects are expected to contribute insights into the material flows of renewable raw materials for biochar production and understand the market dynamics. Additionally, the funded demonstration plants aim to catalyze regional carbon storage projects. The DemoPyro funding guidelines, effective from August 2nd, 2023, have been officially released. The DemoPyro funding guidelines, effective from August 2nd, 2023, were officially released. Starting from September 1st, 2023, interested parties could submit funding applications to the Technologie- und Förderzentrum (TFZ).

Eligibility:

- **Eligible Applicants:** Natural persons, legal entities, partnerships, church institutions, and legal entities under public law of indirect state and federal administration with their own legal entity (such as local authorities, institutions, foundations, chambers).
- **Ineligible Applicants:** Manufacturers of systems or components for pyrolysis systems, companies in financial distress, and recipients of aid who have not complied with recovery orders in the past.

Project Funding Focus: Investments in new, environmentally friendly pyrolysis plants for biochar production, meeting the quality standards of the European Biochar Certificate (EBC) and being used as materials, are supported. Each applicant is limited to submitting one application. The funding allows for a maximum of 2 pyrolysis plants to be funded in each of the specified asset classes:

- Asset class I: < 250 kW

- Asset class II: 250 kW to 1 MW
- Asset class III: > 1MW

Application Process:

- Prior to submitting an application, a mandatory project discussion is required. Participants include applicants, a representative from the Biomass Promotion Center at the TFZ, and a representative from the office responsible for the technical assessment of the project.
- Initial project meetings are schedule, with two appointments per system class. Expressions of interest, including the application form, a project description, and economic efficiency data, must be submitted exclusively by email
- The funding is provided as de minimis aid, with a maximum funding rate of 50% of eligible expenses, up to €200,000 per measure.

Additional Funding Requirements:

- All biochar production must be certified according to the EBC quality criteria.
- At least 2 reference systems of the applied-for type must have been in regular operation for at least six months (in Germany or Europe).
- Only natural, chemically untreated biomasses may be used as starting materials.
- The funded system must be built within Bavaria and operated appropriately for at least 7 years.
- A plausible marketing concept must be presented for the biochar produced, along with any generated heat and electricity. If marketing CO2 sink certificates is planned via a recognized trading platform, a viable concept must be presented during the application submission.

Austria: Austria showcases several positive examples of best practices in biochar production and utilization, representing diverse applications and innovative approaches. Here are notable examples:

1. **Sonnenerde:**
    - Website: Sonnenerde

- Description: Sonnenerde utilizes a continuous screw reactor system from the Pyreg company to produce biochar specifically for garden applications. The owner incorporates biochar as a cement additive in his house constructed with "climate concrete," highlighting the potential of biochar in reducing crack formation in concrete.

2. **Nawaro Energie:**
    - Website: Nawaro Energie
    - Description: Nawaro Energie operates a wood gas power plant in Perg, Austria, producing electricity, heat, and biochar. The plant exemplifies regional high-efficiency and innovation in utilizing biomass resources for multiple purposes.
3. **Humus+ Project in Modell Ökoregion Kaindorf:**
    - Website: Humus+
    - Description: The Humus+ project in the Modell Ökoregion Kaindorf envisions promoting living soils. One measure involves introducing biochar into the soil to build up humus. The project includes workshops for farmers to learn how to produce their own biochar, emphasizing the role of biochar in enhancing soil health.
4. **Vulkanland:**
    - Website: Vulkanland
    - Description: The biomass heating plant in Bad Gleichenberg, operated by Vulkanland, produces not only heat and electricity but also biochar. This multifaceted approach exemplifies the regional production and diverse uses of plant charcoal (Pflanzenkohle).
5. **Energiwerk Ilg:**
    - Website: Energiwerk Ilg
    - Description: EnergieWerk Ilg, located in Dornbirn, Vorarlberg, has developed a road surface incorporating 2 percent carbon. This innovative approach results in asphalt that stores more CO2 than was consumed during its production, demonstrating the potential of biochar in sustainable infrastructure.

