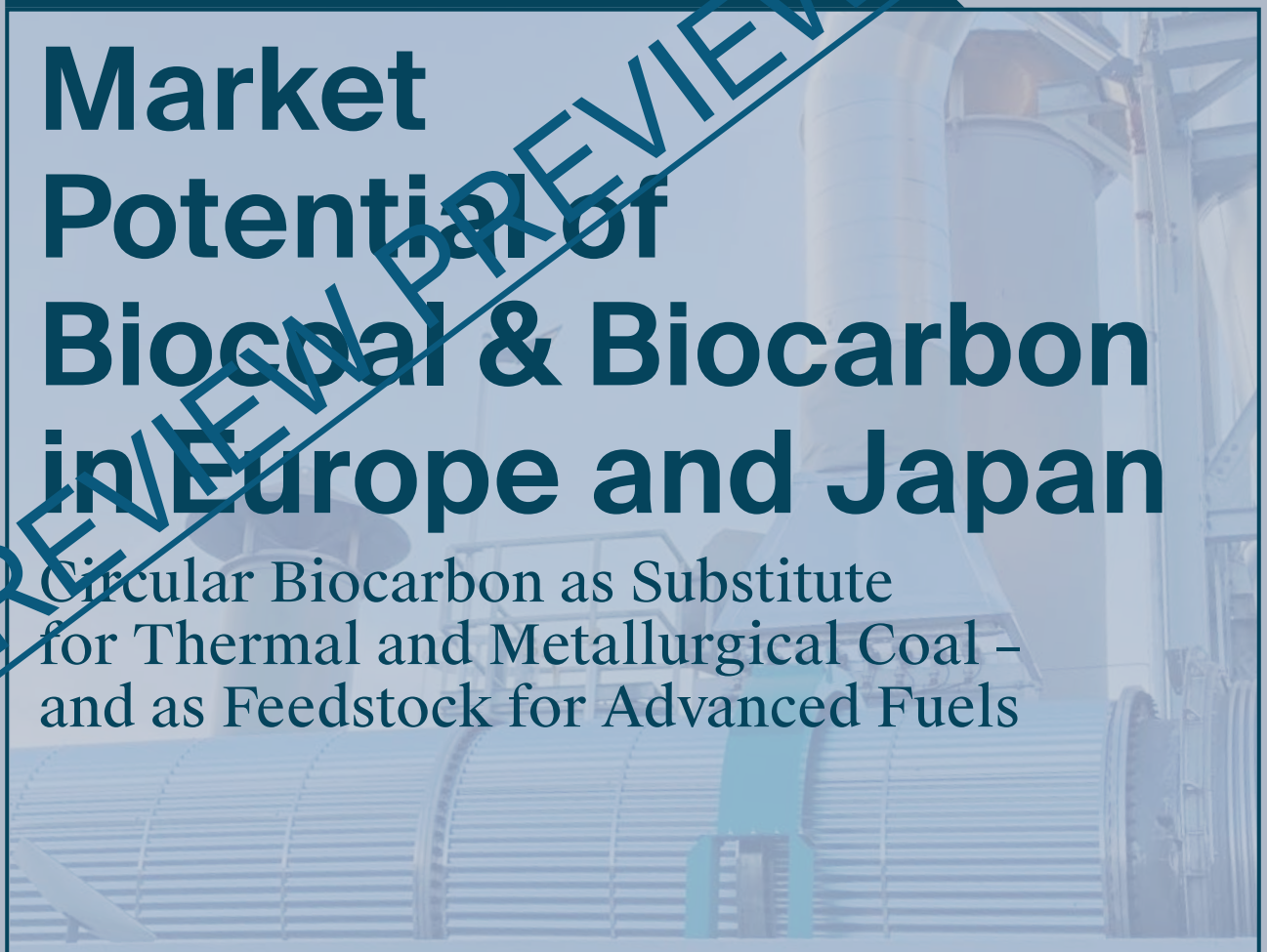
IBTC International Biomass Torrefaction and Carbonisation Council

09/2026

01 Circular Biocarbon Focus Report

Market Potential of Biocoal & Biocarbon in Europe and Japan

Circular Biocarbon as Substitute for Thermal and Metallurgical Coal – and as Feedstock for Advanced Fuels



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Publisher: IBTC – International Biomass Torrefaction and Carbonisation Council

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Imprint

Publisher: International Biomass Torrefaction and Carbonisation Council (IBTC), Vienna, Austria.

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Series: Circular Biocarbon Focus Reports

Suggested citation: Schulten, M.; Sieverts, T.; Wild, M. (2026): IBTC Market Potential Report – Biocoal & Biocarbon in Europe and Japan. Circular Biocarbon Workbook Series #1; IBTC, Vienna, September 2026.

