

Biochar: Capturing the Multi-Billion Dollar Activated Carbon Market Shift

Report

November 2025



Bio-Based Activated Carbon: Investment Thesis Snapshot

Massive Market Cap: The activated carbon market is projected to hit \$11 Billion by 2030, with a decisive and permanent shift toward bio-based feedstocks.

Domestic Demand Surge: Global supply chains are failing (disruptions, tariffs), creating strong, sustained demand for domestic, renewable AC protected from price volatility.

Triple-Digit Margins: Biochar conversion allows producers to capture premium segments, delivering a 3x to 10x revenue multiple over standard biochar.

Success Pillars: Key drivers are securing sustainable feedstock, ensuring high-capacity/quality-assured production, and meeting stringent PFAS regulatory standards.

Risk Mitigation: While CAPEX is high, operational flexibility and powerful ESG differentiation provide strong counterbalancing advantages against established global competitors.

9% CAGR
Total AC market
to 2030

4.3x

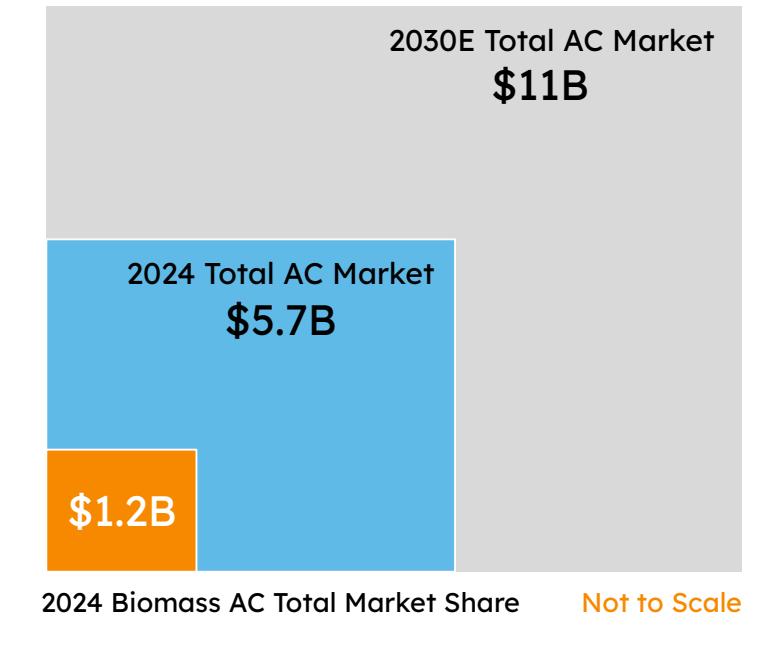
**Biomass & Other
AC market growth
factor by 2030**

46% MoM
Total Coconut shell
AC import value
growth into China
(Sep 2025)

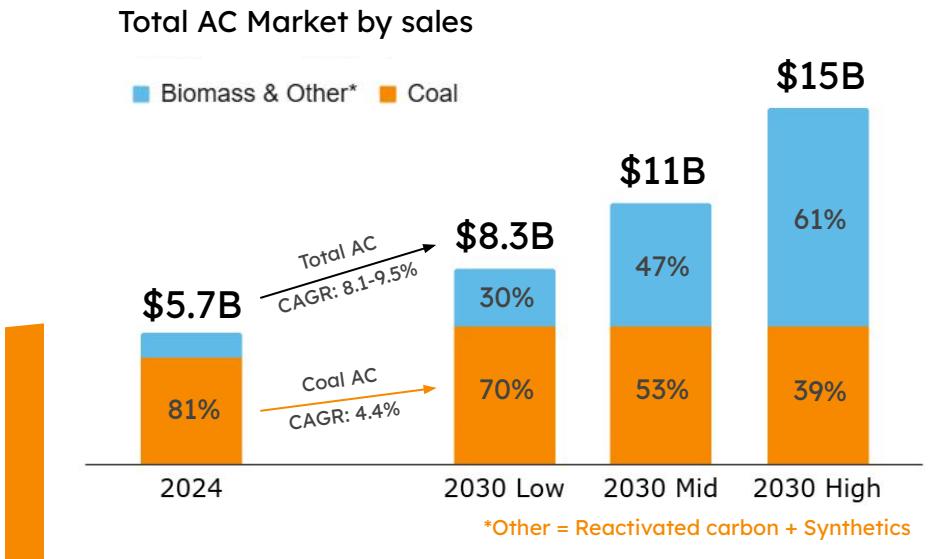
34% YoY
Total Coconut shell
AC import value
growth into USA
(Jul 2025)

