BioTheRoS

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

Deliverable 7.7

Database on Technology Readiness Levels and demonstrations of process steps

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The BioTheRoS Project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101122212

Disclaimer

Executive Summary

This document is a brief report describing the Deliverable D7.7 Database on Technology Readiness Levels and demonstrations of process steps, which is a public website developed within WP7. The introduction includes a general description of the BioTheRoS project, the importance of international cooperation and network development and the scope of this report. Then the database on Technology Readiness Levels (TRLs) and demonstration of process steps is presented including the concept and structure of the Tech State Navigator, the TRL of BioTheRoS pathways and process steps, the pyrolysis and gasification pathway selector and the presentation and integration into the BioTheRoS website.

The Tech State Navigator is an extension of the existing BioTheRoS Knowledge Hub, a database designed for global knowledge sharing on advanced biofuels. This new component focuses on TRLs and process step demonstrations within pyrolysis and gasification pathways for biomass and waste feedstocks. A detailed list of all feedstock-technology combinations and results is included in the Annex.

The Tech State Navigator provides:

- Flowsheets for the BioTheRoS value chains and TRLs for the process steps
- A structured overview of TRLs for different technology-feedstock combinations and listings of existing demonstration facilities.
- An interactive tool where users can select a feedstock-technology combination to view relevant TRLs and demonstration sites.

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Contents

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List of abbreviations

aDFB	Advanced Dual Fluidized Bed
AI	Artificial Intelligence
CFD	Computational Fluid Dynamics
DFB	Dual Fluidized Bed
EU	European Union
FPBO	Fast Pyrolysis Bio Oil
FT	Fischer Tropsch
HPO	Hydrotreated Pyrolysis Oil
IEA	International Energy Agency
LCA	Life Cycle Assessment
LCC	Life Cycle Costing
R&D	Research and Development
SAF	Sustainable Aviation Fuel
SPO	Stabilized Pyrolysis Oil
sLCA	Social Life Cycle Assessment
TRL	Technology Readiness Level

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Introduction

The BioTheRoS project

BioTheRoS Project aims at developing a holistic methodology that will boost the scale-up of sustainable biofuels via thermochemical conversion technologies. These are pyrolysis upgrading through hydrodeoxygenation and Fischer-Tropsch synthesis from biomass gasification. The project will bring together key actors at both European and International level, such as technological and social experts, renewable energy-oriented associations along with industrial experts that will bring and exchange their knowledge in order to reach the project targets.

Within the project, several non-food biomass feedstocks will be analyzed and optimized across their entire value chain. Barriers linked with the selected feedstocks supply and pretreatment will be identified. Furthermore, AI-based predictive models will be developed, in order to be adapted to the scale-up cases. Then, the most promising biomass feedstock will be tested experimentally in the studied thermochemical reactors. At this point of the project, technical constraints and opportunities for the scale-up of the sustainable biofuels thermochemical processes will be identified. Possible synergies of blending pyrolysis oil and gasification based advanced biofuels will be investigated by a potential end-user (petroleum company). The selected data will be used as an input for advanced modelling tools, including process modelling, CFD tools and LCA/LCC/sLCA tools results of which will feed a multi-criteria analysis to derive generalized up-scaling rules and guidelines of the produced biofuels.

The engagement of several stakeholders in the planning of the scaling-up of sustainable biofuels production will be crucial at this point, since they will review the project results and assess if a biofuel production technology can be delivered from the lab/pilot to a larger-scale, by considering operational difficulties, plant cost and plant capacity limitations (technological barriers).

International cooperation and network development

For the integration of stakeholders and experts the project has a work package on “International cooperation and network development”. Scaling up sustainable biofuels is a global challenge in terms of environmental, social, and economic sustainability, which can benefit from international collaboration and knowledge exchange. The objectives of the work package are to

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- map and use synergies with European and international research groups working on relevant research questions for scaling-up sustainable biofuels
- exchange information with European and international groups and networks on topics related to sustainable biofuels value chains
- develop a network for knowledge sharing and information exchange through international collaboration

International cooperation activities including active seeking for synergies with EU and international projects, cooperation with international networks and setting up a network for knowledge sharing to ensure that the project builds on and contributes to global knowledge building for sustainable scaling of advanced biofuels value chains.

Scope of this report

Deliverable 7.7 is a public website which contains the database on TRLs and demonstrations of process steps. This report is a descriptive supplement and documentation of this database. The deliverable is dedicated to the Task 7.4 ”Tracking and communication of Technology Readiness Levels (TRLs) and demonstrations of process steps”. Within this task the communication exchange between the technical tasks and the continuous tracking of Technology Readiness Levels along the value chain proceeds. This deliverable shows the status of the public website “Tech State Navigator”, which established a clear picture of the TRL of process steps in the BioTheRoS value chains (technologies of pyrolysis and gasification) and for the whole value chains using BioTheRoS feedstocks.

Database on TRLs and demonstrations of process steps

Concept and structure

The planned database on Technology Readiness Levels and demonstrations of process steps is meant to be integrated in the existing “Knowledge Hub”. The BioTheRoS Knowledge Hub is a database established in the course of the project and a network for knowledge sharing and information exchange through

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international collaboration and contributes to global knowledge building for sustainable scaling of advanced biofuels value chains.

The knowledge hub is now extended by the database on TRLs and demonstrations of process steps, which has been renamed to “Tech State Navigator”.

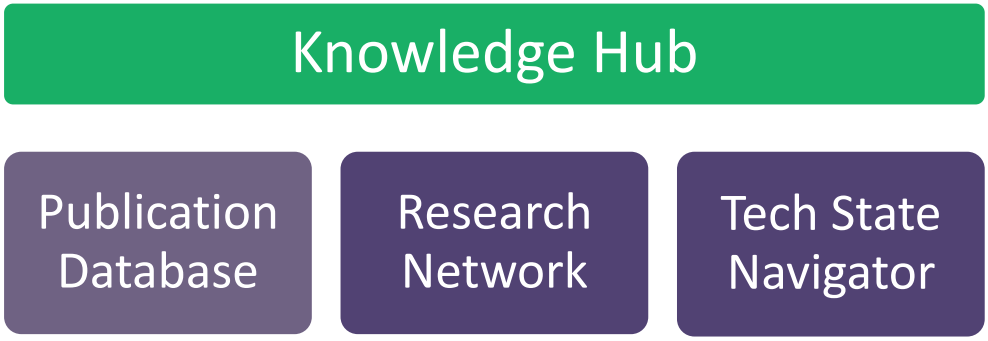

Figure 1: Extended concept of Knowledge Hub

The Tech State Navigator provides a structured overview of the Technology Readiness Levels (TRL) and of process steps in the BioTheRoS value chains based on pyrolysis and gasification technologies for biomass and waste feedstock. For chosen technology-feedstock combinations the current TRLs are explained and existing demonstration facilities are listed.

