FORTUNE BUSINESS INSIGHTS

REPORT

Biochar

UK Market Analysis, Insights and Forecast, 2023-2030

Table of Contents

Table of Contents

Introduction

Section 1

FORTUNE BUSINESS INSIGHTS

Research Scope

Section 1.1

Research Scope

- ✓ Competitive analysis
- ✓ Profiles of key companies operating in the market
- ✓ Technological and market developments shaping the market
- ✓ Key insights

- ✓ Market size and growth rate by various segments at the country level for the 2019-2030 period, with 2019-2021 as historical data, 2022 as base year and 2023-2030 as forecast period
- ✓ Market dynamics – Market drivers, restraints, and opportunities
- ✓ Overall market size and growth rate for key countries for the 2019-2030 period

Research Scope – Key Insights

- Key Emerging Trends
- Latest Technological Advancement
- Regulatory Landscape
- Porters Five Forces Analysis
- Impact of COVID-19 on the Biochar Market

Market Segmentation

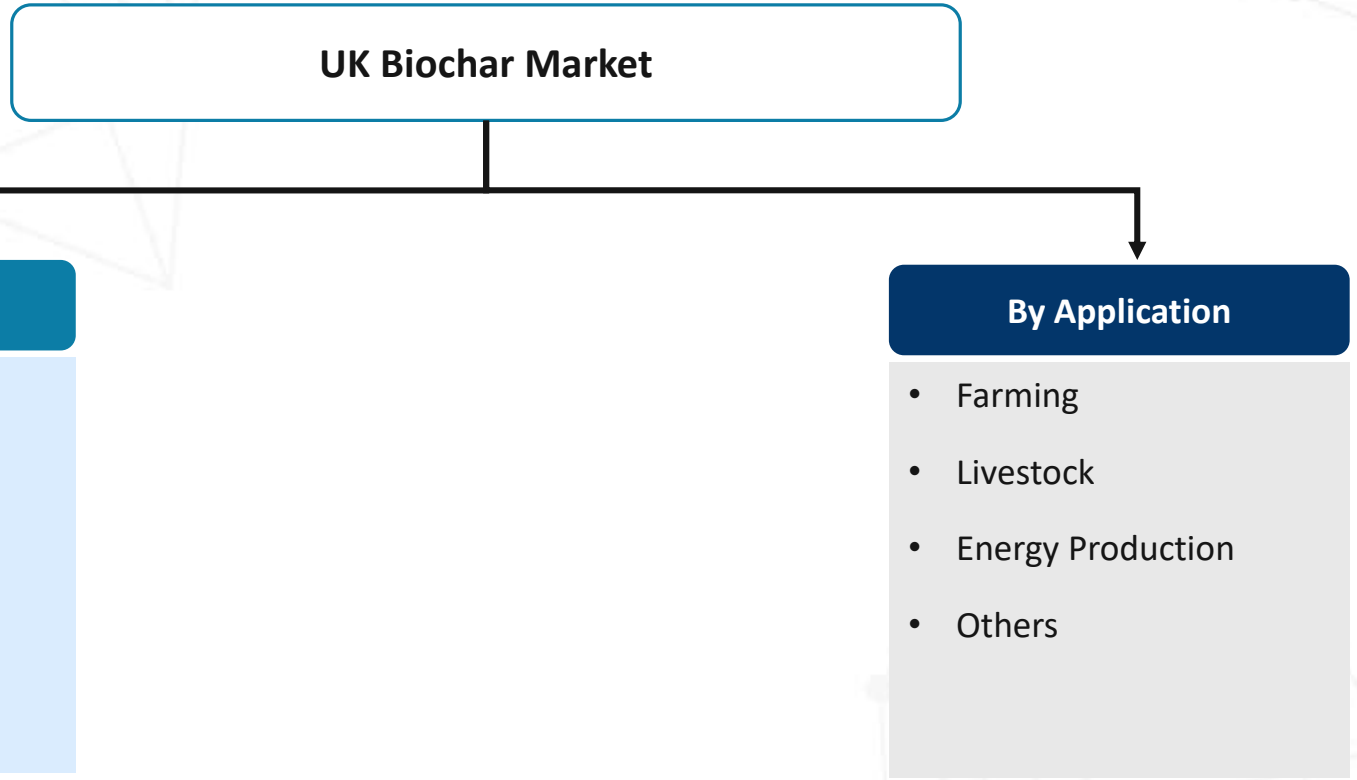
Section 1.2

FORTUNE BUSINESS INSIGHTS

Segmentation

By Geography

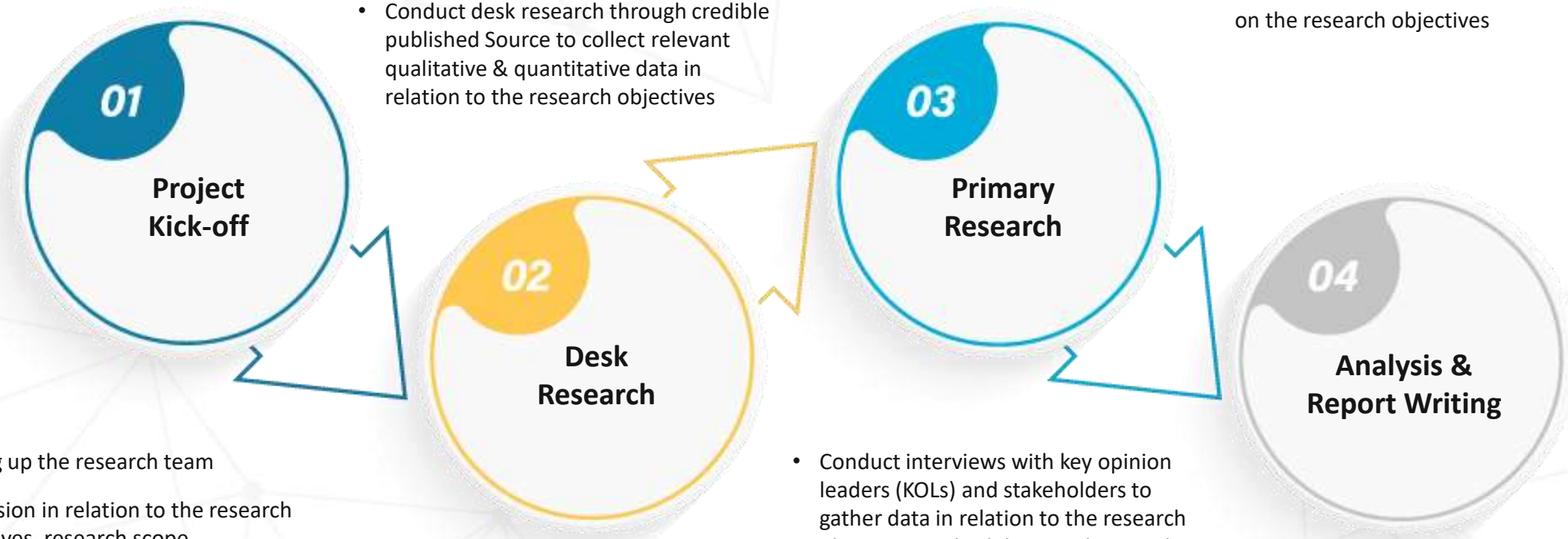
- UK



Research Methodology

Section 1.3

Research Methodology – Research Process



- Setting up the research team
- Discussion in relation to the research objectives, research scope, methodology, timeline and challenges

- Develop contact lists, questionnaires and market models
- Conduct desk research through credible published Source to collect relevant qualitative & quantitative data in relation to the research objectives