Large, Expanding, and Changing Global Market

Activated Carbon market is large and expanding rapidly

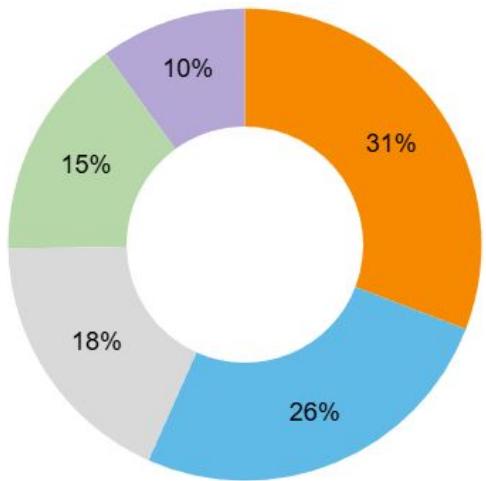


Biomass derived AC expected to be an increasing part of the AC market



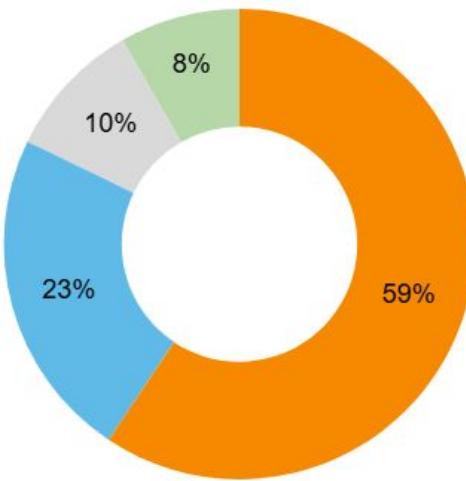
Activated Carbon Market Snapshot

Market Share by Application



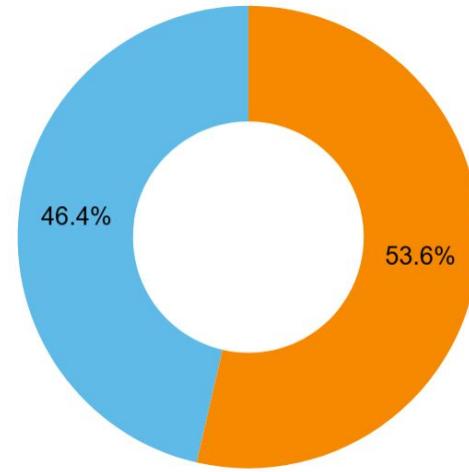
- Water treatment
- Air Treatment
- Gold Treatment
- Respirators
- Solvency Recovery

Market Share by Product



- Powder Activated carbon (PAC)
- Granular Activated Carbon (GAC)
- Extruded Activated Carbon (EAC)
- Charcoal activated carbon cloth (ACC)

Market Share by Adsorption Medium



- Gas Phase
- Liquid Phase

Activated Carbon Key Global Players

The sector is dominated by a few integrated global groups, whose leadership is based on massive production scale, proprietary technology, and strategic acquisitions. These top players command a substantial majority of the market share, especially in the high-value, regulated segments (e.g., municipal water and automotive).



Differentiator

Global GAC Leader & Reactivation. Dominant in high-volume Granular AC (GAC), coal-based, and North American municipal water treatment.

World's largest manufacturer of coconut shell-based AC; Strong focus on value-added services (Ion Exchange Resins, Mobile Filters, & Reactivation).

