BioTheRoS

Collaborative actions to bring novel **BIO**fuels **THE**rmochemical **RO**utes into industrial **S**cale

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Disclaimer

Executive Summary

The initial version of BioTheRoS’ exploitation plan outlines the key exploitable results (KERs) and provides a framework for strategically exploiting these results. This plan is structured to identify targeted groups, responsible partners, and effective methods for realizing each KER.

Project partners actively monitor collaboration opportunities to leverage the strengths and resources of other organizations. This engagement is crucial for successful commercialization potential of the project's results. Intellectual property (IP) protection is essential to the project’s exploitation strategy. Therefore, a robust IP framework, including patents and confidentiality measures, has been developed to protect innovations and maintain a competitive advantage for the project and its partners. This IP strategy is detailed in the document.

Furthermore, the plan identifies potential barriers to the successful commercialization of BioTheRoS technologies and outlines strategies to overcome these challenges. The next steps for addressing these barriers and advancing the project’s commercialization efforts are also explained in this deliverable.

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List of abbreviations

DFB	Dual fluidized bed
FT	Fischer Tropsch
FTS	Fischer–Tropsch synthesis
GIS	Geographic Information System
IPR	Intellectual Property Right
KER	Key Exploitable Result
MI	Mission Innovation
SAF	Sustainable Aviation Fuel
SBCR	Slurry Bubble Column Reactors

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Introduction

The first version of Exploitation Plan aims to identify how to make concrete use of the project's results to be exploited, shared and made available during project life and beyond. A structured approach is necessary to properly utilize and disseminate them. First and foremost, it is necessary to identify key stakeholders, that has already been done during the project development phase and these stakeholders have been described in D8.1 Communication and Dissemination Plan. Namely, they are biomass providers, technology and service providers, fuel producers and distributors, public authorities, research and academia, general public/citizens, EU commission initiatives, biofuel end users, biofuel experts in mission innovation (MI) countries. Several strategies have been planned to reach these stakeholders to effectively communicate project results. This is the first step of effective use of project outcomes.

Moreover, partners continuously monitor the opportunities for collaboration and partnerships. The aim is to leverage the strengths and resources of other organizations to maximize the impact and commercialization potential of the project's results. The possibility of successful exploitation is increased through access to distribution channels, scalability, and market validation that come with forming strategic partnerships with significant players in the industry.

It is important to mention that during all the activities beyond the project, intellectual property protection is being considered. This approach enhances the project's commercial potential.

Two additional updates to the Exploitation Plan are forthcoming. These updates will delve deeper into concrete strategies, taking into account the planned market assessment report (D8.8) and the continued progress of BioTheRoS. In contrast, this initial plan primarily focuses on clarifying the Key Exploitable Results (KER) and answering critical questions like who the leading and associated partner for each KER is, how to realize it, and what could be the potential barriers.

Key Exploitable Results

The table below shows the exploitation targets, the rest of the chapter describes each target in detail.

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Table 1: Exploitation goals

Exploitation Goal	Partners Involved	Targeted sectors
Sustainable biofuel production from fast pyrolysis	BTG, MOH	Transportation (aviation, maritime); energy (power generation, heat production);
Sustainable biofuel production via gasification	BEST, CERTH	Transportation (aviation, maritime); energy (power generation, combined heat and power)
Carbon capture of off gases from fast pyrolysis and gasification	CERTH, BEST, BTG, MOH	Industrial sectors (chemical manufacturing, energy intensive industries); transportation (aviation, shipping); environmental management (carbon offset projects)
Predictive biomass demand models	CIRCE	Energy (power generation and bioenergy production to forecast biomass needs); industrial sectors (biomass processing); general public, biomass suppliers, agro-waste managers

1) Sustainable Biofuel Production via Fast Pyrolysis

The KER 1 exploitation strategy, which focuses on using Fast Pyrolysis to produce sustainable biofuels, lays out a comprehensive plan intended to maximize the technology's commercialization potential. The strategy's focus is on joint implementation and commercialization with sister companies BTG-neXt and BTG Bio-liquids by BTG as the IPR-holder. The aim is to convert various biomass sources into drop-in advanced biofuels by utilizing knowledge and resources, with fast pyrolysis and pyrolysis upgrading acting as the key technologies.

A key aspect of the exploitation strategy involves the delivery of knowledge, essential components and related services for the upgrading of pyrolsis oil to sustainable biofuels. BTG is the knowledge provider here, and the company BTG-NeXt is in charge of commercializing the technology via a license model. This dual approach of component delivery and process licensing enhances the accessibility and scalability of the technology, fostering its adoption across different sectors and regions.

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In terms of IPR strategy, we prioritize securing patents for the upgrading technology. Moreover, protection of technical know-how is undertaken to maintain competitive advantage in the market. By establishing this basis, we aim to minimize potential risks associated with IPR and position ourselves as a trusted partner in the market.