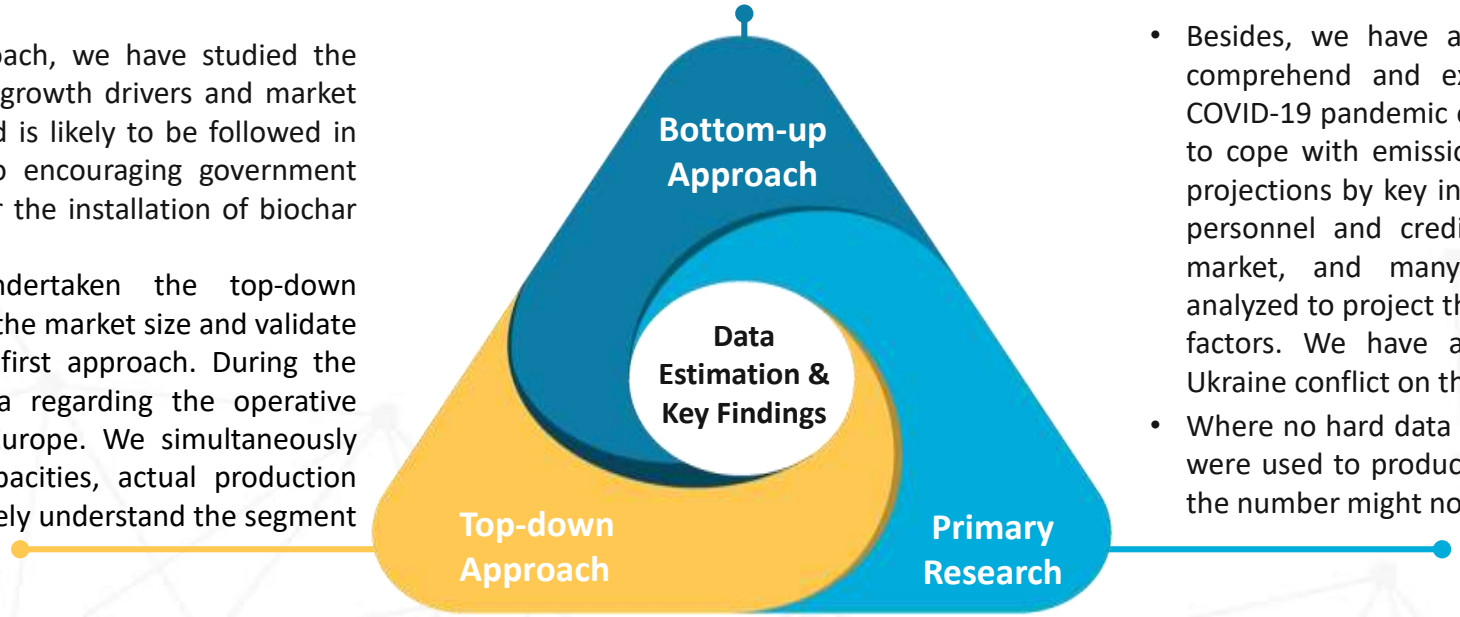
- Conduct interviews with key opinion leaders (KOLs) and stakeholders to gather data in relation to the research objectives and validate market numbers estimated through market models

- Analyze the data gathered through desk and primary research and build report, conclusions and recommendations based on the research objectives

Research Methodology – Data Triangulation

- As per the customization requested, the market sizes in Revenue and Production are included in the sheet. Wherein 'Production' represents biochar produced (Tons) in the UK while 'Revenue' represents the value generated in USD after the sales of produced biochar at certain prices.
- We have followed the top-down and bottom-up approaches to arrive at the market size and cross-verify our findings with the methods.
- Under the bottom-up approach, we assessed the number of biochar projects nationwide to quantify the total market. As per our analysis, the growth of biochar is increasing significantly owing to a boost across the UK.
- Furthermore, the trend is likely to be followed in the upcoming years owing to encouraging government initiatives and huge targets for the installation of biochar plants.
- Subsequently, we have undertaken the top-down analytical method to calculate the market size and validate our initial results during the first approach.
- During the calculation, we gathered data regarding the operative biochar projects across the Europe. We simultaneously estimated the production capacities, actual production data, and CAPEX data to precisely understand the segment and sub-segments.
- Under this approach, we have also estimated the average prices at which locally produced biochar is sold during certain time period.

- Similarly, the top-down approach, we have studied the country market and their key growth drivers and market trends. Furthermore, the trend is likely to be followed in the upcoming years owing to encouraging government initiatives and huge targets for the installation of biochar plants.
- Subsequently, we have undertaken the top-down analytical method to calculate the market size and validate our initial results during the first approach. During the calculation, we gathered data regarding the operative biochar projects across the Europe. We simultaneously estimated the production capacities, actual production data, and CAPEX data to precisely understand the segment and sub-segments.



- Besides, we have also undertaken various insights to comprehend and exhibit the tangible impact of the COVID-19 pandemic on the industry. Government policies to cope with emission targets in the post-COVID world, projections by key industry participants, views of leading personnel and credible organizations operating in the market, and many other parameters were deeply analyzed to project the implications caused by the various factors. We have also considered impact on Russia-Ukraine conflict on the market.
- Where no hard data was available, models and estimates were used to produce comprehensive data sets. Besides, the number might not add up due to rounding off.

Definition

Section 1.4

Definitions

Biochar

- **Biochar -** Biochar is a charcoal-like material that is produced from plant materials such as grass, agricultural and forest residues that are decomposed at high temperatures, often during renewable energy production. During the process, the physical and chemical properties of the plant material change into a highly porous, stable, carbon-rich material known as biochar.
- **Pyrolysis -** Pyrolysis is widely known as the manufacturing process by which charcoal is produced from wood. However, this is a narrow application and pyrolysis sees the transformation of any low-energy-dense biomass into bio-oils, syngas and biochar. Pyrolysis conditions can be optimized to favor the production of a specific product, with slow pyrolysis at lower temperature favoring higher biochar yields and fast pyrolysis at higher temperatures favoring syngas production.
- **Gasification -** Gasification is a process that converts organic or fossil-based carbonaceous materials at high temperatures (>700°C), without combustion, with a controlled amount of oxygen and/or steam into carbon monoxide, hydrogen, and carbon dioxide. The carbon monoxide then reacts with water to form carbon dioxide and more hydrogen via a water-gas shift reaction. Adsorbers or special membranes can separate the hydrogen from this gas stream.

Definitions

Biochar

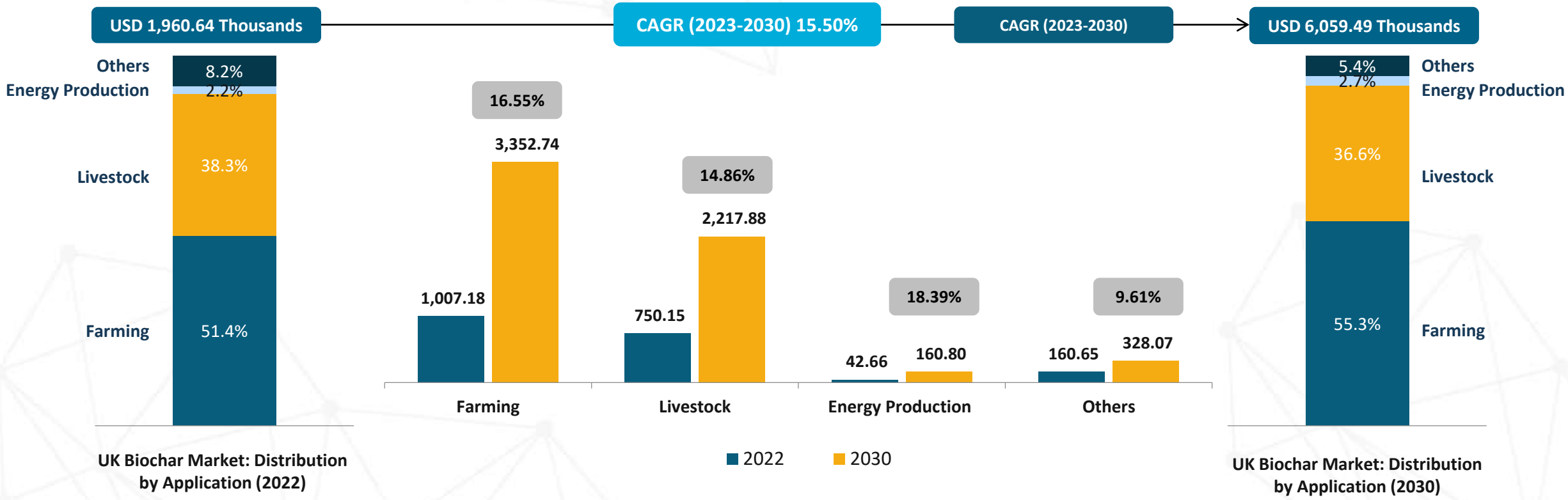
- **Farming:** Farming is the act or process of working the ground, planting seeds, and growing edible plants and also describes raising animals for milk or meat as farming. Biochar is mainly used in farming to enhance soil fertility, improve plant growth, and provide crop nutrition.
- **Livestock:** Livestock are domesticated terrestrial animals that are raised to provide a diverse array of goods and services such as traction, meat, milk, and eggs. The use of biochar in livestock farming as a feed supplement has been increased to improve animal health and increase nutrient intake efficiency.
- **Energy Production:** Biochar production involves the partial burning of plant material that transforms carbon-rich substances like biomass into a synthesis gas (syngas) primarily comprised of hydrogen and carbon monoxide. This syngas can be used for heat generation or as a fuel in combustion engines or gas turbines to create electricity**.**
- **Others:** The other segment includes applications such as water filtration, construction & roadways, and cosmetics, among others.