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PREVIEW PREVIEW PREVIEW

Foreword

When in 2012 the IBTC was founded, torrefaction was a promising idea in search of an industry. Today, Circular Biocarbon is an industrial reality in search of scale. Plants supply utilities across multiple continents, steelmakers write biocarbon into their procurement specifications, agricultural residues are entering the feedstock base at commercial scale, and technology licensors embed torrefaction into the front end of advanced fuel platforms. The question is no longer whether biogenic carbon will substitute fossil carbon, but how fast, to what extent - and under which conditions.

We have written this report to answer that question with discipline. It deliberately separates theoretical volumetric ceilings from addressable markets, and both from what can realistically be deployed by 2030. It names the barriers - cost, supply build-out, standardisation, certification, and project execution - as clearly as it names the opportunities. That candour is, in our view, the most valuable service the IBTC can render to its members and to the wider market.

The report's central finding deserves to be stated plainly: demand is documented but not yet contracted. Utilities, steelmakers, ferroalloy producers and fuel developers have published specifications, targets and - in individual cases - made capital commitments. What is still largely missing on the demand side is, first, clarity on which fungible product grades in the higher-carbonisation range are required and can be produced at scale, and second, offtake structures that allow producers to finance capacity. What is missing on the supply side is operating proof at scale - more large projects, substantially more installed capacity, and reference plants running reliably at around 7,500 hours per year. Neither side can move alone. Based on our market analysis, we have concluded that the following conditions must be met to accelerate further growth: agreed product specifications (ideally as ISO standards), contract structures that investors and banks can accept, and reliably operating reference plants. Alongside that, the pre-competitive foundations must be laid - harmonised terminology, standardised product grades, and logistics chains fit for solid biogenic carbon. This is precisely the work the IBTC has taken on, every day and together with its members, because no single company can build a commodity market alone.

Our thanks go to the many member companies and conference speakers whose openly shared data and experience form the evidence base of this report. We invite every reader who recognises their own challenges in these pages to join this work: the potential documented here will become a market through shared effort, and there are vacant seats at the table.

PREVIEW PREVIEW PREVIEW

Table of Contents

Foreword 3
Executive Summary 6
1. Methodology and Scope 8
2. Introduction and Strategic Context 8
3. Market Volumes and Structural Demand Trends (2025–2030) 9
3.1 The Thermal Coal Market 9
3.2 The Metallurgical Coal Market 9
3.3 Ferroalloys, Silicon Metal, and Non-Ferrous Metallurgy 10
4. CO_2 Substitution Methodology and Indicative Reduction Potential 11
4.1 Methodological Approach and Stated Assumptions 11
4.2 Indicative Substitution Potential 11
4.3 Contextualisation Against Regional Net-Zero Commitments 12
5. Supply Resilience and Import Dependency: A Supporting Consideration 13
5.1 European Import Dependency on Fossil Coal 13
5.2 The Primary Case: Decarbonisation, Technical Fit, and Long-Term Economics 14
6. Commercial and Advanced-Stage Use Cases: Torrefied Biomass in Power Generation 15
6.1 Arbaflame / ArbaCore - Very Long Commercial Track Record in Biocoal 15
6.2 Idemitsu Green Energy Pellet (Vietnam to Japan) 16
6.3 Rainbow Pellet / ANDRITZ - Asia's First Commercial Steam-Explosion Plant Based on Agricultural Residues (Malaysia) 17
6.4 Belledune Generating Station (Canada) 19
6.5 Huntly Power Station (New Zealand) 19
6.6 The LEAG Schwarze Pumpe Project (Germany) 19
7. Technical Requirements, Industry Demand, and Market Constraints 20
7.1 Biocarbon in EAF Steelmaking: The GMH Gruppe Case 20
7.2 Product Standards: A Necessity and Work in Progress 21
7.3 Safety in Handling and Storage 22
7.4 Submerged-Arc-Furnace Reduction: Silicon and Ferroalloys 23
7.5 Biogenic Carbon for Silicon Production: The Wacker / Aymium Case 23
7.6 Tata Steel: Product Specifications and Transition Blueprint 24
7.7 Japan: Technical Evaluation Present, Commercial Deployment Less Visible 25
8. Sustainable Aviation Fuel and Bio-Methanol: Market Demand and the Role of Torrefied Biomass 26
8.1 SAF Policy Mandates and Volume Targets 26
8.2 The HEFA/UCO Pathway: Dominance Today, Structural Constraints Ahead 26
8.3 Fischer-Tropsch SAF via Biomass Gasification: Technology and Feedstock Logic 27
8.4 Bio-Methanol via Torrefied Biomass Gasification 31
9. Consolidated Demand Summary across Application Sectors 33
10. Non-ETS and Non-Carbon-Price-Driven Market Segments 34
10.1 Activated Carbon: Water, Air, and Industrial Purification 34