The target groups for this KER and its exploitation strategy include biomass owners, oil companies, sustainable biofuels users (e.g. airlines) and investors. Actions towards these target groups can be:

- Engaging biomass owners by promoting the fast pyrolysis technology upgrading for biofuel production, highlighting its economic and environmental benefits.
- Collaboration with oil companies and sustainable biofuel users aims to integrate BioTheRoS' upgrading technologies into their existing infrastructure, facilitating the production of advanced biofuels.
- Attracting investors also helps to improve operations and expand market reach, with the strategy focusing on demonstrating the commercial viability of project's fast pyrolysis technology to secure investment opportunities.

A detailed report will be provided to guide industrial stakeholders. This report will describe the methods and lessons learned in BioTheRoS project to produce advanced biofuels via fast pyrolysis upgrading. Simulation and modelling for scaling up the pyrolysis value chain will also be carried out during the project. By analyzing the outcomes and insights from modeling and simulation, valuable lessons can be learned, and guidelines can be derived for scaling up the fast pyrolysis biofuel production value chain. These lessons and guidelines can inform future decisions and investments in similar projects, accelerating the exploitation of sustainable biofuel technologies. Finally, the exploitation strategy emphasizes continuous innovation and improvement to enhance the efficiency and effectiveness of improved fast pyrolysis technology and biofuel production processes.

2) Sustainable Biofuel Production Via Gasification

The exploitation strategy for KER 2, focuses on sustainable biofuel production via gasification technology, and is designed to benefit the expertise of BEST as the IPR holder. The primary exploitation route for BEST is through knowledge dissemination to industry and the research community, primarily via publications and academic papers. By sharing their findings and collaborating with national and international partners,

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BEST aims to further develop and industrial implementation of gasification. This approach fosters a mutual relationship between scientific and industrial excellence.

As part of the exploitation strategy, BEST will target four stakeholder groups: biomass providers, technology and service providers, fuel producers, researchers and academia. Publications will serve as the primary means of knowledge transfer, sharing research outcomes and advancements in gasification. By sharing disseminating results and research findings, BEST aims to inspire further development and innovation while also providing valuable insights for industry stakeholders interested in implementing gasification technologies for sustainable biofuel production.

In terms of IPR strategy, BEST will focus on publications and potential patents in the field of dual fluidized bed (DFB) gasification and Fischer–Tropsch synthesis (FTS) based on slurry bubble column reactor (SBCR) technology. Industrial confidentiality will be maintained, with specific results being published selectively to protect sensitive information. This balanced approach to IPR management ensures that BEST can continue to drive innovation and development in gasification, and Fischer Tropsch (FT) systems while also protecting valuable intellectual property.

Similar to fast pyrolysis technology, in KER1, a report will be produced to identify the constraints and opportunities for biomass gasification scale-up. This report will inform industry stakeholders and decision-makers about the potential of gasification technology for sustainable biofuel production and highlight areas for further research and investment. By implementing these market uptake methods, BioTheRoS will effectively disseminate knowledge, foster collaboration, protect intellectual property, and provide valuable insights to industry stakeholders, ultimately accelerating the market uptake and implementation of gasification technology for sustainable biofuel production.

3) Carbon Capture of Off Gases from Fast Pyrolysis and Gasification

To enhance the impact of the novel CO_2 capture unit, CERTH as the IPR owner plans to integrate it into future EU-funded projects. These projects will explore further the additional concepts with a focus on upscaling and integrating the technology across various industrial sectors, such as cement and lime production.

The primary route for exploitation is through the transfer of knowledge within the research community, shared via detailed publications. These publications will disseminate valuable findings and data on the

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development and assessment of the novel CO_2 capture unit, encouraging further research and innovation in this area.

The IPR strategy involves publishing research findings and potentially filing a patent for a novel CO_2 capture unit. With this approach CERTH is ensured to protect its intellectual property while promoting an open exchange of knowledge within the academic and industrial communities.

Several key target groups have been identified for the exploitation strategy, including biomass providers, technology and service providers, fuel producers, researchers, and academia. Engaging these groups is crucial for facilitating the adoption and implementation of CO_2 capture technology among various sectors. CERTH will actively seek collaborations with industry stakeholders to integrate the CO_2 capture unit into their operations. These collaborations could involve joint research projects, technology transfer agreements, and pilot studies, demonstrating the unit's effectiveness in real-world industrial conditions.