Executive Summary

Section 02

Executive Summary

Figure 01: UK Biochar Market Revenue Breakdown (USD Thousands, %) by Application , 2022 & 2030



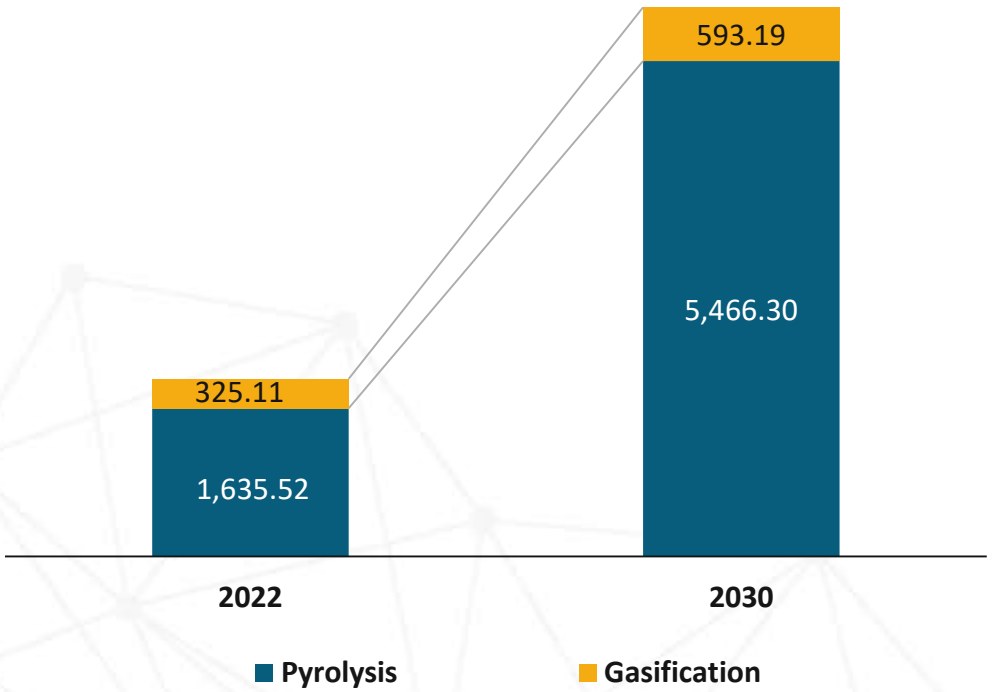
UK Biochar Market: Distribution by Application (2022)

UK Biochar Market Size (USD Thousands) by Application (2022 and 2030)

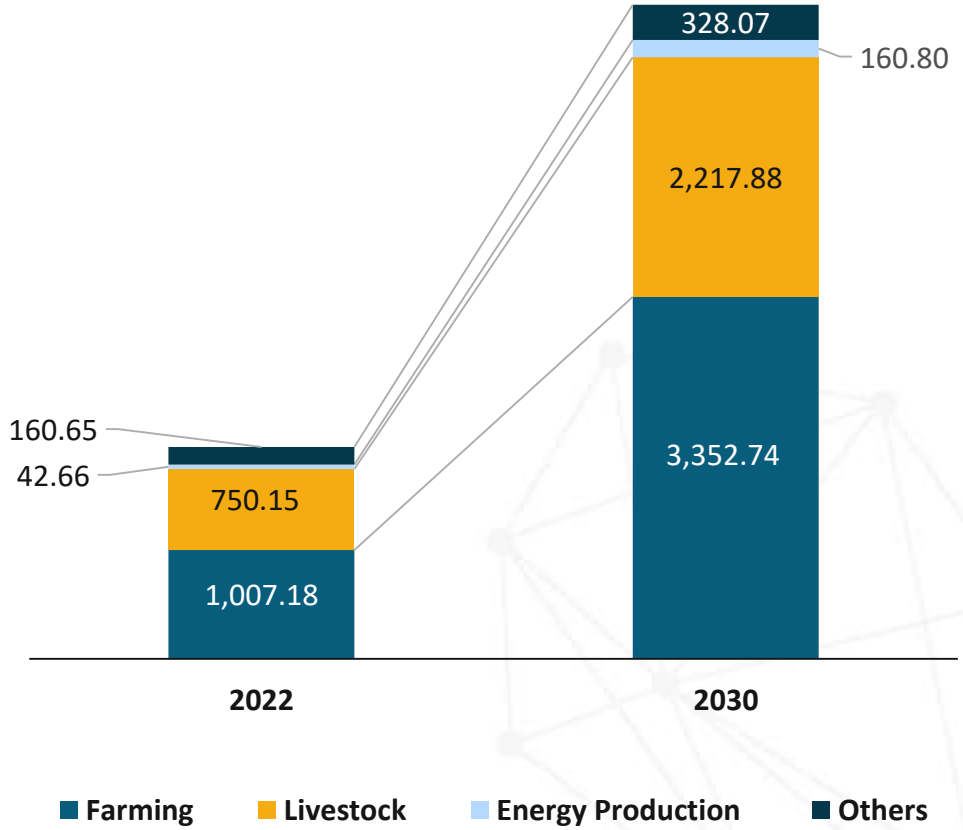
UK Biochar Market: Distribution by Application (2030)

Executive Summary

UK Biochar Market By Technology, 2022 and 2030 (in USD Thousands)



UK Biochar Market By Application, 2022 and 2030 (in USD Thousands)



Market Dynamics

Section 03

Market Dynamics

Market Dynamics

Growing Demand from Agriculture Industry is Positively Impacting the Growth of the Biochar Market

Burgeoning Use of Biochar in Animal Feed to Stimulate the Demand for Biochar

High Cost and Lack Knowledge of Manufacturing Process is Restraining the Market Growth

Market Drivers

Section 3.1

Market Drivers

Growing Demand from Agriculture Industry is Positively Impacting the Growth of the Biochar Market

- Farming in the UK underpins the nation's food security, generates economic benefits and shapes a rich and varied landscape. Food is still the primary purpose of farming, and always will be. Farming plays an important role in managing the environment of over 70% of the UK's land area.
- The UK produces 7.8 million tons of wheat for bread making each year, with the average household buying 43 loaves per. It is clear that as an industry farming is vital to the UK economy. The growing farming will increase the use of biochar for crop development both directly and indirectly depending on its natural nutritional content and capability for nutrient.
- Agriculture accounts for 72% of land use in the UK and provides employment for close to half a million people. Most of the arable cropland is situated in the lowlands of southeast Great Britain, which have relatively warm temperatures and lower rainfall. The remaining quarter is made up of urban (14%), forest and woodland (12%) and inland water (1%).
- As soon as biochar is incorporated into the soil, it starts to interact with soil chemistry, In addition to increasing soil fertility, particularly over a long term, its ability to store carbon and nitrogen may lessen both immediate and long-term environmental deterioration and its harmful impacts on human and animal health, due to its vital property biochar is being used in the farming.
- Consequently, biochar improves the soil's ability to absorb and hold onto nutrients and agricultural chemicals while lowering their vaporization and leaching into surface and groundwater, enhancing nutrient retention in soil.
- Through its persistence, biochar enables a long-lasting impact on soil quality and carbon sequestration due to its greater half-life of carbon, potentially over thousands of years.
- UK investment in agricultural research and development has focused on technologies for industrial farming to the exclusion of small and medium-scale technology. Hence, growers are forced to rely on old, and sometimes unreliable, machinery or import equipment from mainland Europe, where the market has driven ongoing development of modern equipment that is of an appropriate scale and price for small farmers.

Market Drivers

Burgeoning use of Biochar in Animal Feed to Stimulate the Demand for Biochar

- Biochar-based fertilizers, which combine traditional fertilizers with biochar as a nutrient carrier, are promising in agronomy. Using biochar as a feed additive for animals shows benefits in terms of overall growth, gut microbiota, reduced enteric methane production, egg yield, and endo-toxicant mitigation.
- Biochar enhances anaerobic digestion operations, primarily for biogas generation and upgrading, performance and sustainability, and the mitigation of inhibitory impurities. In composts, biochar controls the release of greenhouse gases and enhances microbial activity. Co-composted biochar improves soil properties and enhances crop productivity.
- Livestock-manure-derived biochar is one of the major products obtained from the pyrolysis of livestock manure. Discharges of manure lead to environmental problems, such as odors rooting in the emission of toxic gases and pollution of waterways because of leaching and runoff of nurtures and heavy metals.
- In the UK for lowland grazing livestock farms, farm business income rose by 85 percent in 2021/22 to US$ 41,923. Cattle output, a main source of revenue for this type of farm, rose by 22 percent, with prices for stored and finished cattle buoyed by a tight market. Output from sheep enterprises increased by 34 percent, reflecting higher average prices for fat and stored lambs annually.
- Biochar prepared by livestock manure is the solid carbonaceous residue from the pyrolysis of livestock manure. The conversion of livestock manure to biochar has a variety of potential economic effectiveness, including agricultural waste reduction, fuel production, and carbon sink.
- In May 2021, The Dorset Charcoal Company claimed that Australian farmer Doug Pow has had some astonishing results from feeding his cattle biochar mixed with molasses. The whole-farm biochar system boosted their farm's productivity, cutting input costs and reducing cattle emissions while storing carbon in the ground.
- Numerous treatment methods can mitigate most of the toxic gas emissions and water pollution due to the leaching of nutrients and heavy metals from livestock manure, such as composting, calcination, gasification, and pyrolysis.