For the structure of the Tech State Navigator we decided to have a definition of TRLs at first, followed by flowsheets of the two BioTheRoS value chains with the respective process steps and at the end an interactive tool for the user, where a combination of feedstock and technology can be chosen and the respective TRL as well as existing demonstrations are listed. This structure can be seen in the following figure. (Figure 2)

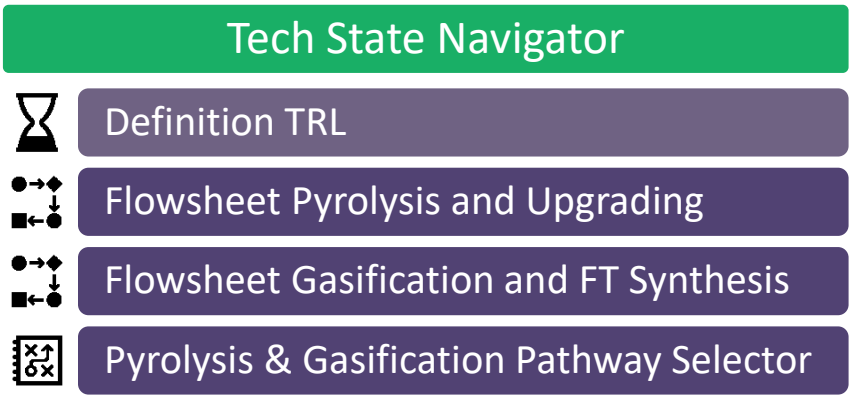

Figure 2: Structure of Tech State Navigator

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TRL of BioTheRoS pathways and process steps

The Technology Readiness Level (TRL) of research facilities plays a crucial role in assessing the maturity of technological developments. However, the TRL of a value chain is not determined solely by individual process steps but is also influenced by the type of feedstock used. Different feedstocks can introduce variability in process efficiency, scalability, and overall system performance, affecting the readiness and applicability of a given technology. Therefore, evaluating TRL requires a holistic approach that considers both technological advancements and feedstock compatibility within the value chain.

For the BioTheRoS project we used following definitions of TRL listed and given as figure (Figure 3):

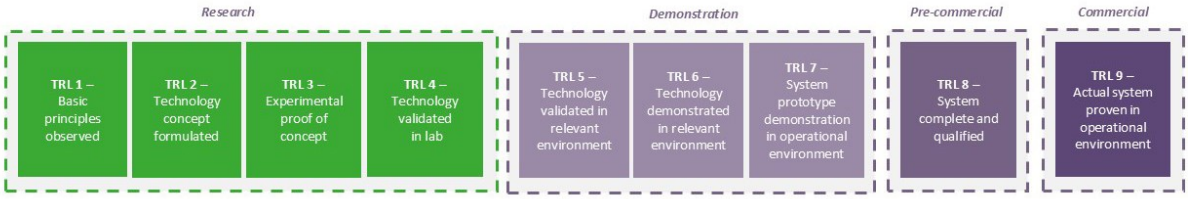

Figure 3: TRL definitions in the BioTheRoS project

TRL 1: Basic principles observed: The basic scientific principles are understood, but no practical application has been identified yet.

TRL 2: Technology concept formulated: The application of the technology has been identified, and basic principles are translated into feasible technology concepts.

TRL 3: Experimental proof of concept: Active R&D is underway to prove the feasibility of the technology in a lab environment.

TRL 4: Technology validated in lab: Components or subsystems are integrated and tested in a laboratory setting to validate functionality.

TRL 5: Technology validated in relevant environment: The technology is tested in a simulated or real-world environment to demonstrate its viability.

TRL 6: Technology demonstrated in relevant environment: A prototype or model is demonstrated in a relevant environment (e.g., field testing).

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TRL 7: System prototype demonstration in an operational environment: The technology has been tested and demonstrated in an operational setting to show it works in real-world conditions.

TRL 8: System complete and qualified: The technology is fully developed, and all components are tested and validated for actual use.

TRL 9: Actual system proven in operational environment: The technology is fully operational and used in real-world, operational settings.

Each level reflects a step in the process of moving from initial concept to full-scale implementation. TRL 1-4 are on a research level, TRL 5-7 is in demonstration level, TRL 8 is pre-commercial and TRL 9 reflects commercial applications.

The BioTheRoS project is centered on two thermochemical pathways for advanced biofuel production: pyrolysis and gasification. Although these technologies have differences, they share core steps—converting biomass through the respective thermochemical technology followed by various upgrading processes to produce advanced biofuels. The Technology Readiness Levels (TRLs) vary across these individual process steps, and when combined with the choice of feedstock, they ultimately determine the overall TRL of the process. The TRLs of the process steps and the overall TRL are shown in the following flowsheets (Figure 4):

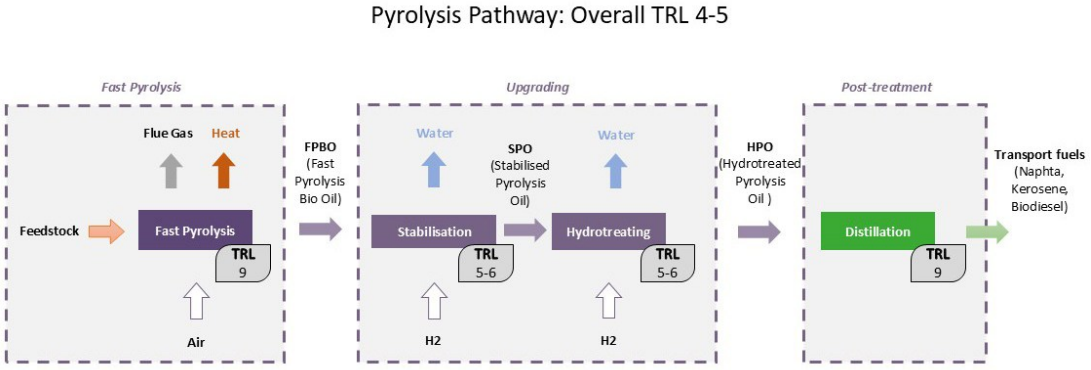

Figure 4: Flowsheet of the BioTheRoS pyrolysis pathway with an overall TRL 4-5

With **pyrolysis**, sustainable transport fuels can be produced from lignocellulosic biomass feedstock. The first step of the process – pyrolysis – is relatively simple and it is proven technology. The biomass is heated up rapidly in absence of oxygen and the resulting vapors are condensed to yield Fast Pyrolysis Bio Oil (FPBO). This is a liquid, which is easier to handle, store and utilize than regular solid biomass. To upgrade this FPBO to transport fuels, it is first stabilized in a high-pressure, catalytic process, using a proprietary catalyst (the