The syngas produced from the experimental activities will serve as a reference gas for trial tests in a pilot-scale CO_2 unit. These results will inform modeling activities and will be useful to demonstrating the viability of integrating CO_2 capture technology into BioTheRoS processes. In collaboration with other partners, the commercial potential and market readiness of this technology will be assessed in the updated exploitation plans. Finally, CERTH will engage in educational and outreach activities to raise awareness about the importance and benefits of these technologies. This involves organizing workshops, seminars, and training sessions to educate industry professionals, students, and the broader community about the novel CO_2 capture unit and its potential applications.

4) Predictive Biomass Demand Models

Predictive biomass demand models aim at the resource availability forecast that is needed to meet the requirements of the sustainable aviation fuel (SAF) and marine biofuels markets. The predictive models gather data from GIS on biomass production and market research, from biomass predictive models and from data visualization interface. CIRCE will utilize these models internally to offer consultancy services to stakeholders within the biofuel production value chain, such as biomass and agro-waste managers, biofuel producers. This will help these stakeholders to evaluate the feasibility of establishing new biofuel value chains and determine the most efficient methods for doing it. This strategic consultancy service will not only enhance the operational efficiency of biomass providers and biofuel producers but also facilitate informed decision-making for establishing sustainable biofuel value chains.

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The IPR strategy for these predictive models centers on industrial confidentiality. By maintaining confidentiality over the specific methodologies and data utilized in the models, CIRCE can protect its competitive advantage while providing high-value consultancy services. This approach ensures that the authorized aspects of the models remain secure.

The primary target groups for this exploitation strategy include the energy sector and industries related to aviation and marine sector, biomass providers, technology and service providers, fuel producers and distributors, and public authorities. Engaging with these groups will be essential for the successful implementation and commercialization of the predictive biomass demand models. Biomass providers and agro-waste managers can use the models to assess the availability and sustainability of their resources. Biofuel producers and distributors can use the insights to optimize their supply chains and production processes. Public authorities can utilize the models to upgrade policy decisions and support the development of sustainable biofuel initiatives.

An explanatory report on the model and its predictive accuracy will be developed to help stakeholders to assess the reliability and effectiveness of the predictive models in forecasting resource availability for SAF and marine biofuels markets.

Additionally, CIRCE plans to explore opportunities to collaborate with technology and service providers to integrate the predictive models into broader biofuel production systems. This collaboration can lead to the development of comprehensive solutions that address the entire value chain, from biomass sourcing to biofuel distribution. One co-creation workshop has already been organized by CIRCE during the second project meeting, with a mission to facilitate interaction and collaboration between industry experts and our project team. More information on this workshop (*Scaling Biofuels into Thermochemical Futures*) can be found on D8.1 – Dissemination and Communication Plan.

Through this exploitation strategy, it is aimed to maximize the utility and impact of the predictive biomass demand models, facilitating the efficient and sustainable development of biofuel value chains. By offering consultancy services and engaging with key stakeholders, CIRCE will contribute to the advancement of the SAF and marine biofuels markets.

Intellectual Property Strategy

The BioTheRoS project's intellectual property (IP) strategy is crucial to protect and maximize the commercial potential of the project's innovative technologies and outcomes (KERs). This section outlines

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the planned approaches to secure IPR for the KERs, ensuring that the project's outcomes are protected and effectively utilized during project life and beyond.

Protection and Patenting

For KER 1, which focuses on sustainable biofuel production via fast pyrolysis, the IPR strategy involves having patents for the fast pyrolysis process and upgrading technologies. By patenting these innovations, BTG can protect its technological advancements and maintain a competitive position in the market. Additionally, the protection of technical know-how as industrial confidentiality is emphasized to further conserve proprietary information.

KER 2, centered on sustainable biofuel production via gasification, has a similar approach. BEST plans to focus on publications and potential patents in the field of DFB gasification and FTS based on SBCR technology. Maintaining industrial confidentiality for specific results ensures that sensitive information is protected, while selected publication allows for the dissemination of non-confidential findings to foster further research and development in the field.

For KER 3, which involves carbon capture of off gases from fast pyrolysis and gasification, CERTH aims to protect its novel CO_2 capture unit through publications and potentially a patent. This approach finds a balance between fostering information sharing between the academic and industrial groups and the requirement to preserve intellectual property. By obtaining a patent, CERTH can protect its innovation.

KER 4 focuses on predictive biomass demand models, and CIRCE's IPR strategy centers on maintaining industrial confidentiality. By keeping the methodologies and data utilized in the models confidential, CIRCE can protect its competitive advantage. This strategy preserves the novel features of the predictive models while enabling CIRCE to offer high-value consulting services.

Continuous Innovation and Improvement

A key aspect of the IP strategy across all KERs is the emphasis on continuous innovation and improvement. By regular feedback from stakeholders and leveraging technological advancements, BioTheRoS aims to enhance the efficiency and effectiveness of its methodologies and results. This approach not only ensures the ongoing competitiveness of the project's outcomes but also supports further market penetration and adoption of sustainable biofuel production processes.