Market Restraints

Section 3.2

Market Restraint

High Cost and Lack Knowledge of Manufacturing Process is Restraining the Market Growth

- The high cost of such products and underlying structural constraints, such as a shortage of finance for producers, an immature carbon market, and shorter timescales for mining land restoration bonds, continue to impede the market growth. While the commercialization of this product is still in its early stages, this hard-to-sell product's lack of consistency and standardization impedes market expansion.

- Biomass is used as the feedstock in the pyrolysis reactor, which has a set heating and gas flow rate, residence duration, and temperature. Following that, biochar can be created. During pyrolysis most of the Ca, K, P, Mg and plant micronutrients as well as half of the N and S in the feedstock are retained in biochar. There are certain byproducts of this process, such as gas and bio-oil. However, when biochar is applied to agricultural land, several prior research identified the following drawbacks: loss of land due to erosion, soil compaction during the application, risk of contamination, removal of crop residues, and reduction in worm life rates; these factors are creating a negative impact on the environment and could affect the market.

- Lack of knowledge of the sustainable biochar manufacturing process will continue to be one of the major constraints limiting this product's development and potential consumption. The lack of effective technology for low-emission char synthesis, particularly for distant or mobile production, has hampered the market value.

Market Opportunity

Section 3.3

Market Opportunity

Biochar Market

Rising Environmental Concern is Uplifting the Usage of Biochar

- Biochar is carbon-rich material made by heating organic matter in low oxygen conditions. It may reduce atmospheric carbon dioxide (CO2) levels, thus helping the UK meet its greenhouse gas emissions reduction targets.
- During pyrolysis, around 50% of the carbon in the biomass is converted into biochar. Around two-thirds of the remaining 50% can be released as useful energy.
- They release CO2 and methane back into the atmosphere. They can also contaminate local ground and surface water. Using these materials to produce biochar removes them from a pollutant cycle and can be extracted from this biomass as a by-product of energy production.
- During biochar production processes, two bioenergy products are also produced in the form of syngas and bio-oil. The relative fractions of each of these depend on the production methods (temperature, heating, etc.). In certain instances, the energy available from the syngas produced can act to self-sustain the biochar formation, reducing fossil fuel inputs, or it can be used in turbines to produce electricity directly.
- The University of Nottingham is leading the world's largest effort to evaluate the ability of a material called biochar to store carbon from the atmosphere to counteract the effects of climate change. The USD 5.5 million project is one of five UK research and innovation-funded demonstration projects investigating greenhouse gas removal (GGR) technologies to reduce CO2 emissions at levels comparable to the could help the UK reach its net zero targets by 2050.
- Biochar can used on sites where the land is contaminated with heavy metals from prior industrial use. Biochar acts as an adsorbent, binding metal pollutants to its surface, immobilizing them, and reducing their toxicity over time.
- In addition, biochar and brown coal waste (BCW) have lower contaminants (e.g., heavy metals) and have been shown to provide additional sustainability and net cost benefits.

Key Insights

Section 04

Key Emerging Trends

Section 4.1

Key Emerging Trends

Description

- Government Policies and initiatives in the UK aim to promote sustainable agriculture and reduce greenhouse gas emissions. This has increased demand for biochar as a soil amendment that helps improve soil fertility and reduce emissions from agricultural activities.
- Biochar has been shown to benefit agricultural ecosystems, including improved yields, improved water retention, and increased nutrient recycling and retention. A carbon-rich biochar could be produced through gasification at the cost of reduced syngas yield but caution should be taken to maintain smooth operation and consistent quality of syngas.
- In 2021, New Urban Biochar greenhouse gas reduction and Sustainable Materials Demonstrator now installed at horticultural nursery site on outskirts of Birmingham. The project is being delivered by the Energy and Bioproducts Research Institute (EBRI) based at Aston University after being granted Local Growth Fund (LGF) funding from the Greater Birmingham and Solihull Local Enterprise Partnership (GBSLEP).
- The project, called the Urban Biochar and Sustainable Materials Demonstrator is being led by the Energy and Bioproducts Research Institute (EBRI) based at Aston University and is being funded by Local Growth Fund (LGF) from the Greater Birmingham and Solihull Local Enterprise Partnership (GBSLEP), as well as the EU European Regional Development Fund (ERDF).
- In the UK, biochar can be produced using biomass from bio-waste (which includes biodegradable municipal and agricultural waste) or purpose-grown re-growing biomass plantations such as willow. When biochar is added to soil, a portion of it degrades, allowing carbon to escape back into the atmosphere. Scientists are currently studying the properties of carbon found in soils from hundreds of years ago to help shed light on the factors that are important for long-term stability.

Latest Technological Advancement

Section 4.2

Latest Technological Advancement

Description

- In July 2023, A green technology company in UK has set out its plans to build a number of hubs in the Wye Valley, aiming to convert the area's considerable supply of poultry litter into biochar a slow release fertilizer. The company, Onnu says it has already demonstrated the efficacy of the "pyrolysis" process on the ground in Namibia combusting organic matter in the absence of oxygen to produce biochar.
- In July 2023, European BeonNAT project has achieved promising results that demonstrate the potential of biomass cultivated to produce bioplastics for bioactive cosmetics, biochar, activated carbon and pet litter with essential oils.
- In August 2023 - Carbo Culture's first industrial pilot facility opens near Helsinki, Finland, demonstrating efficient and scalable biochar carbon removal. The facility, named R3, or Reactor 3, is funded by the European Innovation Council and it uses a method called biochar carbon removal (BCR) to permanently remove carbon dioxide (CO2) from the atmosphere.
- In Sept 2022, Danish cleantech company MASH Makes A/S has developed a new pyrolysis technology to produce carbon-negative biofuels and biochar from agricultural residues. The company has just secured USD 0.46 million in green financing from Nefco, the Nordic Green Bank, to accelerate the first commercial implementation of the solution.
- In June 2021, SUEZ Group and Airex Energy have formed a partnership in order to provide solutions to regions and industries on their path towards carbon neutrality. The expertise of the two Groups will enable them to industrialize the recovery of biomass residues into biochar (a stable form of organic carbon), which is essential to the resilience, vitality and fertility of urban and agricultural soils.

Regulatory Landscape

Section 4.3

Regulatory Landscape (1/2)

Description

- Initiatives such as European Biochar Certificate (EBC) [16] and the International Biochar Initiative (IBI) are trying to define production criteria and biochar properties and quality but are not recognized by any national legislation as official methods within the EU. In particular, the EBC represents some elemental limits, such as a total organic carbon content of > 50% and O/C and H/C ratios.
- Diverse biochar certificates currently have put forward a proposal for guidelines for the specification of biochar, intending to provide a product classification and description for quality requirements while also confirming consumer assurance. The International Biochar Initiative (IBI), European Biochar Certificate (EBC), Biochar Quality Mandate (BQM), and the European Community Biochar Criteria (ECBC) are ready guidelines for the sustainable usage of biochar in soil. These initiatives describe production criteria, biochar properties, and classes but are not familiar with national legislation as authorized methods within the EU. Biochar scientists have developed biochar certificates to ensure sustainable biochar production and low-hazard use in agronomic systems.
- Users of biochar and biochar-based products will benefit from transparent and verifiable monitoring and independent quality control. Biochar produced per the standards fulfills all the requirements of sustainable production and has a positive carbon footprint. However, there are essential differences between benchmarks. Biochar has implications in several EU policy areas, with environmental protection, waste management, and agricultural and climate change policy.
- The core objective is to incorporate benefits and impacts into a common agenda and discover the most appropriate and reasonable solutions. The waste-to-energy technologies have become a root and are increasingly attractive, as observed from both an energy supply perception and waste management.
- However, a new regulation on a range of fertilizing products (revision of EC Regulation 2003/2003) has been launched in 2016 by the European Commission (EC) as part of a package to stimulate the circular economy within the EU27.
- Due to this new legislative framework, biochar is expected to be included in the REACH regulation (EC Regulation 1907/2006). This regulation is a system set up for the Registration, Evaluation, Authorization, and Restriction of Chemicals. A REACH registration is required if a fertilizing product is sold in quantities of one tons or more per year.