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Picula catalyst). After that, the stabilized pyrolysis oil is hydrotreated – using hydrogen - to yield a mix of transportation fuels. This mix can be separated into bio-naphta, SAF (Sustainable Aviation Fuel) and BioDiesel. (Figure 5)

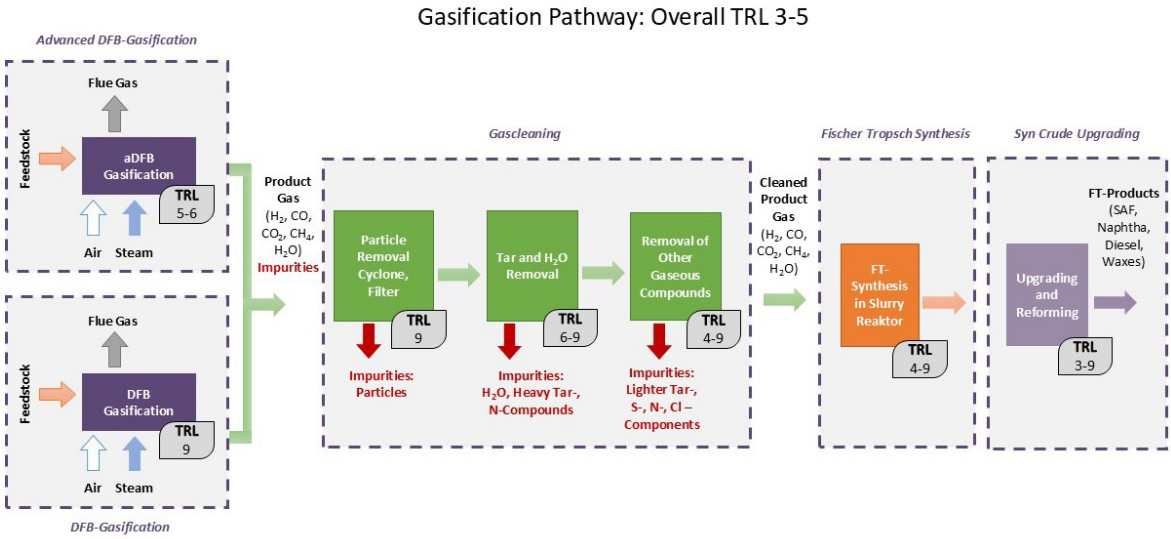

Figure 5: Flowsheet of the BioTheRoS gasification pathway with an overall TRL 3-5

Dual fluidized bed steam **gasification** is an already commercially used thermochemical technology which produces a highly valuable product gas from woody biomass. The advanced version of this gasifier should be able to handle a wider variety of residual feedstocks and has been erected at a 1 MW demonstration scale in 2022 at the Syngas Platform Vienna. For the downstream Fischer-Tropsch Synthesis application, an application dependent amount of gas cleaning has to be done, which reduces impurities like particles, tar components, as well as S-, N-, Cl- and other harmful components to a certain level to prevent unwanted reactions or catalyst poisoning. The FT Synthesis takes place in a slurry reactor, which is at a TRL 9 for big scales (>several 100 MW up to GW Scale), and now under development for small to medium scale Syngas application. After separation of the FT product biocrude, upgrading and reforming steps are performed to obtain the final products SAF, Naphtha, Diesel and Waxes.

Pyrolysis and Gasification Pathway Selector

The pyrolysis and gasification pathway selector is an interactive tool where the user can explore feedstock-technology combinations and view the TRL of the value chain along with explanations and existing

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demonstrations. The feedstock-technology combinations are relating to the value chains explored in the BioTheRoS project. (Figure 6)

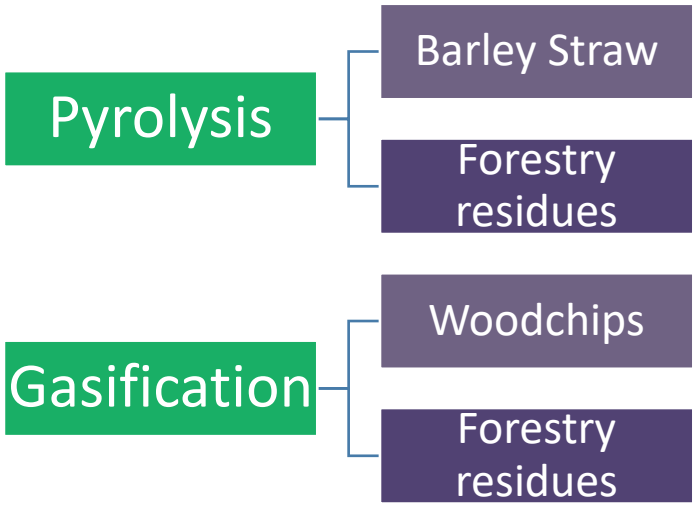

Figure 6: Technology-Feedstock combinations in the pyrolysis and gasification pathway selector

After selection of the technology (pyrolysis or gasification) the feedstock can be chosen and a list of results appears with a description of the value chain, a list of products for advanced biofuels, the TRL of the value chain and a list of plants that implement the technology. A template of the result tables for the feedstock-technology combinations is given in the following tables (Table 1):

Table 1: Result table for feedstock-technology combination

Feedstock	Technology	Product	TRL	Description
…	…	…	…	…

Organisation	Country	Technology	Feedstock
…	…	…	…

Descriptions and TRLs of the value chains based on pyrolysis were elaborated by BTG, while BEST elaborated the entries for the value chains based on gasification. The lists of plants implementing pyrolysis and gasification were compiled after conducting a literature research. The main sources of information for pyrolysis plants were the “Pyrowiki Commercial Plants” webpage [1] and the IEA Bioenergy Task 34 Fast Pyrolysis Demoplant Database [2]. Information about the gasification plants was mainly found in the IEA Bioenergy Task 33 webpage [3], in the IEA Bioenergy Task 39 Database [4] and in a presentation of IEA

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Bioenergy Task 33 [5]. Websites of individual plant owners were also checked for further details about the plants, such as the used feedstocks.

The entries in the database and the results of all feedstock-technology combinations are listed in the Annex.