6. Example of Best Practice in Biochar Production or Utilization beyond the Alpine Region

Italy: Italian partners suggested:

Company Name: *CORC - Cooperative for Organic Resources and Carbon*

Webpage: https://puro.earth/

Country: France

Description of the Best Practice: CORC, the Cooperative for Organic Resources and Carbon, is highlighted as a positive example of best practice in biochar production or utilization in France. While specific details about the company's operations are not provided, the link emphasizes the importance of their biochar in the context of CO2 removal certification. The company seems to be engaged in carbon removal efforts, and its biochar production is associated with a CO2 removal certificate.

Key Points:

1. **CO2 Removal Certification:** CORC's biochar is associated with a CO2 removal certificate, indicating a commitment to carbon removal practices. This certification likely attests to the positive environmental impact of the biochar produced by the cooperative.
2. **Link with Puro.earth:** The information about CORC and its biochar practices is found on the Puro.earth platform. Puro.earth focuses on providing a marketplace for companies to buy and sell verified carbon removal certificates, emphasizing the role of biochar in carbon sequestration.
3. **Collaborative and Cooperative Approach:** Being a cooperative, CORC may exemplify a collaborative and community-based approach to biochar production or utilization. This cooperative structure could support sustainable and environmentally friendly practices.

The example from CORC in France showcases how biochar can be integrated into carbon removal strategies, with a focus on obtaining certifications that validate the positive environmental impact of the biochar produced. This aligns with a broader trend of recognizing biochar as a valuable tool in climate change mitigation efforts.

Slovenia:

Chamber of Commerce and Industry of Štajerksa, as a coordinator of SRIP Circular Economy has organised a business delegation to Denmark in June 2023, where we have visited the company AquaGreen - a company focused on sustainable biomass treatment.

Company Name: *AquaGreen*

Webpage: https://aquagreen.dk/

Country: Denmark

AquaGreen specializes in unique patented technology for upcycling both dry and wet biomass into valuable resources.

Patented Technology:

- AquaGreen's patented technology involves a combined super-heated steam dryer and pyrolysis process.
- This process eliminates pollutants and converts wet sewage sludge into climate-positive (GHG-negative) biochar and renewable energy.
- The technology utilizes embedded energy from the biomass itself to dry the sludge, eliminating the need for external heat sources.

Environmental Impact:

- The pyrolysis process further decomposes drug- and pesticide- and microplastic-residues, addressing concerns in municipal sewage sludge.
- The resulting biochar serves as carbon storage, sequestering CO2 from the atmosphere

Operational Details:

- **Commercial Installations:** AquaGreen offers commercial installations for its technology.
- **Application:** The technology is designed to work with sewage sludge, converting it into biochar and renewable energy.

- **Use of Renewable Energy:** The process utilizes renewable energy generated from the biomass itself, contributing to sustainability.

Austria: austian partners suggested :

Swedish Examples:

1. **Biochar Ecoera Millennium:**
    - Link to Certificate
    - Description: This example from Sweden, associated with CORC's CO2 removal certificate, highlights the eco-friendly practices of Biochar Ecoera Millennium.
2. **Biochar in Sweden - Hjelmsaeters Egendom:**
    - Link to Certificate
    - Description: The biochar practices at Hjelmsaeters Egendom in Sweden contribute to carbon removal efforts and are certified by CORC.
3. **Stockholm Exergi:**
    - Description: Stockholm Exergi is recognized for its practices in Sweden, potentially involving biochar in energy and heat production.

German Examples:

1. **Pflanzenkohle Darmstadt:**
    - Link to Carbonization Plant
    - Description: Pflanzenkohle Darmstadt operates a carbonization plant in Germany, emphasizing sustainable practices in biochar production.
2. **Sewage Sludge Pyrolysis by WUDAG:**
    - Link to Article

- Description: WUDAG showcases ongoing sewage sludge pyrolysis operations in Germany, highlighting a sustainable approach to waste treatment.