Focus on high performance and specialty carbons; Strong in activated carbon fiber (ACF) and unique molding technologies.

Focus on high-quality SHIRASAGI™ branded carbons; Specialises in spherical and pelletized AC for gas/air purification and catalysis.

Known for comprehensive, global solutions; Strong heritage in powdered AC (PAC) for food, pharma, and water treatment. Offers reactivation services.

Global leader and specialist in coconut shell-based activated carbon. Emphasis on sustainability and low-ash, high-purity products (e.g., gold recovery).

Primary Feedstock

Bituminous Coal (Historical strength)

Coconut Shell

Wood

Primarily Coconut Shell

Wood

Coconut Shell

Coconut Shell

Peat (Historical strength)

Lignite

Primarily Coconut Shell

Wood

Global Presence & Ownership

Headquartered in the US with global manufacturing.

Subsidiary of Kuraray Co., Ltd.

Swedish-founded global company

Subsidiary of Osaka Gas Chemicals.

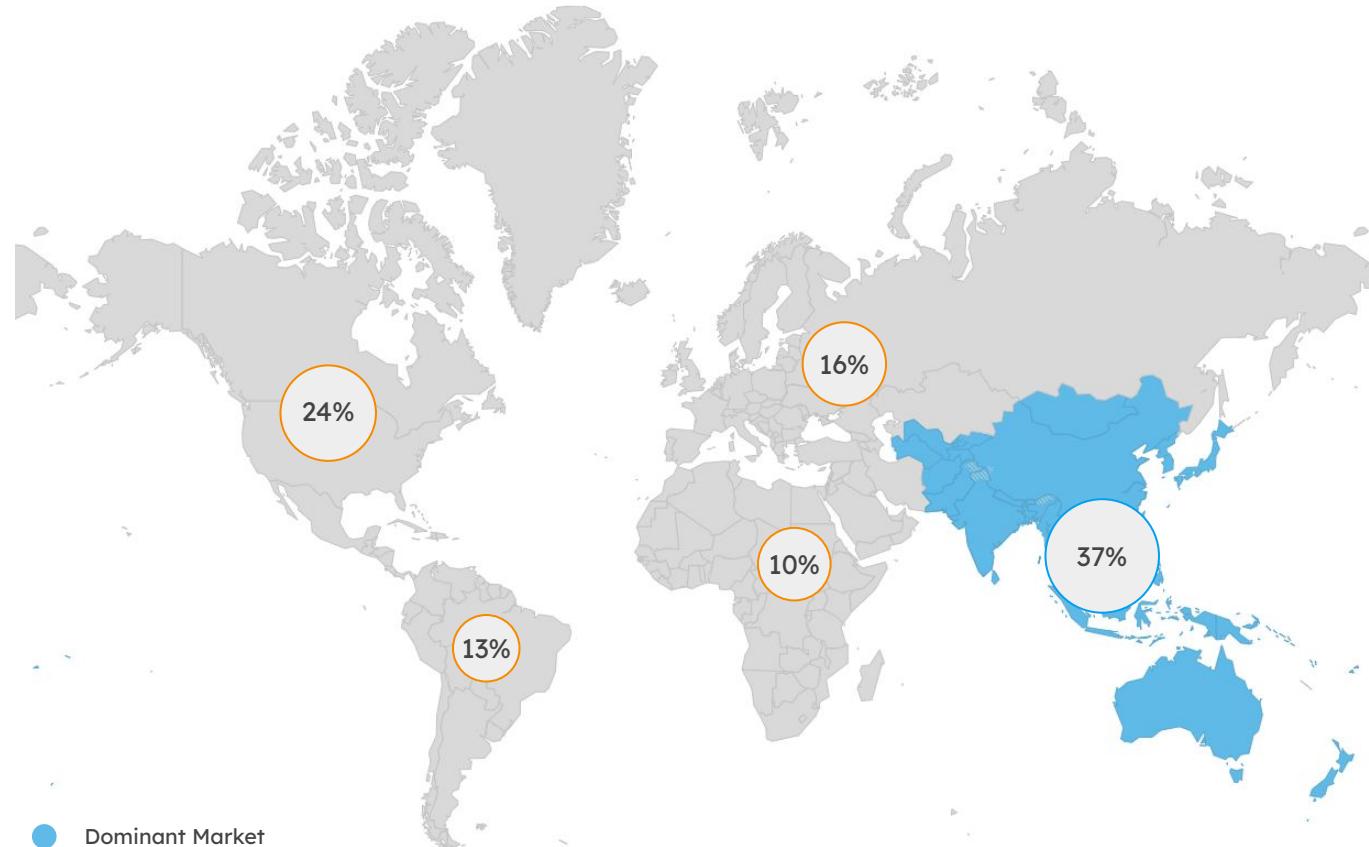
Japanese MNC with global operations leveraging Calgon Carbon's US base.