PREVIEW PREVIEW PREVIEW

10.2 Cosmetics and Personal Care: Activated Charcoal 34
11. Market Entry Roadmap and Strategic Priorities 35
12. Conclusion 37
References and Source Materials 39
Conference Presentations, Interviews, and Working Papers 39
Additional Data Sources 43

PREVIEW PREVIEW PREVIEW PREVIEW

Executive Summary

Circular Biocarbon is transitioning from demonstration-scale speciality product to the early stages of commercial commodity deployment. Torrefied biomass (biocoal) is a technically demonstrated drop-in capable substitute for thermal coal; carbonised biomass (biocarbon) can substitute selected fossil carbon carriers in metallurgical applications, including PCI coal, carbon carriers in EAF operations, and reductants in submerged-arc-furnace processes. Both address markets in Europe and Japan that are governed by binding emissions frameworks.

The theoretical ceiling is very large; realistic near-term adoption is a fraction of it. At 2025 consumption, full substitution of thermal coal in Europe and Japan alone would avoid roughly 986 Mt CO_2 per year - of comparable magnitude to the entire remaining 2030 emissions gap of both regions. IBTC estimates realistic near-term biocoal deployment at 10–30 Mt/a by 2030, broadly consistent with the scale of coal substitution implied by IEA transition trajectories, with metallurgical biocarbon adding roughly 0.5–1.5 Mt/a across EAF, BF-PCI, and submerged-arc-furnace applications.

Commercial proof points now exist across multiple continents and across the full value chain. Arbaflame (steam explosion, Norway/Canada), Idemitsu (torrefaction, Vietnam–Japan), Belledune, Huntly, and LEAG document utility-scale conversion. Rainbow Pellet and ANDRITZ have launched Asia's first commercial steam-explosion plant based on palm-oil residues (EFB), opening the agricultural-residue feedstock base. GMH Gruppe, Elkem, Outokumpu, ArcelorMittal, and Tata Steel document metallurgical demand with published specifications; Wacker's long-term supply contract with Ayfium for biogenic carbon at its Holla silicon plant is one of the few publicly documented offtake commitments in the sector. Shell/Yilkins, Elyse Energy, Alfanar, and Perpetual Next define torrefied biomass as gasification feedstock for SAF and biomethanol.

The binding constraints are cost, supply build-out, product qualification, process integration, and standardisation - and they sit on both sides of the market: demand is documented, but not yet contracted. Utilities, steelmakers, ferroalloy producers and fuel developers have published specifications, targets and, in individual cases, capital commitments; what is still largely missing is clarity on which fungible grades in the higher-carbonisation range are actually required and producible at scale, and offtake structures that allow producers to finance capacity - while the supply side still owes the market operating proof at scale. Biocarbon must remain internationally competitive against fossil benchmarks; rising CO_2 prices are an opportunity to close the gap, not a licence to price above it. Harmonised product standards are a necessity and work in progress: ISO/TC 238 is developing them, with first publications expected from 2027, and the IBTC contributes to this pre-competitive work (Section 7.2).

Non-ETS segments provide margin resilience. Activated carbon (PFAS remediation, air and water purification) and cosmetics-grade charcoal are growing independently of carbon prices and diversify producer portfolios.

PREVIEW PREVIEW PREVIEW

Terminology Used in This Report

Circular Biocarbon - IBTC umbrella term for biomass-derived carbon products across the full devolatilisation spectrum.

Biocoal / Torrefied Biomass - Mid-devolatilised, thermally upgraded biomass (200–350 °C). Drop-in capable substitute for thermal coal. Cfix ~25–50%; NCV ~19–23 MJ/kg. ISO 17225-8. Steam-exploded black pellets are likewise classified as biocoal.

Biocarbon - Highly carbonised biomass with low volatile matter (>450 °C). Substitute for selected fossil carbon carriers in metallurgical applications, including PCI coal and other process-specific carbon materials. Cfix 60–95%; NCV ~25–32 MJ/kg.

Pyrogenic Biocarbon - An umbrella term discussed in ISO/TC 238 for all thermally treated biomass regardless of the degree of devolatilisation [14].

Torrgas - The combustible syngas released during torrefaction, typically combusted in the afterburner to make the process autothermal.

TBP / TAP - Torrefaction before Pelletisation (TBP): a process where biomass is first coarsely ground if at all, torrefied, milled and at the end of the process densified to pellets. Torrefaction after Pelletisation (TAP): biomass is first ground and pelletised in a standard pelletisation procedure and the product is thereafter thermally treated [14].

EFB - Empty fruit bunches - the fibrous residue remaining after palm fruit extraction; an agricultural residue feedstock (for its treatment under the EUDR see Section 6.3).

The IBTC Biocarbon Terminology (Version 3) [1] provides the full sector reference and is available free of charge at www.ibtc-council.org.

PREVIEW PREVIEW PREVIEW