Regulatory Landscape (2/2)

Description	
Parameter	**Regulation/Standard**
Emission, inc. Particulates and PFAS	DIRECTIVE 2010/75/EU
Destruction of Pathogens	DIRECTIVE 86/278/EEC
Heavy Metals: As, Cd & Hg	• European Biochar Certification • International Biochar Initiative Certification
Heavy Metals: Cr, Cu, Pb, Ni & Zn	• European Biochar Certification • International Biochar Initiative Certification
Organic Contaminants, inc. PCB and PFAS	• European Biochar Certification • International Biochar Initiative Certification
Destruction of Micro/Nano plastics	No comprehensive Law: • DIRECTIVE 2010/75/EU • Regulation (EU) 2019/1009 – Fertilizing Products Regulation

Climate Change Analysis

Section 4.4

Climate Change Analysis

- Biochar is a solid material obtained from the carbonization of any biomass including weeds, crop residues and other wastes of plant origin. Currently, the use of biochar has got scientific attention in agriculture sector. Using renewable energy from noncompetitive waste residue is now a day becoming a commercial reality.
- The main benefit of biochar is that it utilizes biomass in a way where carbon is locked-in and stored compared to outright combustion (slash and burn), natural decomposition and other waste management options which involve the release of CO_2 and other greenhouse gasses (GHGs) into the atmosphere.
- Biochar has been indicated to retain up to 50% of its initial carbon content compared to 3% in traditional burning and 10 – 20 % via decomposition. Recently, it was noted that biochar production and use as a soil additive was predicted to act to reverse CO2 emissions and that it could lead to maximum global net reductions of 1.67 tons of CO2 equivalent emissions per tons of feedstock used, with this reduction being based on a combination of the direct and indirect beneficial effects.
- Other direct climate effects apparent with biochar soil addition includes the reduction of N2O emissions from soils, with data suggesting 38% reductions are possible due to the promotion of soil bacterial breakdown of N to N2 instead of N2O(though these reductions are only seen for a year after application).
- As well as the atmospheric CO2 removal levels needed to maintaining global warming below 1.5 °C, biochar production from forest and crop residues and its use in soils was noted to have the potential to account for 10% of these required CO2 reductions via both direct and indirect benefits.
- Furthermore, if extra crops were grown specifically for biochar production as well as these residue biomass' being used, the produced biochar could increase CO2 reductions to cover up to 15-35% of the 1.5°C CO2 reductions needed. Biochar addition to the soil is a promising option for improving soil chemical property by improving cation exchange capacity (CEC) and soil pH and reducing exchangeable acidity of the soil.

Climate Change Analysis

- First, biochar neutralizes soil acidity through a direct liming effect, improves the structure of microbial communities, controls nutrient bioavailability, retention and leaching, and causes plant toxicity above or below certain.
- Second, biochar increases the pH buffering capacity of soils by increasing the cation exchange capacity (CEC) due to negative functional groups (COO− and O−) that are bound to the biochar surfaces. Biochar increases the available reactive surface area of low-fertility soils, which in addition to increasing CEC and buffering capacity, increases porosity, water retention, and the ability of plant roots to more fully explore the soil volume. Increases in CEC after biochar application are particularly pronounced in coarse-grain or highly-weathered soils
- Also biochar was found to increase soil biota, through increasing nutrient availability, enhancing habitat suitability, increasing water retention and aeration and reducing toxic chemicals in the soil. Biochar has a significant role in climate change mitigation through sequestration of carbon in the soil and reduction of nitrous oxide (N2O) and methane (CH4) gas emissions to atmosphere by improving uptake of the soil.
- Biochar production and application could act positively towards mitigating GHG emissions globally through direct carbon sequestration and other indirect GHG emission reduction effects.
- Biochar holds the potential to positively influence climate change in the UK by aiding in carbon sequestration, enhancing soil quality, and promoting sustainable agricultural practices. However, it's important to note that while biochar presents numerous potential advantages, its influence on climate change depends on several factors, such as the adoption rate, the types of materials used for producing biochar, and the precise agricultural and land management practices employed. The UK's efforts to address climate change would probably gain from a holistic approach incorporating biochar within a wider array of sustainable measures to curb emissions and amplify carbon sequestration.

Porters Five Forces

Section 4.5

Porter's Five Forces Analysis

Threat of New Entrants – Moderate

- Biochar companies trying to enter the market require advanced technologies to effectively produce biochar, which poses a barrier for new entrants. Furthermore, the market is captured by some of the renowned and leading companies in the world, which results in a moderate risk for new entrants. Therefore substantial investment in R&D, along with standing competition with already established industry players, makes it difficult for any new entrant to establish a footprint in the market.

Bargaining Power of Suppliers – Moderate

- The suppliers in the biochar market are waste suppliers and equipment providers. There is a large number of suppliers that operates in the market.
- Hence, suppliers' bargaining power in the market is projected to be low during the forecast period.

Degree of Competitiveness – High

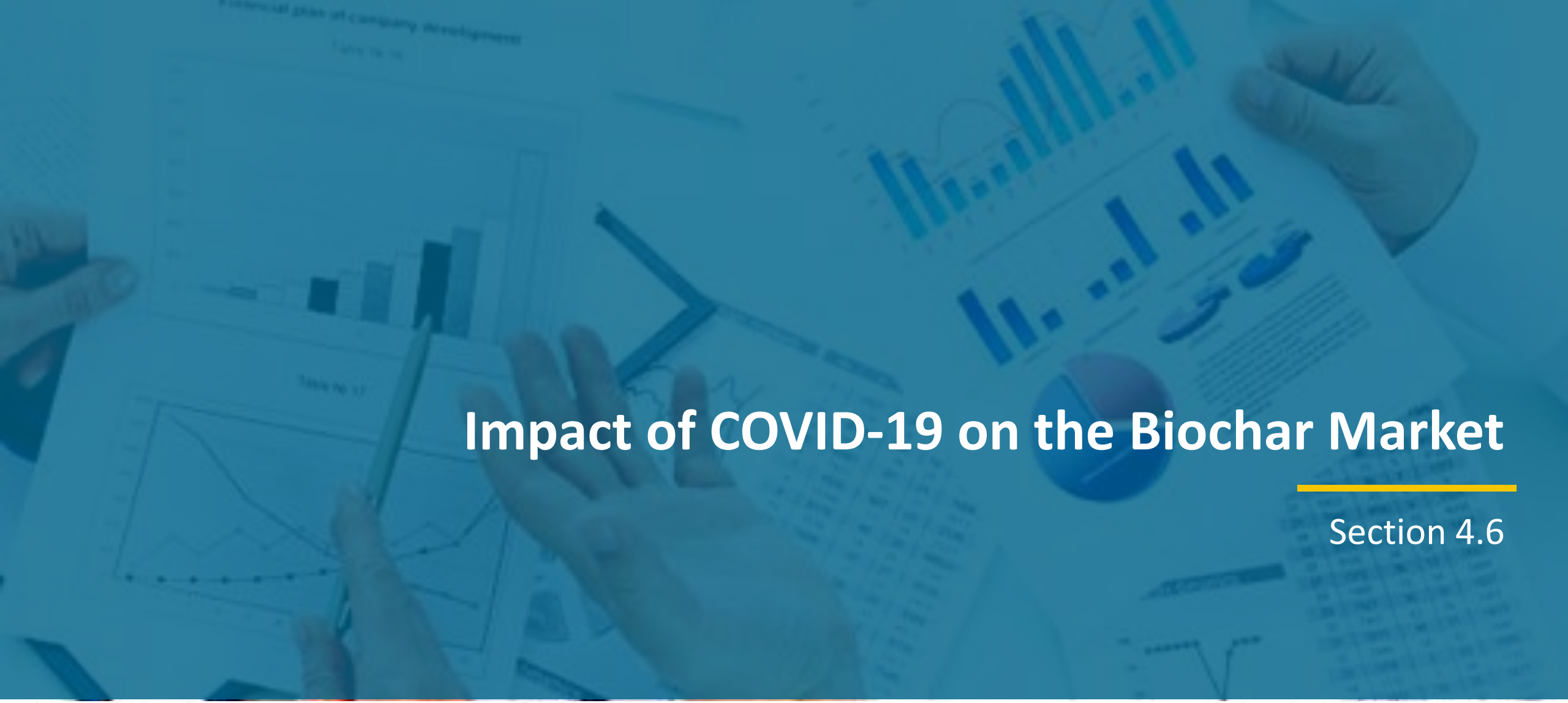
- The market has the presence of comparatively fewer biochar providers & operators. Furthermore, a significant number of firms have already established their foothold in the market, and few small firms with similar product offerings.
- The degree of competition is expected to be High during the forecast period owing to the rising adoption of biochar in the market with fewer companies present in the market.