Japanese MNC; Parent Company of Jacobi Group.

Independent global company (Owned by One Equity Partners); European/US manufacturing base.

Sri Lankan-based company with a large, integrated Asia-Pacific manufacturing network.

Activated Carbon Regional Market Share



Source: Stellar Market Research, "Activated Carbon Market: Global Industry Analysis and Forecast (2025-2032) With Emerging Key Trends"

37%

Asia Pacific Market Share, 2024



Bio-Based Activated Carbon: Market Drivers & The Biochar Opportunity

Key Market Drivers & Supply Constraints

The global market for activated carbon derived from renewable sources (coconut, wood) is facing **severe stress** from both **explosive demand growth and contracting supply**, creating a sustained high-price environment.

- Explosive New Market Demand** - Sodium-Ion Batteries: Coconut shell charcoal is a key precursor for hard carbon in Na-ion batteries. This new market is expected to consume over **1,500 MT of charcoal per GWh of battery production**, driving unprecedented demand growth.
- Regulatory-Driven Demand PFAS Regulation** - Tightening federal and state regulations (e.g., U.S. EPA, EU) for Per- and Polyfluoroalkyl Substances (PFAS) in drinking water requires **massive new investment in GAC filtration**, with a preference for high-quality, bio-based carbons.
- Contracted & Costly Supply Raw Material Scarcity** - Global supply is constrained by **climate shocks** in key regions (drought, pests) and policy changes like **export tariffs** (Vietnam) and **phytosanitary controls** (Indonesia) that **prioritise domestic use over export**.
- Logistics & Price Volatility** - Average import prices for coconut shell charcoal have risen significantly globally. Shipping crises (like the Red Sea reroutes) inflate freight rates and extend shipping times by 30-40%, making **imported AC less reliable** and more expensive.

Source: Lyntra analysis; Kuraray Group Medium-Term Management Plan 2022-2026, Passion 2026 Progress and Outlook; FY2024 Earnings Announcement and Progress & Outlook of Medium-Term Management Plan; Jacobi's company news



Market & Industry Evidence

Jacobi: Increased prices of their coconut AC by 15 - 20% twice in 3 months in 2025. "The root cause of the cost increase is related to the limited availability of charcoal and shell in a large part of Asia and the high demand for Carbon."

Kuraray (Calgon Carbon): Opened a new U.S. facility in 2024 and is actively pursuing M&A to expand, explicitly "responding to increased demand due to strengthened PFAS regulations."

Bio-Based Activated Carbon: Market Drivers & The Biochar Opportunity

The Biochar Opportunity: Capitalising on the Gap

The market's reliance on high-cost, high-risk Asian supply creates a **powerful business case for domestic biochar producers** to enter the premium AC supply chain.

- CAPEX Offset & Premium Pricing - The current high-price environment allows biochar producers to **command premium pricing** for locally manufactured activated carbon, thereby **shortening the payback period** and offsetting the capital expenditure (CAPEX) required to build AC activation facilities.