Presentation and integration on the project website

The Tech State Navigator can be accessed via the BioTheRoS main page and the drop-down menu or via the subpage of the knowledge hub (see **Figure 7**). The Knowledge Hub (https://www.biotheros.eu/en/knowledge-hub/knowledge-hub/) is integrated as a section on the BioTheRoS website the individual databases can be accessed.

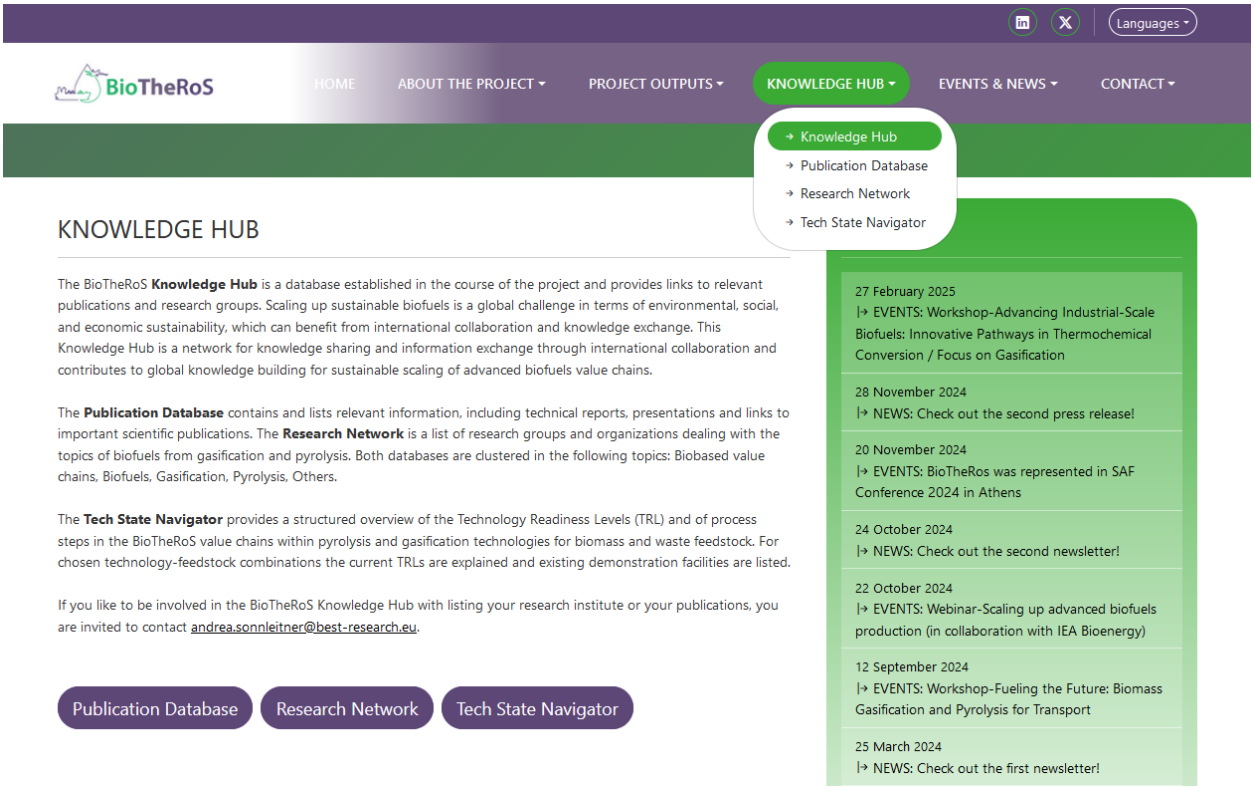

Figure 7: Screenshot Knowledge Hub Subpage

The subpage Tech State Navigator (https://www.biotheros.eu/en/knowledge-hub/tech-state-navigator/) contains definition of TRLs and an overview of the TRLs of process steps in the BioTheRoS value chains. Those are given in two flowsheets, one on the pyrolysis pathway and one on the gasification pathway. At

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the bottom of the subpage is a link to the Pyrolysis & Gasification Pathway Selector, which is located on an additional subpage. (Figure 8, Figure 9, Figure 10)