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In conclusion, the BioTheRoS Project's intellectual property strategy is designed to protect and maximize the commercial potential of its innovative technologies. By securing patents, maintaining industrial confidentiality, and fostering collaboration with key stakeholders, the project aims to protect its intellectual property while promoting knowledge exchange and continuous innovation. This comprehensive IP strategy is essential for ensuring the successful exploitation and long-term impact of project results.

Exploitation Barriers

Despite the comprehensive exploitation strategies outlined for the BioTheRoS KERs, several barriers may occur and affect the utilization and commercialization of the project's outcomes. Identifying and addressing these barriers is crucial to maximize the project's impact. The following are potential exploitation barriers for BioTheRoS:

Technological Barriers

Scalability: While the project's technologies are promising at pilot and experimental scales, scaling up these technologies to commercial levels might have challenges. To overcome this, we aim to maximize process efficiencies and minimize related costs in larger scale.

Integration Complexity: The integration of new technologies, such as fast pyrolysis and gasification, into existing industrial processes and infrastructure could be complex. Adoption may be limited by compatibility problems with existing systems and the requirement for significant changes.

Market Barriers

Market Readiness: The market readiness for advanced biofuels and related technologies varies significantly across regions. In some markets, there might be limited demand or insufficient infrastructure to support the widespread adoption of biofuels. The upcoming market assessment report will assist us in tackling a potential market barrier.

Competition: The presence of established competitors in the biofuel and renewable energy sectors can pose a challenge. Competing against well-established technologies and companies with more resources can make market penetration difficult. Besides, a possible competition between industries for the use of feedstock to decarbonize.

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Financial Barriers

Economic Viability: The economic viability of biofuel production depends on various factors, including the cost of biomass feedstock, technological efficiency, and market prices for biofuels. Fluctuations in these factors might affect the profitability and attractiveness of biofuel production.

Regulatory and Policy Barriers

Regulatory Compliance: It can be challenging to navigate the regulatory systems around the production of biofuels. Compliance with safety standards, environmental restrictions, and other legal mandates can present substantial challenges. Again, the market assessment will serve as a guide in this regard. A particular challenge is the certification requirements for new fuels – such as those produced by the BioTheRoS technologies – before use in especially aviation, but also for use in maritime applications.

Policy Support: The level of policy support and incentives for biofuel production varies across countries. Insufficient or inconsistent policy frameworks have the possibility to hinder the expansion of the biofuel industry and impact the acceptance of project outcomes.

IPR and Knowledge Transfer Barriers

Intellectual Property Protection: Ensuring robust intellectual property protection while promoting knowledge transfer can be challenging. Balancing confidentiality with the benefits of open innovation and collaboration requires careful monitoring and management.

Knowledge Dissemination: Effectively disseminating knowledge and research findings to relevant stakeholders is significant for the successful exploitation of project results.

Social and Public Acceptance Barriers

Public Perception: Public perception and acceptance of biofuels and related technologies may significantly influence market adoption. Misconceptions about the environmental impact or safety of biofuels can limit their acceptance and use.

Technical Skill and Workforce Barriers

Skill Gaps: The successful implementation and commercialization of advanced biofuel technologies require a skilled workforce with expertise in relevant technical fields. Skill gaps and shortages in the workforce might limit the technology deployment and scalability.

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Next Steps

To ensure commercialization and realization of BioTheRoS' goods and services, it is crucial to conduct a comprehensive market analysis. As previously mentioned, a joint market assessment report, coordinated by WIP and CERTH, will be produced to collect relevant information on potential market sizes and competition. This report will focus on the main products of interest to BioTheRoS, namely advanced aviation and shipping fuels. The assessment will cover the markets in the Netherlands, Germany, Greece, Spain, and Austria, as these are the countries involved in the project.

For the updated exploitation plan, due in M12, a pre-assessment of the KERs is planned to understand their competitive position in the market. Porter Five Forces approach will be used as the analytical tool. This method helps companies evaluate industry attractiveness, understand how trends will impact industry competition, determine which industries to compete in, and identify strategies for positioning themselves for success. This approach examines five key aspects of the industry: the bargaining power of buyers, the bargaining power of suppliers, the threat of new entrants, the threat of substitute products or services, and the rivalry among existing competitors[1].

The initial market assessment report will be aligned with the updated exploitation plan (M12), with both reports updated at the end of the second year (M24) and during the final phase of BioTheRoS (M36). By proactively addressing potential barriers through tailored exploitation strategies for each KER and associated IPR management strategy, and by successfully implementing the next steps, BioTheRoS will increase the potential of successful exploitation and maximize the impact of its sustainable biofuel technology.

[1] https://www.isc.hbs.edu/strategy/business-strategy/Pages/the-five-forces.aspx

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