- Local, Secure, and Sustainable Supply - Biochar is a domestic, carbon-neutral raw material, eliminating supply chain risk from global shipping crises, customs delays, and foreign policy volatility. It directly addresses the growing demand for renewable, localized materials in national supply chains.

Quality & Policy Compliance - Modern biochar pyrolysis processes can produce char with high fixed carbon content (often >70%) that meets or **exceeds the quality specifications** now being set by stringent environmental policies and high-end applications (like sodium-ion batteries and advanced water treatment).

Vertical Integration & Value Capture - Upgrading biochar to activated carbon represents the highest form of vertical integration, **allowing producers to capture the vast majority of the final product value** while maximizing resource utilisation from agricultural waste streams.

Source: Lyntra analysis; International Coconut Community, "Market Review of Coconut Activated Carbon August 2025

Market & Industry Evidence (USA)

20%
YoY

The average import price rose from \$2078/mt in 2024 to \$2502/mt in July 2025

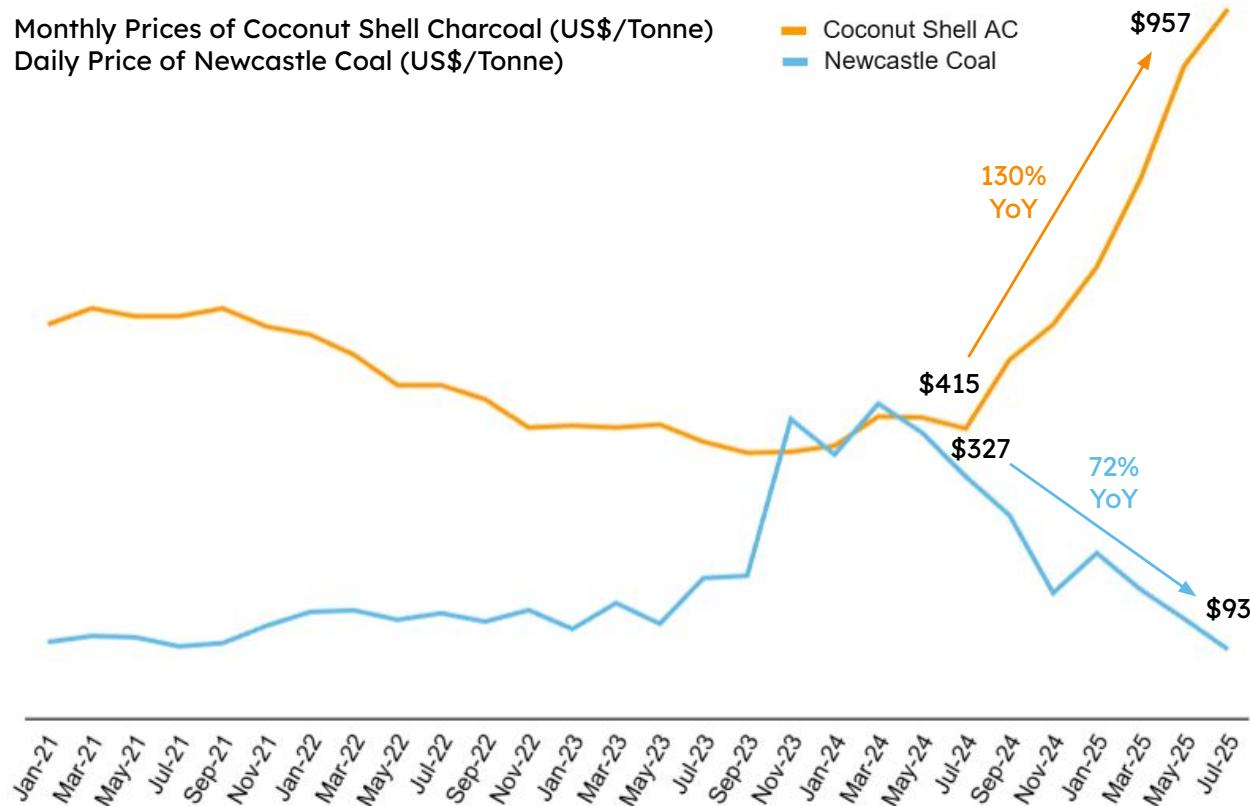
11%
YoY

Coconut shell charcoal imports rose to 30,460 mt in July 2025

Despite falling coal prices, demand for coconut shell AC has continued to climb

Monthly Prices of Coconut Shell Charcoal (US\$/Tonne)
Daily Price of Newcastle Coal (US\$/Tonne)