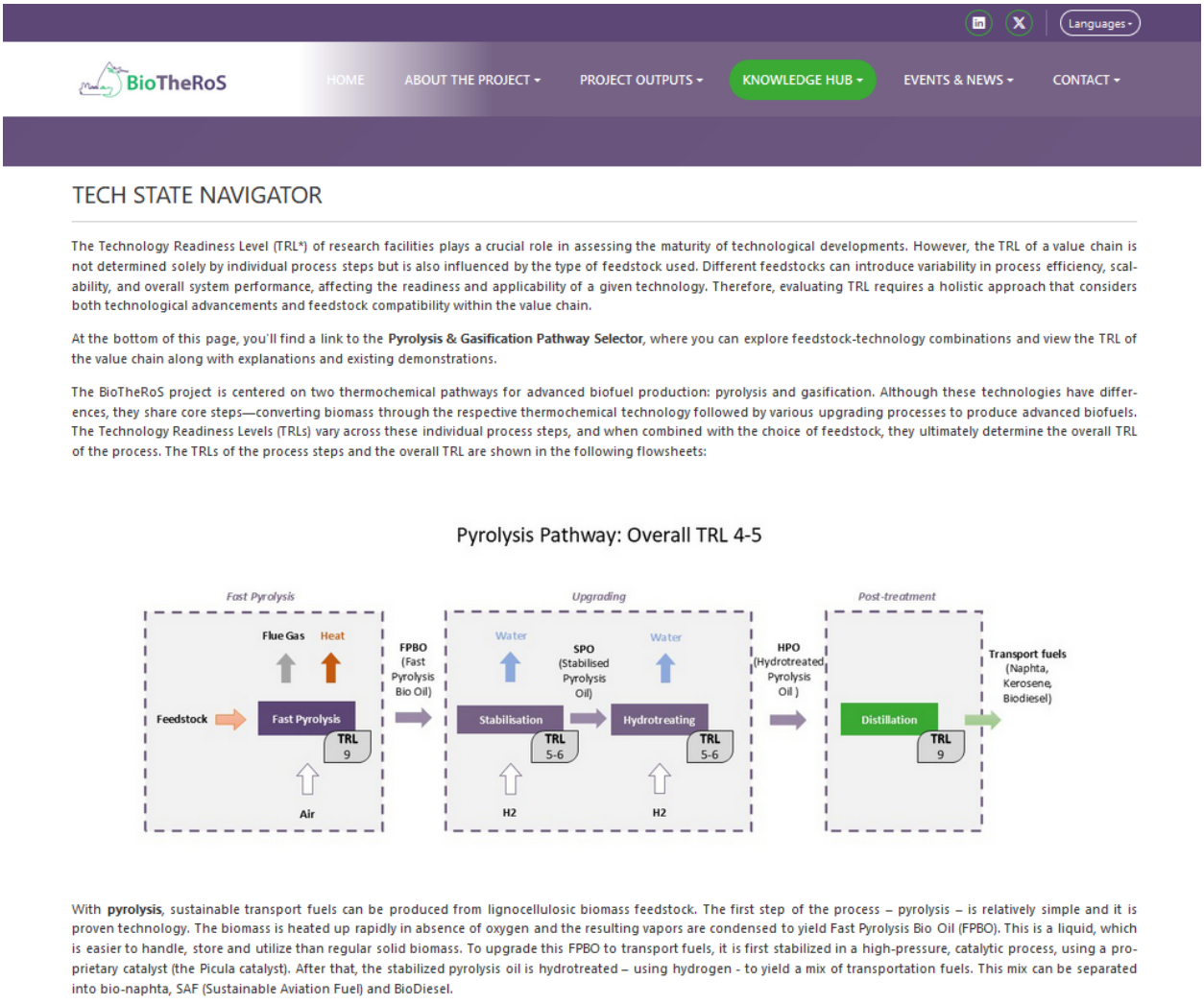

Figure 8: Screenshot Tech State Navigator Subpage Part 1

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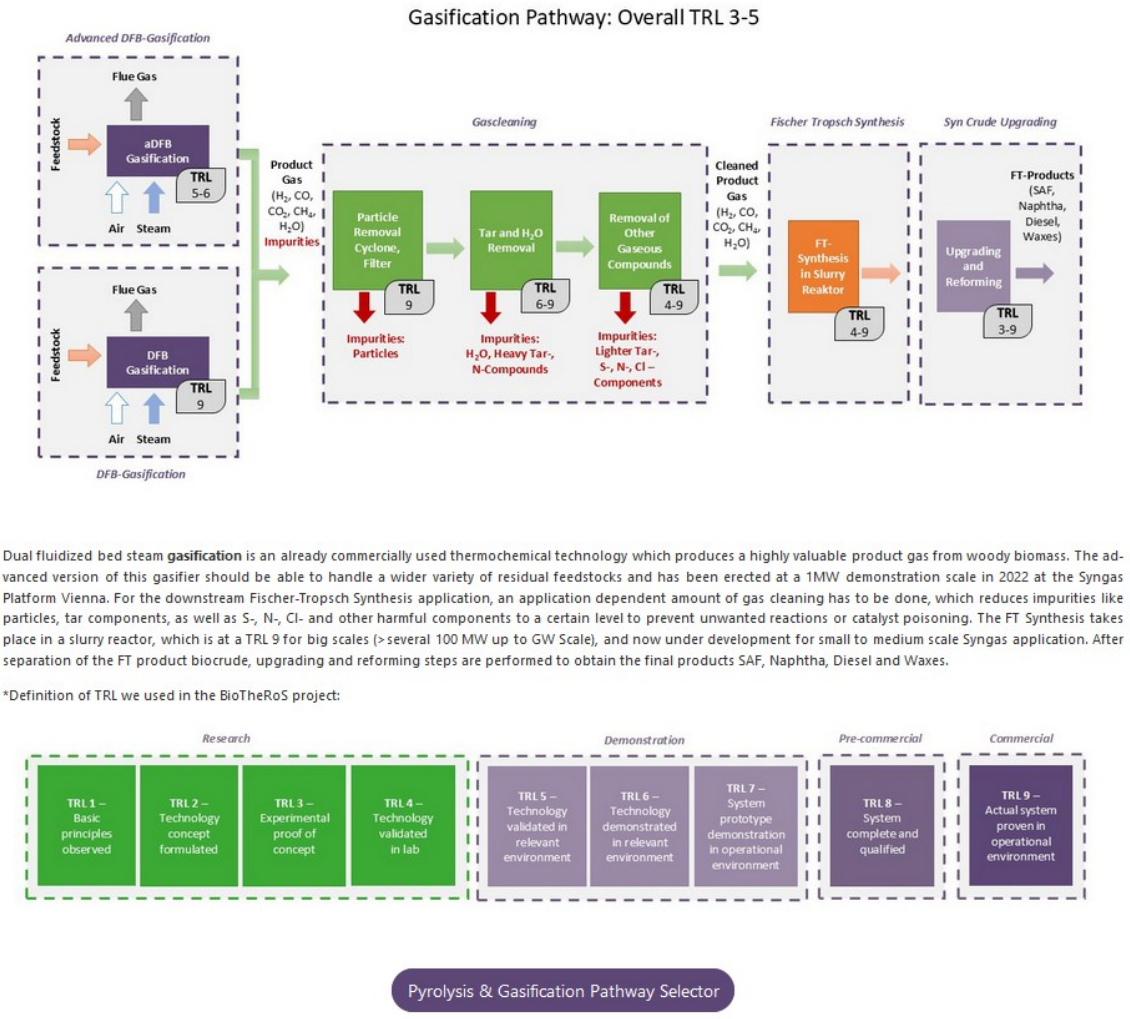

Figure 9: Screenshot Tech State Navigator Subpage Part 2

The pyrolysis and gasification pathway selector (https://www.biotheros.eu/en/knowledge-hub/pathway-selector/) is an interactive subpage where the TRLs with explanations and existing demonstrations are given for dedicated feedstock-technology combinations.