3. **Terra Preta GmbH:**

   - Terra Preta GmbH Website
   - Description: Terra Preta GmbH in Germany utilizes biochar from sources like coking plants to produce Terra Preta, a nutrient-rich black earth designed for horticulture.

These examples from Sweden and Germany exemplify diverse applications of biochar, ranging from carbon removal certification in Sweden to innovative carbonization plants and the production of nutrient-rich soil amendments in Germany. The integration of biochar into various sectors underscores its versatility as a sustainable solution.

7. Conclusion

In the pursuit of sustainable energy solutions, Italy, Slovenia, and Austria stand at the forefront, each contributing to a cleaner and more sustainable future shaped by their unique political, financial, and environmental landscapes.

Italy's approach focuses on citizen awareness and cohesive strategies, aligning policies with a common sustainable vision. In Slovenia, the political landscape centers on transitioning from coal mines to cleaner energy sources, while Austria maintains a steadfast commitment to renewables, especially biomass.

Financial support mechanisms play a pivotal role in fostering biomass conversion technology. Italy's initiatives, including Conto Termico and White Certificates, showcase a commitment to energy efficiency. Slovenia's environmental fund supports biomass conversion projects, and Austria employs multi-level funding opportunities from EU programs to regional initiatives.

Cost competitiveness varies across the countries, with Italy highlighting biomass for heat generation, Slovenia emphasizing biomass availability, and Austria showcasing competitiveness in heating, particularly in pellet sales.

Geographical and climatic factors influence biomass efficiency, with each country adapting strategies to seasonal variations and diverse landscapes. Italy emphasizes technological efficiency and

environmental considerations, Slovenia navigates geographical complexity, and Austria focuses on residue availability, facing challenges in supply chain disruptions.

Logistical challenges vary, with Italy dealing with an outdated forest road system, Slovenia managing geographical distribution complexity, and Austria optimizing economic efficiency in a well-established infrastructure.

Collaboration is a common theme, emphasizing citizen involvement in Italy, stakeholder coordination in Slovenia, and an integrated transport network in Austria. All three nations underscore the importance of adapting strategies to evolving conditions.

Transitioning to biochar development is identified as a key strategy. By bridging knowledge gaps, designing targeted incentives, and advocating for supportive policies, these countries aim to foster a conducive environment for biochar technologies. This contributes to sustainable practices, environmental conservation, and widespread adoption, with potential benefits ranging from improved soil health to carbon sequestration.

Our exploration of best practices in biochar production across the Alpine region any beyond has unveiled a rich tapestry of innovative approaches and sustainable solutions. From Sonnenerde's adept utilization in garden applications to Nawaro Energie's multi-purpose biomass plant, and Humus+'s impactful soil-enhancing project, each example represents a unique facet of biochar's versatility and potential. Vulkanland's biomass heating plant showcases a multifaceted regional approach, while Energiwerk Ilg's pioneering work in developing a sustainable road surface underscores the diverse applications of biochar in infrastructure. In the cooperative realm, CORC stands out for its collaborative biochar production model, emphasizing carbon removal certifications and aligning with broader climate change mitigation trends. AquaGreen in Denmark introduces a groundbreaking patented technology, addressing environmental concerns by converting wet sewage sludge into climate-positive biochar and renewable energy. In Sweden and Germany, where practices vary from Biochar Ecoera Millennium's eco-friendly initiatives to WUDAG's sewage sludge pyrolysis are highlighting the wide-reaching versatility of biochar across various sectors Collectively, these examples not only signify the current state of biochar practices in the Alpine Space but also illuminate a path forward towards sustainable, collaborative, and environmentally impactful biochar production and utilization.

In conclusion, the success of biomass conversion technology relies on strategic planning and ongoing support. A nuanced understanding of geographical, climatic, and logistical factors, coupled with proactive policies and financial incentives, is crucial for the continued growth and successful integration of biomass solutions in Italy, Slovenia, and Austria. As these nations navigate the path towards sustainable energy, biomass conversion stands as a pivotal contributor to a greener and more resilient future.