Coconut Shell AC
Newcastle Coal



Source: International Coconut Community, "Market Review of Coconut Activated Carbon August 2025"; Shanghai Metal Markets, "Shell Charcoal Imports Surge in Both Volume and Price: Commercialization of Sodium-Ion Batteries May Ignite Biomass Carbon Material Demand"

Market & Industry Evidence (China)

9%
MoM

The average import price rose from \$755.4/mt in August to \$819.6/mt in September

35% 64%
MoM YoY

Coconut shell charcoal imports rose to 16,164.37 mt in September 2025

What are the most noteworthy technologies?

Chemical Activation

- **Operating principle:** Chemical agents (KOH, H₃PO₄) react with carbon, etching out and expanding pores, often at lower temperatures.
- **High Value/Specialty Focus:** Enables the production of ultra-high surface area carbons (e.g., 3000+ m²/g with KOH).
- **Lower Energy Input:** Activation occurs at generally lower temperatures (400-900°C depending on the agent) than physical methods, offering reduced energy costs and higher final activated biochar yields.
- **Targeted Market:** Energy Storage (Supercapacitors), High-Value Specialty Adsorption (Pharmaceuticals, CO₂ Capture).

Physical Activation

- **Operating principle:** Hot oxidizing gases (steam, CO₂) selectively gasify non-crystalline carbon at high temperatures, clearing and widening pores.
- **Lower Operating Complexity:** Eliminates the use of hazardous chemicals, the high cost of chemical purchase, and the complex wastewater treatment step necessary for chemical activation.
- **Integration Potential:** Can be directly integrated into the existing pyrolysis/gasification unit by utilizing the hot syngas or flue gas as the activating agents for a closed-loop, low-cost system.
- **Target Markets:** Air/Gas Purification and Industrial Water Treatment.

New Frontiers



The AC industry is on the verge of a major shift. Next-generation production methods, including CO₂ pyrolysis, plasma, and microwave activation, are advancing rapidly toward commercial scale.

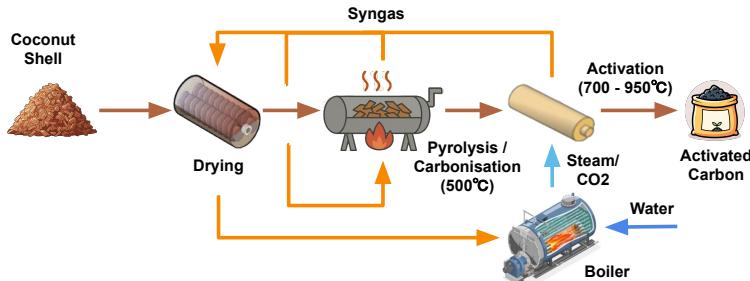
These techniques are attractive because they promise major cost savings and efficiency gains by streamlining the entire process.

The biggest challenge they face right now is scaling up without losing quality. It's tough to guarantee a uniform product when moving from small-scale pilots to massive industrial reactors.

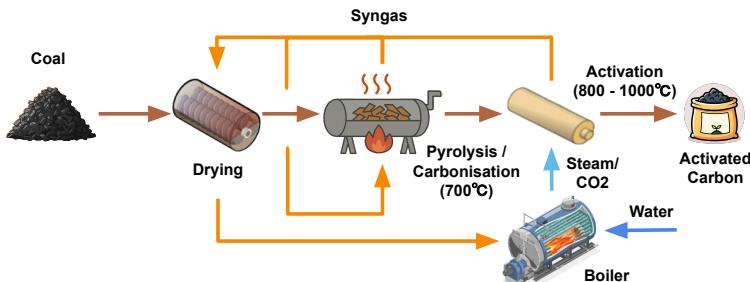
With significant investment already flowing into this new engineering, we project these high-efficiency methods will achieve widespread commercial success in the next five to seven years.