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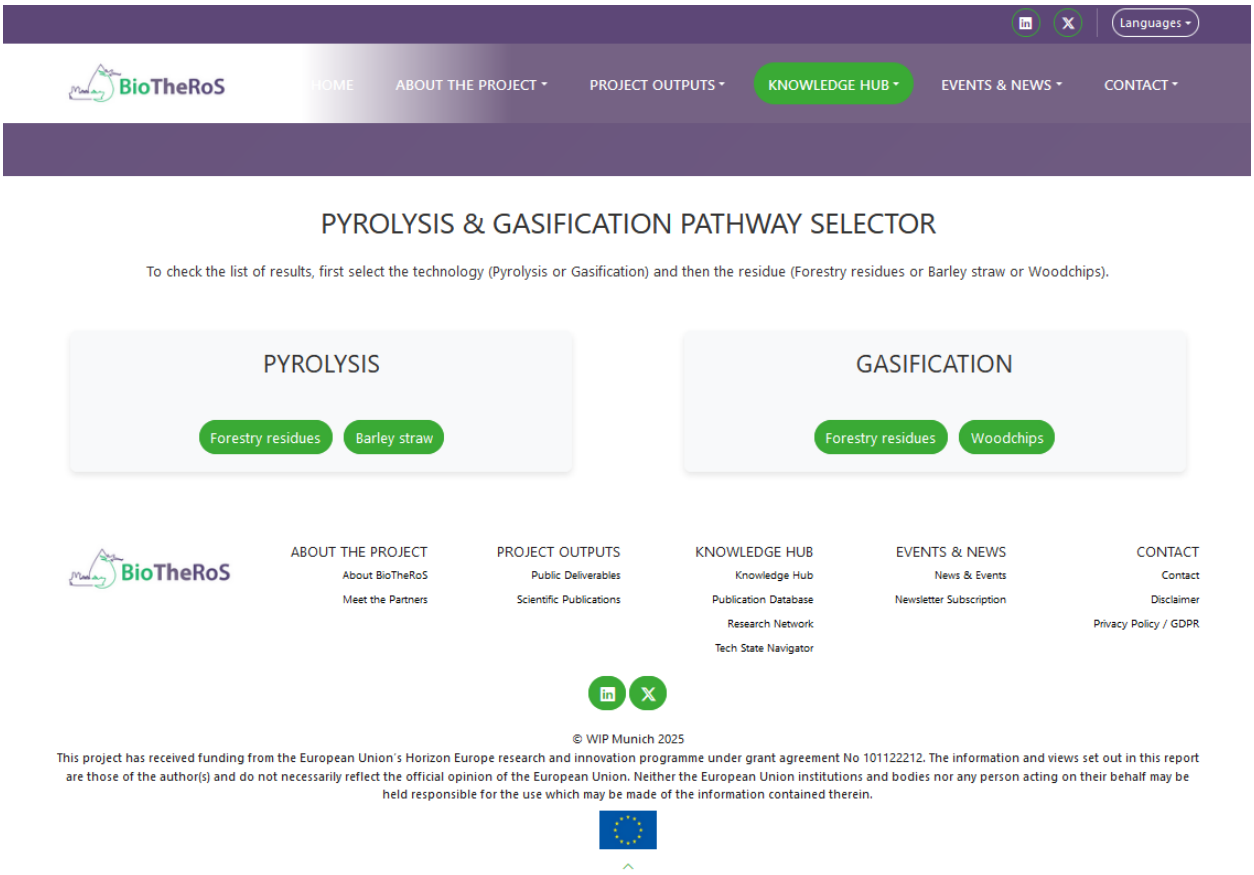

Figure 10: Screenshot Pyrolysis & Gasification Pathway Selector

After selecting the technology and the feedstock a result table with information appears as pop-up. As example the results of the feedstock-technology combination pyrolysis and forestry residue is given in the following screenshot (Figure 11):

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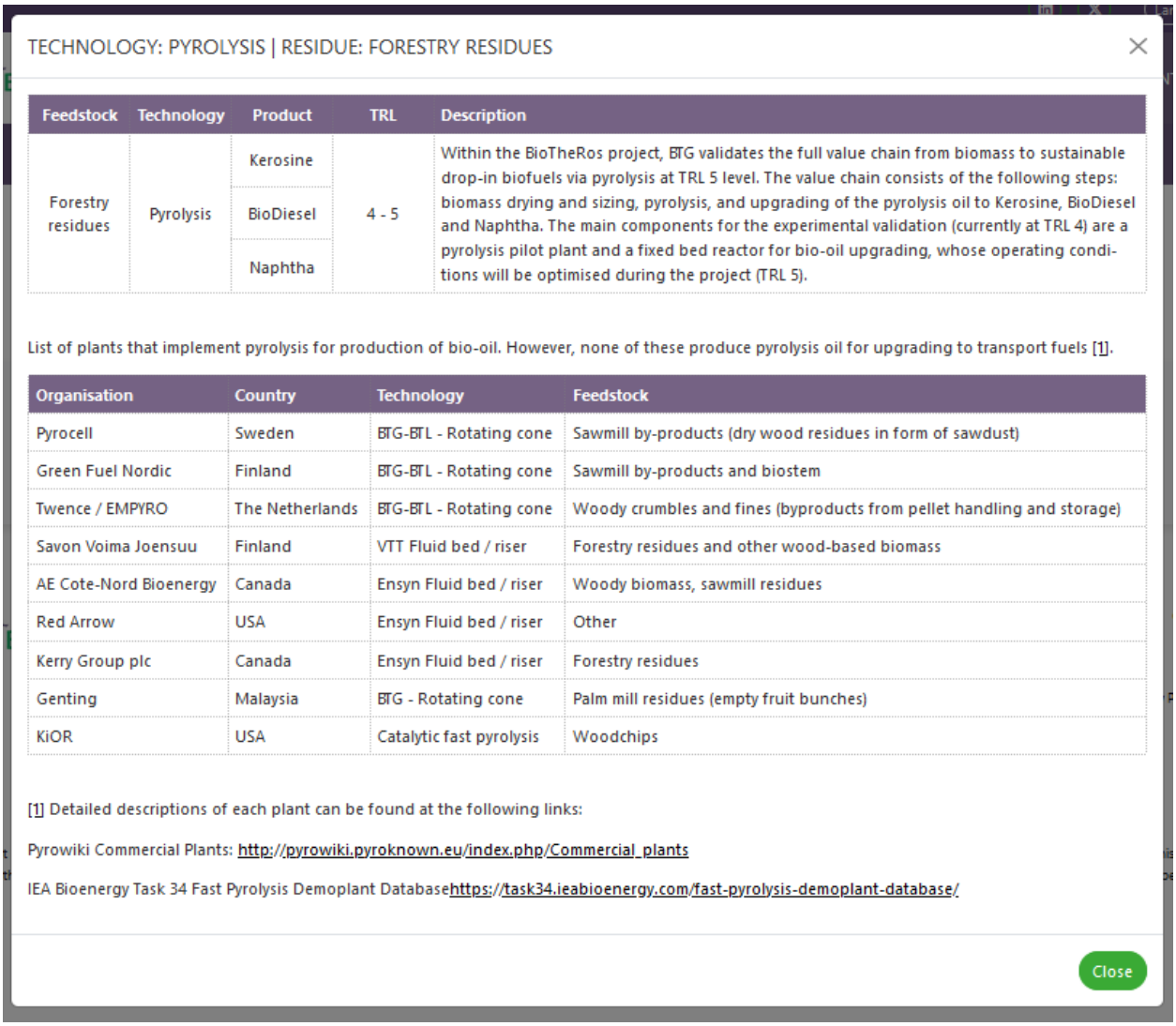