Threat of Substitutes – Moderate

- The threat of substitutes refers to the effect of a substitute product on the concerned product market. The easy availability of natural gas is the major substitute present in the market. Thus, the threat of substitutes in the biochar market is estimated to be medium during the forecast period.

Bargaining Power of Buyers – Moderate to Low

- There are large numbers of buyers available for the biochar market. The switching cost of buyers is low to moderate as many suppliers are present in the market. Thus, buyers' bargaining power in the market is projected to be medium to low during the forecast period.



Impact of COVID-19 on the Biochar Market

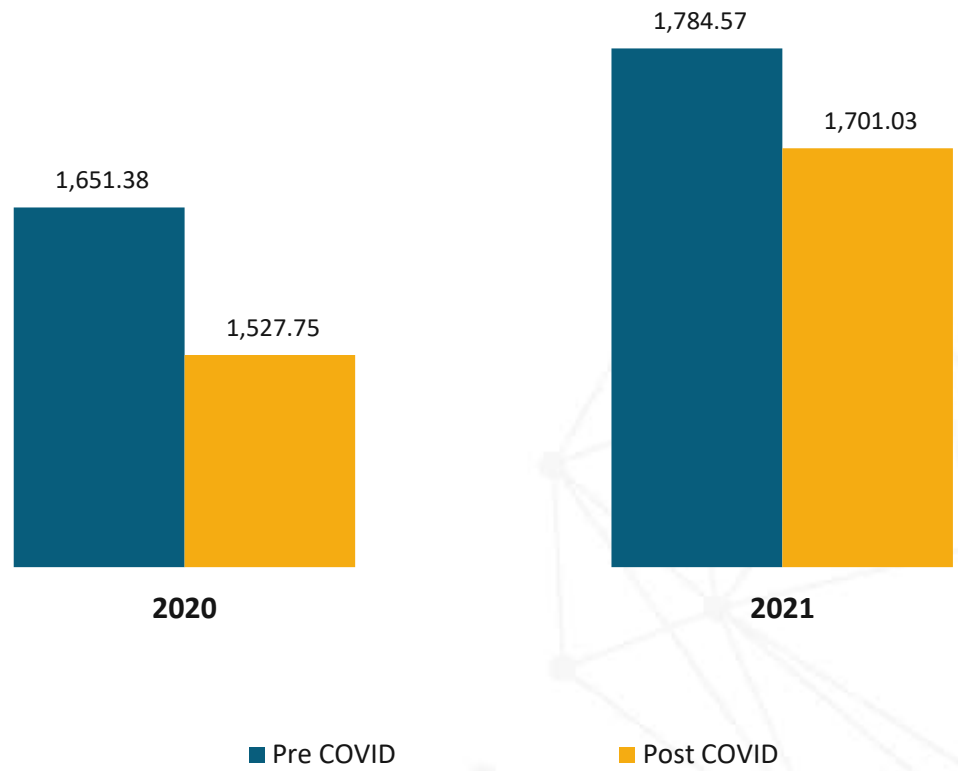
Section 4.6

Impact of COVID-19: Qualitative Analysis

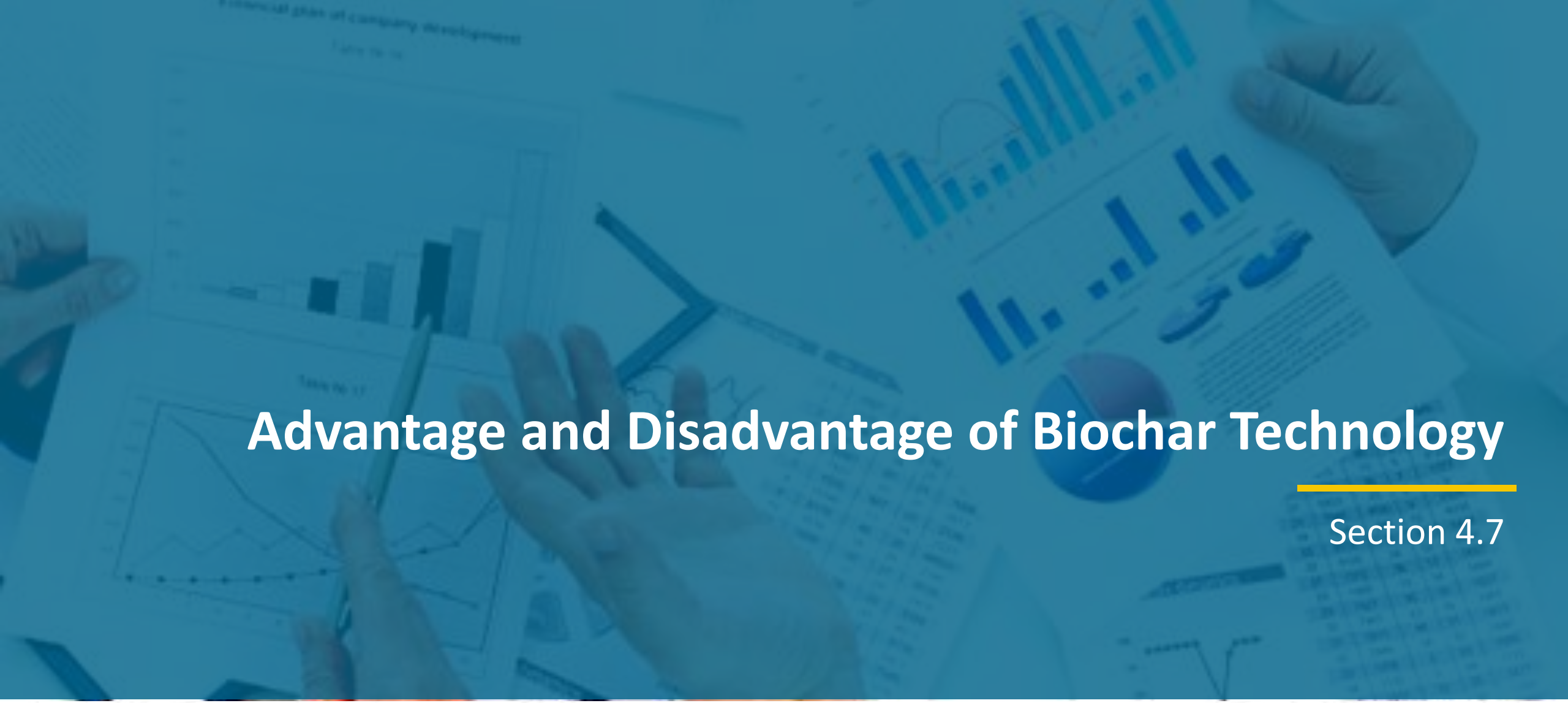
Impact of COVID-19 on Biochar Market

- The sudden outbreak of the infectious disease recognized as the coronavirus disease (COVID-19) triggered by the newly discovered coronavirus has caused chaos and panic across the globe, causing the termination of all normal daily activities like going to work, gathering, meetings, and commute between countries even stepping a foot outside the house.
- However, the suggestions of this pandemic crisis have affected many industries in diverse ways, such as the halt of domestic industrial procedures, decreased production, disruptions in value chains, raw material shortage, no international transactions, imports and export stopped, unreachability of new orders and clients, lack of operating staffs, and many others things.
- The blowout of COVID-19 has expressively impacted the biochar producing plant market due to supply chain disruption and a fall in investment in this Technology of upcoming plant in the European Union. The overall energy demand has broadly decreased in this region due to the pandemic as most of the industries and commercial sectors were closed.

COVID-19 Impact Analysis (in USD Thousands)



Source: Fortune Business Insights Analysis



Advantage and Disadvantage of Biochar Technology

Section 4.7

FORTUNE BUSINESS INSIGHTS

Advantage and Disadvantage of Biochar Technology (1/2)

Advantage and Disadvantage of Pyrolysis Technology

Advantages of Pyrolysis Technology:

- Biochar is made by heating biomass in an oxygen-limited environment through a process called pyrolysis. The biomass, which has removed CO_2 from the atmosphere during plant growth, is broken down into a carbon-rich material that is then compressed into a solid form.
- Biochar pyrolysis equipment is a type of machinery that uses pyrolysis technology to convert biomass (such as agricultural and forestry waste) into biochar. Pyrolysis of biochar is a process of heating organic materials in the absence of oxygen, which causes them to break down into smaller molecules and release volatile gases.
- The resulting biochar is a stable form of carbon that can be used to improve soil fertility, store carbon, and produce energy.
- The biochar pyrolysis technology is considered to be an environmentally friendly technology because it converts waste biomass into a useful product while reducing greenhouse gas emissions.
- Biochar pyrolysis equipment is emerging as a key technology for managing organic waste and reducing greenhouse gas emissions.
- This versatile tool can convert a wide range of biomass feedstocks into high-quality biochar, as well as other valuable products such as wood vinegar, tar as well as combustible gas.
- Increasing pyrolysis temperature could remarkably increase the pore volume and surface area of biochar due to the carbon phase change from amorphous to graphitic form and the driving off of pore-blocking substances.