Physical Activated Carbon Process Flow

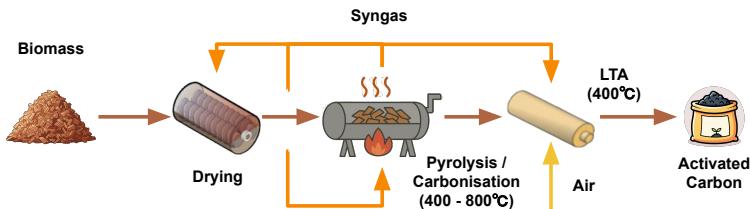
Coconut Shell Physical Activation



Coal Physical Activation



Bygen Low Temperature Activation

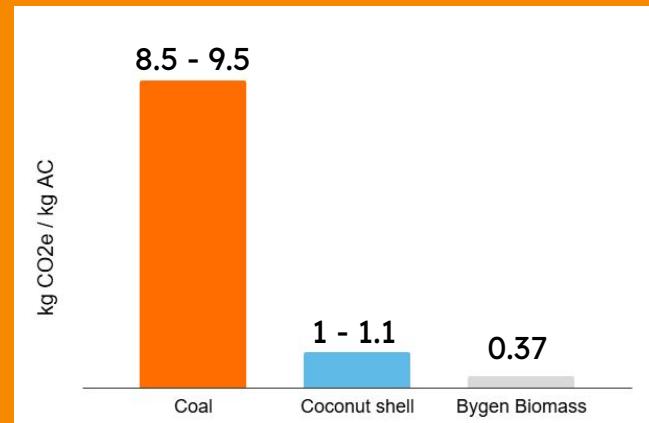


Source: Lyntra Analysis; Vilén, A, Laurell, P Vahala, R, 2022, "Comparative life cycle assessment of activated carbon production from various raw materials", Journal of Environmental Management, Volume 324; Jiunn Boon, Yong & Tan, Lian & Tan, Jully. (2022). Comparative life cycle assessment of biomass-based and coal-based activated carbon production. Progress in Energy and Environment. 20. 1-15. 10.37934/progee.20.1.115; Bygen website



Global Warming Potential

When a life cycle assessment (LCA) is conducted on the Global Warming Potential (GWP), coconut shell and biomass AC has a considerably lower kg CO₂e / kg AC than coal based AC. The bulk of the Coal CO₂e is from the collection and preprocessing.



Activated Carbon Equipment Manufacturers



| | | | | | |
|--------------------------|--|--|--|--|---|
| Country of origin | Australia | USA | China | China | South Korea |
| Core Technology | Low temperature activation (LTA) | Material Handling & Thermal Processing | Heavy-Duty Continuous Rotary Kilns | Pyrolysis & Carbonization Furnaces | High-Efficiency Rotary & Pusher Kilns |
| Overview | <p>World-first patented technology that combines carbonization and activation into a single, highly efficient, and largely self-sustaining exothermic process. It uses closed-loop gas recycling and low heat, dramatically reducing energy requirements and emissions. LTA allows for the decentralized production of premium-quality, carbon-negative AC (validated to ISO standards) from sustainable biomass feedstocks.</p> | <p>Core expertise in custom, end-to-end thermal systems (since 1951). They specialize in high-capacity rotary kilns (up to 50 TPH+) for calcination, carbonization, and reactivation, handling diverse materials like biochar and waste. Offers tailored direct kilns for high volume or indirect kilns for precise atmosphere control and processing of fine materials, along with all necessary material handling and support equipment.</p> | <p>Leveraging its core competence in the cement and lime industries, AGICO provides extremely robust, large-scale rotary kilns for the high-temperature carbonization and activation of AC (up to 1050°C). Strategic strength lies in manufacturing heavy-duty, reliable equipment (up to 6,000 kg/h throughput per model) designed for continuous, severe-duty industrial environments and large-volume commodity AC markets.</p> | <p>Strong focus on cost-effective, high-yield production of activated carbon from agricultural waste (e.g., hazelnut/coconut shells). Offers full-process lines integrating drying, continuous carbonization (600-850°C), and high-temp steam activation (850-950°C). Specialises in achieving high iodine values (800-1300 mg/g) and specific surface areas (800-1500 m²/g) for competitive, mid-to-large scale commodity AC production (up to 20 T/D).</p> | <p>Global leader with 125+ years of experience. They offer turnkey production lines and expertise in large-scale physical activation using rotary and pusher kilns. Supported by R&D centers in Korea and Germany, they focus on high throughputs (up to 3,000 kg/h) and advanced energy efficiency/process gas recycling for reduced operational cost.</p> |