TECHNOLOGY: PYROLYSIS | RESIDUE: FORESTRY RESIDUES

Feedstock	Technology	Product	TRL	Description
Forestry residues	Pyrolysis	Kerosine	4 - 5	Within the BioTheRos project, BTG validates the full value chain from biomass to sustainable drop-in biofuels via pyrolysis at TRL 5 level. The value chain consists of the following steps: biomass drying and sizing, pyrolysis, and upgrading of the pyrolysis oil to Kerosine, BioDiesel and Naphtha. The main components for the experimental validation (currently at TRL 4) are a pyrolysis pilot plant and a fixed bed reactor for bio-oil upgrading, whose operating conditions will be optimised during the project (TRL 5).
		BioDiesel		
		Naphtha		

List of plants that implement pyrolysis for production of bio-oil. However, none of these produce pyrolysis oil for upgrading to transport fuels [1].

Organisation	Country	Technology	Feedstock
Pyrocell	Sweden	BTG-BTL - Rotating cone	Sawmill by-products (dry wood residues in form of sawdust)
Green Fuel Nordic	Finland	BTG-BTL - Rotating cone	Sawmill by-products and biostem
Twence / EMPYRO	The Netherlands	BTG-BTL - Rotating cone	Woody crumbles and fines (byproducts from pellet handling and storage)
Savon Voima Joensuu	Finland	VTT Fluid bed / riser	Forestry residues and other wood-based biomass
AE Cote-Nord Bioenergy	Canada	Ensyn Fluid bed / riser	Woody biomass, sawmill residues
Red Arrow	USA	Ensyn Fluid bed / riser	Other
Kerry Group plc	Canada	Ensyn Fluid bed / riser	Forestry residues
Genting	Malaysia	BTG - Rotating cone	Palm mill residues (empty fruit bunches)
KiOR	USA	Catalytic fast pyrolysis	Woodchips

[1] Detailed descriptions of each plant can be found at the following links:

Pyrowiki Commercial Plants: http://pyrowiki.pyroknown.eu/index.php/Commercial_plants

IEA Bioenergy Task 34 Fast Pyrolysis Demoplant Databasehttps://task34.ieabioenergy.com/fast-pyrolysis-demoplant-database/

Close

Figure 11: Screenshot of exemplary result table of pyrolysis and gasification pathway selector

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References

[1] Pyrowiki Commercial Plants, URL: http://pyrowiki.pyroknown.eu/index.php/Commercial_plants [14/03/2025]

[2] IEA Bioenergy Task 34 Fast Pyrolysis Demoplant Database, URL: https://task34.ieabioenergy.com/fast-pyrolysis-demoplant-database/ [17/03/2025]

[3] IEA Bioenergy Task 33: Status report on gasification of biomass and waste – Research special; Annex 3 and Annex 4, URL: https://task33.ieabioenergy.com/projects/ [17/03/2025]

[4] IEA Bioenergy Task 39 Database on facilities for the production of advanced liquid and gaseous biofuels for transport, URL: https://demoplants.best-research.eu/ [14/03/2025]

[5] Jitka Hrbek, International Trends in Gasification - IEA Bioenergy Task 33, BioTheRoS Technical Expert Workshop Advancing Industrial-Scale Biofuels: Innovative Pathways in Thermochemical Conversion, 12.03.2025, Vienna, URL: https://www.biotheros.eu/en/events-news/news-events/news-events-workshop-advancing-industrial-scale-biofuels-innovative-pathways-in-thermochemical-conversion-focus-on-gasification/5.-International-trends-in-gasification.pdf [27/03/2025]

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Annex

The tables listed in the annex show the results of the different possible feedstock-technology combinations in the BioTheRoS pyrolysis and gasification pathway selector.

Technology: Pyrolysis | Feedstock: Forestry Residue

Table 2: Results of combination Technology: Pyrolysis, Residue: Forestry Residue

Feedstock	Technology	Product	TRL	Description
Forestry residues	Pyrolysis	Kerosine	4 - 5	Within the BioTheRos project, BTG validates the full value chain from biomass to sustainable drop-in biofuels via pyrolysis at TRL 5 level. The value chain consists of the following steps: biomass drying and sizing, pyrolysis, and upgrading of the pyrolysis oil to Kerosine, BioDiesel and Naphtha. The main components for the experimental validation (currently at TRL 4) are a pyrolysis pilot plant and a fixed bed reactor for bio-oil upgrading, whose operating conditions will be optimised during the project (TRL 5).
		BioDiesel		
		Naphtha		

List of plants that implement pyrolysis for production of bio-oil. However, none of these produce pyrolysis oil for upgrading to transport fuels [1, 2].

Table 3: Existing demonstrations with pyrolysis technology

Organisation	Country	Technology	Feedstock
Pyrocell	Sweden	BTG-BTL - Rotating cone	Sawmill by-products (dry wood residues in form of sawdust)

Green Fuel Nordic	Finland	BTG-BTL - Rotating cone	Sawmill by-products and biostem
Twence / EMPYRO	The Netherlands	BTG-BTL - Rotating cone	Woody crumbles and fines (byproducts from pellet handling and storage)
Savon Voima Joensuu	Finland	VTT Fluid bed / riser	Forestry residues and other wood-based biomass
AE Cote-Nord Bioenergy	Canada	Ensyn Fluid bed / riser	Woody biomass, sawmill residues
Red Arrow	USA	Ensyn Fluid bed / riser	Other
Kerry Group plc	Canada	Ensyn Fluid bed / riser	Forestry residues
Genting	Malaysia	BTG - Rotating cone	Palm mill residues (empty fruit bunches)
KiOR	USA	Catalytic fast pyrolysis	Woodchips

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Technology: Pyrolysis | Feedstock: Barley straw

Table 4: Results of combination Technology: Pyrolysis, Residue: Barley Straw

Feedstock	Technology	Product	TRL	Description
Barley straw	Pyrolysis	Kerosine	4 - 5	Within the BioTheRos project, BTG validates the full value chain from biomass to sustainable drop-in biofuels via pyrolysis at TRL 5 level. The value chain consists of the following steps: biomass sizing, washing to remove minerals and drying, pyrolysis, and upgrading of the pyrolysis oil to Kerosine, BioDiesel and Naphtha. The washing step is necessary to remove impurities from the biomass prior to pyrolysis and upgrading. Especially this last step, and its implications for transport fuel quality are being investigated.
		BioDiesel		
		Naphtha		

List of plants that implement pyrolysis for production of bio-oil. However, none of these produce pyrolysis oil for upgrading to transport fuels [1, 2].