Disadvantages of Pyrolysis Technology

- With insufficient gas treatment at the outlet, incomplete pyrolysis creates furans, hexanes, and dioxins even when using clean virgin wood. If this happens, because of poor quality control, the syngas must be burnt at high temperature before being ejected. This way, there are no toxic chemicals exiting the plant. However, the process had drawbacks of less yield percentages, less energy and excessive air pollution
- Pyrolysis temperature has an influence on the structure of biochar due to the release of volatiles and the formation and volatilization of intermediate melts. Increasing the temperature leads to a decreased content of volatile matter (VM).

Advantage and Disadvantage of Biochar Technology (2/2)

Advantage and Disadvantage of Gasification Technology

Advantages of Gasification Technology:

- Gasification is an effective thermochemical conversion process for biomass into energy fuel while producing biochar as a byproduct. Typically, carbonaceous materials derived from organic fossil fuels can be converted into hydrogen, carbon monoxide, and carbon dioxide employing gasification.
- The gasification process has several advantages over other thermal processes the ability to dissolve material at lower reactor volumes, the formation of low amounts of contaminants and more efficient utilization of the produced syngas.
- Compared to pyrolysis, it has the advantage of working auto thermally without the need for external energy. During the gasification process, heat transfer within a particle that increases the localized temperature of biomass leads to the removal of water and follows by the progressive release of pyrolytic volatiles.
- Municipal solid waste, agricultural and industrial waste, sewage sludge, etc. are also being used as a feedstock while performing gasification operation.
- Gasification produces around 85% gaseous products, 10% solid char, and 5% liquid products

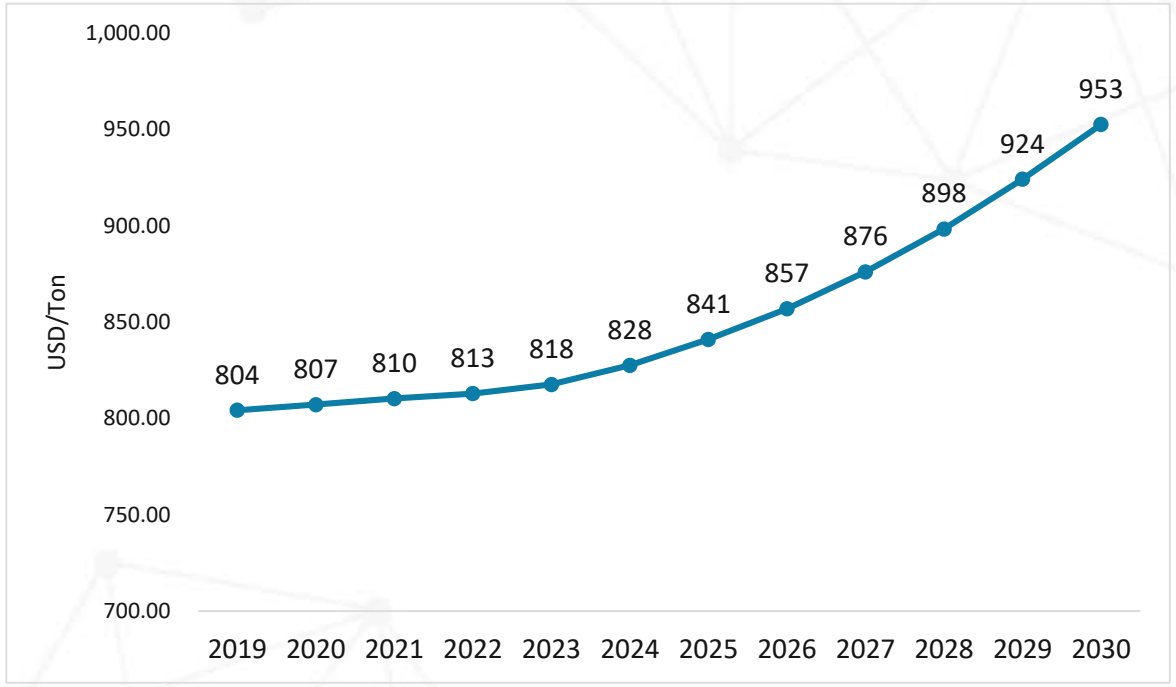
Disadvantages of Gasification Technology

- The gasification process is known to yield products that can cause various forms of environmental degradation.
- This includes greenhouse gases like methane and water vapor (steam), and toxic materials like particulate matter and carbon monoxide such effluents can have negative environmental impacts, especially if released in large quantity.
- By reducing air quality, and contaminating water and soil, the products of gasification, in the absence of proper handling, can pose a threat to environmental sustainability, economic growth and public health. The reason behind this is the chemical composition of biomass feedstock that are used as substrate in gasification. These materials are usually carbon sinks, and may function as carbon sources as they undergo thermal decomposition.
- The thermo-chemical reactions in gasification may produce toxic compounds from feedstock, alongside useful products like biofuel.
- Although gasification is not a totally sustainable process, it produces less hazardous effluents than other processes like open combustion and incineration, which are known to yield significant amounts of furans and dioxins.
- Gasification is a time-consuming process, especially in as a result of multiple treatment stages. Pretreatment and post-treatment all involve measures to remove unwanted constituents from feedstock or products of gasification. These measures make gasification more time-intensive, and add to the operational cost involved.

Price Trend Analysis of Biochar in UK

Section 4.8

Price Trend Analysis of Biochar (USD/Ton)



- Some current markets for biochar are soil amendments for gardens and landscaping where volumes are low and prices are high, so biochar's are often more expensive than farmers can afford.
- Large scale utilization of non-merchantable forest biomass as a feedstock for biochar production will be made possible by transparent and consistent feedstock supply chains coupled with 1) high carbon market prices, 2) a subsidy or other price mechanism to lower feedstock costs, or 3) economies of scale.
- There are emerging opportunities but overall the market is in its infancy with limited production and high cost.
- For instance, low profit and high cost assumed 50% importance in market category and 50% importance in technical category

- The cost of feedstock acquisition can be computed as either the production cost, if a feedstock is produced explicitly for pyrolysis, or the opportunity cost of an existing feedstock diverted to pyrolysis.
- However, biochar supports the retention of the soil and water, thus reducing irrigation costs and fertilizers and recovering depleted soils. Biochar, as an additive to the soil, lasts long and does not need to be added every year when compared to agricultural fertilizers thus, it is cost-effective.
- Therefore, biochar production can be attractive if the proceeds of the economic costs of raising, harvesting, hauling, and storing the biomass feedstock, alongside those of employing pyrolysis, transportation, and application of biochar.

Timeline Required for Biochar Plant

Section 4.9

FORTUNE BUSINESS INSIGHTS

Timeline Required for Biochar Plant (1/4)

Timeline Required for Biochar Plant

- Biochar production involves the conversion of biomass into biochar through a process called pyrolysis and gasification. Building a biochar production facility involves a range of requirements to ensure its successful construction, operation, and compliance with regulations. These requirements span various aspects, including technical, environmental, regulatory, and safety considerations.
- Selection of a suitable location that considers factors such as access to feedstock sources, transportation infrastructure, proximity to markets, and compliance with zoning and land-use regulations. Conduct an assessment to evaluate the potential environmental impacts of the facility. This may involve studies on air quality, water usage, waste management, and ecological impacts.
- Platform deployment within a biochar facility creates a structured and integrated system that streamlines various processes, data management, and operations. Such a platform can help optimize production, enhance efficiency, and facilitate decision-making. Platform development can be implemented within a biochar facility are: Software development, trial software with farmers, iterate on software, testing of software with live biochar deliveries and usage, iterate on software with stakeholder feedback.
- Implement automation systems to control and monitor different stages of biochar production, including feedstock handling, pyrolysis, emissions control, and biochar processing. Automation helps reduce human error, improve consistency, and enhance overall production efficiency. Develop a remote monitoring system that allows operators and managers to access real-time data and control facility operations from a distance. This feature is particularly useful for overseeing operations, diagnosing issues, and making adjustments remotely.
- Emissions monitoring and reporting is the important aspect of BUILD a module for monitoring emissions in real-time and generating reports to meet regulatory compliance requirements. This ensures that emissions stay within acceptable limits and facilitates reporting to authorities.
- Developing a platform for a biochar facility requires collaboration between experts in platform development, machine installation, biochar demonstration hub, and monitoring and evaluation of biochar production. An effective platform can significantly enhance the facility's operational efficiency, data management, and overall performance.