Biochar to AC: Risk vs. Reward

Not exhaustive

Benefits & Opportunities

Operational Flexibility: The integration is designed as a simple, bolt-on module to the pyrolysis reactor. This allows the producer to flexibly switch between producing high-value AC and standard biochar based on market demand.

New Revenue Stream: AC sells for 3x to 10x the price of basic biochar, allowing the producer to capture the highest value segment of the carbon market and significantly increase gross margins.

Carbon Credit Diversification (New AC-Specific Credits): Potential to participate in new, high-value carbon accounting streams, such as verified carbon avoidance (e.g., displacing fossil-fuel-derived AC) or specific end-of-life credit mechanisms.

De-Risked, High-Volume Market Access: Gain entry into highly regulated, high-volume markets (Water Treatment, Air Purification) where demand is non-discretionary and backed by government policy.

Sustainability & ESG Leadership: Provide a circular, net-zero carbon product solution to major corporations and municipalities seeking to meet their strict ESG procurement targets.

Source: Lyntra analysis

Risks & Uncertainties

Feedstock Suitability: Not all biochar is suitable for activation. The chemical composition and ash content of the original biomass (e.g., high-silica feeds) may result in an AC product that fails to meet the low-ash, high-porosity standards required for premium industrial and environmental applications.

Carbon Credit Loss or Invalidation: The upgrade process (steam or chemical activation) structurally changes the material. Your current biochar carbon sequestration methodologies (e.g., Verra, Puro.earth) may not apply to the final AC product, potentially invalidating existing carbon credit revenue streams.

High CAPEX & Activation Risk: Requires significant upfront capital investment for specialized equipment.

Regulatory & Quality Hurdles: Market entry requires costly and time-consuming certifications (NSF/ANSI 61 for drinking water). Quality control must be flawless to maintain these certifications.

Intense Global Competition: Competing directly with massive, integrated global players in a commoditized industry where scale economics usually win, and who offer reactivation services that smaller players cannot easily match.

Next Steps: Converting Thesis into Execution

Strategic Mandate (Why Act Now)

The current market window is an excellent opportunity for Biochar producers to capture the premium segment:

- **Supply De-Risking:** Global volatility in AC supply mandates securing a domestic, sustainable, and reliable source now.
- **Regulatory Lock-In:** PFAS and Na-ion regulations have made bio-based carbon demand non-discretionary and long-term.
- **Structural Advantage:** The path to 3x to 10x margins requires an immediate commitment to specialised AC conversion technology.
- **Carbon Advantage:** Bio-based AC offers equivalent performance with 7.7x to 9.5x less kg CO₂e than coal AC, directly addressing corporate Scope 3 reduction goals.

Source: Lyntra analysis

About Lyntra



Lyntra partners with clients to accelerate growth in renewable energy, bio-based carbon, and emerging technologies by combining strategic business advisory with expert engineering and project management. We help businesses navigate complexity, aligning market insights, technology selection, and operational execution to deliver scalable, sustainable impact. Our flexible, senior-level support bridges strategy and delivery, empowering clients to capture premium opportunities and lead transformation in evolving markets.

— Travis Mays, Founder & Managing Director,
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