Table 5: Existing demonstrations with pyrolysis technology

Organisation	Country	Technology	Feedstock
Pyrocell	Sweden	BTG-BTL - Rotating cone	Sawmill by-products (dry wood residues in form of sawdust)
Green Fuel Nordic	Finland	BTG-BTL - Rotating cone	Sawmill by-products and biostem

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Twence / EMPYRO	Netherlands	BTG-BTL - Rotating cone	Woody crumbles and fines (byproducts from pellet handling and storage)
Savon Voima Joensuu	Finland	VTT Fluid bed / riser	Forestry residues and other wood-based biomass
AE Cote-Nord Bioenergy	Canada	Ensyn Fluid bed / riser	Woody biomass, sawmill residues
Red Arrow	USA	Ensyn Fluid bed / riser	Other
Kerry Group plc	Canada	Ensyn Fluid bed / riser	Forestry residues
Genting	Malaysia	BTG - Rotating cone	Palm mill residues (empty fruit bunches)
KiOR	USA	Catalytic fast pyrolysis	Woodchips

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Technology: Gasification | Feedstock: Forestry residues

Table 6: Results of combination Technology: Gasification, Residue: Forestry residues

Residue	Technology	Product	TRL	Description
Forestry residues	Gasification +FT	FT-Diesel	TRL 3-5	Within the BioTheRos project, BEST validates the full value chain from forestry residues to Fischer-Tropsch (FT) raw products at overall TRL 3-5 level. Gasification tests are carried out in a 1 MW advanced Dual Fluidized Bed Steam Gasifier (TRL 5-6) and in a downstream 250 kW Slurry FT Reactor (TRL 4-5) at the Syngas Platform in Vienna. The focus of technical developments is the (fine) gas cleaning section. Commercially available processes are highly resource-intensive, prompting the exploration of alternative options, such as temperature swing adsorption for sulfur and BTX removal (TRL 4-9). The produced FT-crude is characterized for its usage as advanced biofuel (FT-Diesel, FT-SAF, FT-Naphtha). For the FT waxes upgrading BEST and CERTH target the advancement from TRL 3 to TRL 5. Tests of optimal operating conditions in a small-scale hydrotreatment plant (TRL 3) are followed by upscaling and validation in a pilot-scale plant (TRL 5).
Forestry residues	Gasification +FT	FT-SAF		
Forestry residues	Gasification +FT	FT-Naphtha		
Forestry residues	Gasification +FT	FT-Waxes		

List of plants (operational and non-operational) that implement gasification for advanced biofuel production [3, 4]:

Table 7: Existing demonstrations with gasification technology

Organisation	Country	Technology	Feedstock

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BioTfueL TOTAL	France	Torrefaction + gasification in Entrained flow reactor	Lignocellulosic biomass (straw, forest waste, dedicated energy crops)
bioliq® of Karlsruhe Institute of Technology	Germany	High pressure entrained flow gasifier	Agriculture residues (Cereal Straw), forestry residues
Velocys bayou fuels	USA	Gasifier + own Fischer-Tropsch reactor	Forestry residues
Advanced Bioenergy Lab ABL Zeltweg	Austria	Dual Fluidised Bed gasifier + FT upgrading	Biomass residues
FULCRUM Bioenergy - Sierra	USA	TRI Indirectly heated gasifier (heat pipes)	Organic landfill waste
GoBiGas	Sweden	FICB bed gasifier, provided by Repotec/Valmet	Wood pellets, wood chips, bark
Biorefinery Ostrand	Sweden	Entrained flow gasification combined with torrefaction	Sawdust, bark
DG Fuels - Lousiana	USA	Technology provided by Nextchem	Sugar cane residues

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Technology: Gasification | Feedstock: Woodchips

Table 8: Results of combination Technology: Gasification, Residue: Woodchips

Residue	Technology	Product	TRL	Description
Woodchips	Gasification +FT	FT-Diesel	TRL 3-6	Within the BioTheRos project, BEST validates the full value chain from woodchips to Fischer-Tropsch (FT) raw products at overall TRL 3-6 level. At the Syngas Platform plant in Vienna, demonstration of the woodchips gasification process is carried out in a 1 MW advanced Dual Fluidized Bed Steam Gasifier (TRL 6), followed by a downstream step in a 250 kW Slurry FT Reactor (TRL 4-5). The focus of technical developments is the (fine) gas cleaning section. Commercially available processes are highly resource-intensive, prompting the exploration of alternative options, such as temperature swing adsorption for sulfur and BTX removal (TRL 4-9). The produced FT-crude is characterized for its usage as advanced biofuel (FT-Diesel, FT-SAF, FT-Naphtha). For the FT waxes upgrading BEST and CERTH target the advancement from TRL 3 to TRL 5. Tests of optimal operating conditions in a small-scale hydrotreatment plant (TRL 3) are followed by upscaling and validation in a pilot-scale plant (TRL 5). Thanks to prior experiences with the testing of woodchips gasification at the Syngas Platform plant, woodchips can be used as a reference for comparing results obtained with others feedstocks.
Woodchips	Gasification +FT	FT-SAF		
Woodchips	Gasification +FT	FT-Naphtha		
Woodchips	Gasification +FT	FT-Waxes		

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List of plants (operational and non-operational) that implement gasification for biofuel production [3, 4, 5]:

Table 9: Existing demonstrations with gasification technology

Organisation	Country	Technology	Feedstock
BioTfueL TOTAL	France	Torrefaction + gasification in Entrained flow reactor	Lignocellulosic biomass (straw, forest waste, dedicated energy crops)
bioliq® of Karlsruhe Institute of Technology	Germany	High pressure entrained flow gasifier	Agriculture residues (CerealStraw), forestry residues
Velocys bayou fuels	USA	Gasifier + own Fischer-Tropsch reactor	Forestry residues
Advanced Bioenergy Lab ABL Zeltweg	Austria	Dual Fluidised Bed gasifier + FT upgrading	Biomass residues
FULCRUM Bioenergy - Sierra	USA	TRI Indirectly heated gasifier (heat pipes)	Organic landfill waste
GoBiGas	Sweden	FICB bed gasifier, provided by Repotec/Valmet	Wood pellets, wood chips, bark
Biorefinery Ostrand	Sweden	Entrained flow gasification combined with torrefaction	Sawdust, bark
DG Fuels - Lousiana	USA	Technology provided by Nextchem	Sugar cane residues

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