Timeline Required for Biochar Plant (2/4)

Project Plan	Year 1				Year 2				Year 3	
	Q 1	Q 2	Q 3	Q4	Q 1	Q 2	Q 3	Q4	Q 1	Q 2
Site Selection										
Raw Material/ Machinery suppliers Identification										
Platform Development										
Machinery Installment										
Purchace Machinery										
Machine Manufacturing										
Supportive Machinery Procurement										
Site Preparation										
Machinery Installation										
Training of BSW Operational Staff										
Biochar Production										

Timeline Required for Biochar Plant (3/4)

Project Plan	Year 1				Year 2				Year 3	
	Q 1	Q 2	Q 3	Q4	Q 1	Q 2	Q 3	Q4	Q 1	Q 2
Biochar Demonstrator Hub										
Farmer Guidebook Preparation										
Farm Emission Reduction and Storage Potential Reports										
Planning of Climate Check Integration with Biochar Farmers										
Small Trial of Biochar / Compatibility Testing										
Training of Farmers for Biochar use										
Farmer Guidebook Iteration										
Focus Group with Farmers										
Categorisation of Biochar use in Systems										
Integration of Biochar into Climate Check										

Timeline Required for Biochar Plant (4/4)

Project Plan	Year 1				Year 2				Year 3	
	Q 1	Q 2	Q 3	Q4	Q 1	Q 2	Q 3	Q4	Q 1	Q 2
Monitoring & Evaluation										
Field Trial Planning and Setup										
Field Trial Sampling										
Annual Treatment Application										
Biochar Testing & Quality Control										

UK Biochar Market

Section 05

Key Findings / Summary

Section 5.1

UK Biochar Market

- Organizations such as the UK Biochar Research Centre (UKBRC) and the European Biochar Certificate (EBC) have developed and promoted some standards for defining biochar. The European biochar market is growing with increasing demand for sustainable and eco-friendly products. Biochar is charcoal produced from organic materials such as agricultural waste, forestry waste, and other biomass, which is then used as a soil amendment to improve soil fertility, increase water retention, and reduce greenhouse gas emissions.
- In recent years, the biochar market in the UK has experienced significant growth due to increasing consumer awareness about the environmental benefits of biochar, as well as favorable regulations and policies aimed at promoting sustainable agriculture and reducing carbon emissions.
- The UK government is awarding US$ 54 million to 15 projects to develop technologies that remove carbon emissions from the atmosphere. The money will help projects further develop their greenhouse gas removal technologies, which include a machine that can pull carbon dioxide out of the air, a plant to convert household waste into hydrogen for use in the transport industry, and a system to remove carbon dioxide from seawater.
- The market is expected to continue growing in the coming years, driven by rising demand for organic and sustainable agriculture products and increasing adoption of biochar in the energy and waste management sectors.
- The market is highly competitive, with companies focusing on expanding their product portfolios, investing in research and development activities, and promoting their products through various marketing strategies.
- Overall, the UK biochar market presents significant growth opportunities for companies operating in the industry and is expected to continue growing in the coming years as demand for sustainable and eco-friendly products increases.

Market Analysis, Insights and Forecast – By Technology

Section 5.2

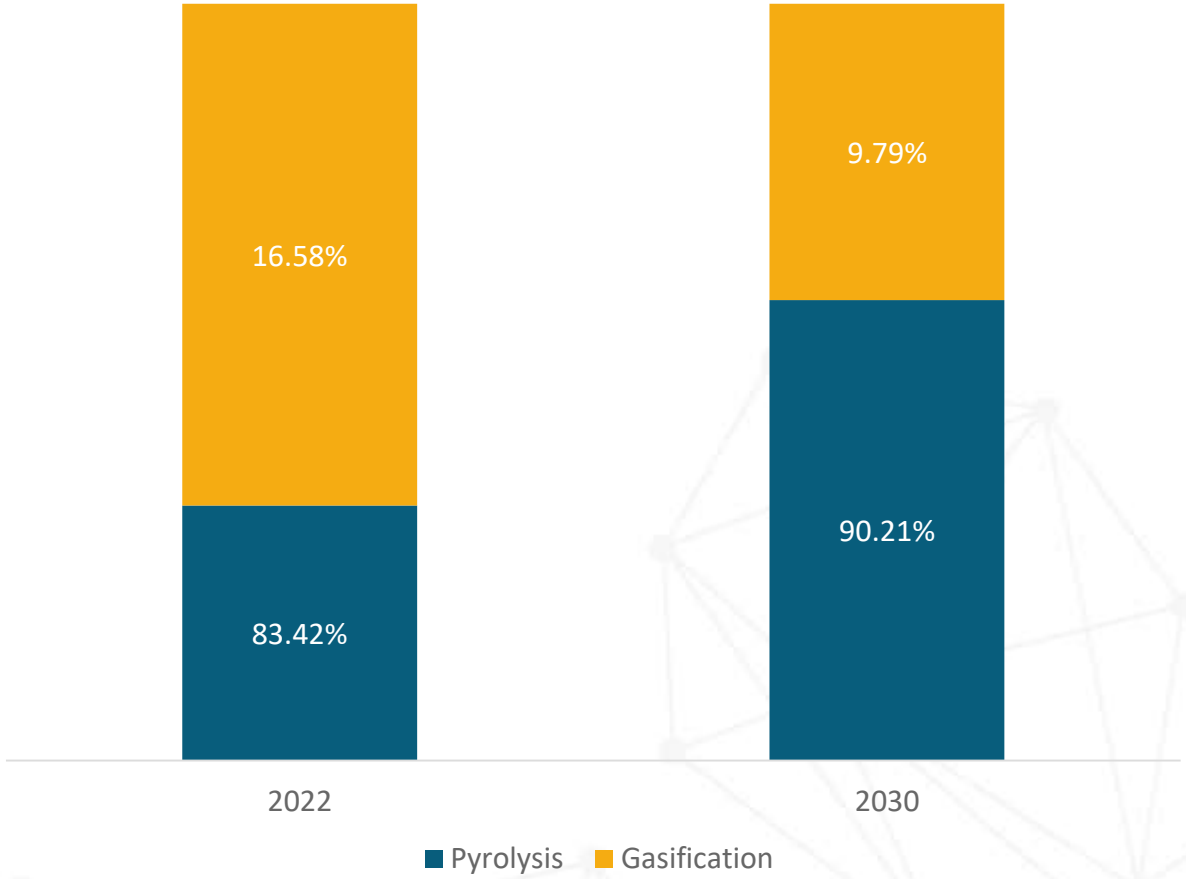
FORTUNE BUSINESS INSIGHTS

UK Market Analysis and Insights, By Technology

Analysis

- Based on technology, the market has been divided into pyrolysis and gasification. The pyrolysis segment is anticipated for a significant share of the UK market, in 2022. The process is widely adopted in the biochar market owing to its huge benefits like cost efficiency, and it is more convenient than the others. Most plants are said to use the pyrolysis process in the country.
- Pyrolysis also has comprehensive capabilities of processing a wide variety of feedstock, making it preferable and contributing to greenhouse gas emission reduction in the environment. The above factors make pyrolysis preferable over others. Pyrolysis is an important method to convert bulky biomass into biochar of higher volumetric energy density, bio-oil of a mixture of organics and gases
- The gasification segment will hold an slight market share in 2022 compared to pyrolysis. The process is not quite much popular as pyrolysis. The demand for such char is estimated to increase in the market in the coming years.

Figure 02: UK Biochar Market Value Share (%), By Technology, 2022 & 2030



UK Market Forecast, By Technology

Table 01: UK Biochar Market Revenue (Tons) Forecast, By Technology, 2019–2030

By Technology	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	CAGR (2023-2030)
Pyrolysis	1,458.08	1,574.08	1,761.21	2,055.02	2,326.99	2,587.21	2,867.69	3,211.35	3,624.09	4,170.58	4,895.47	5,830.23	14.02%
Gasification	300.07	318.62	338.01	356.98	376.45	396.92	417.99	439.58	461.81	484.61	507.58	530.81	5.03%
TOTAL	**1,758.15**	**1,892.70**	**2,099.23**	**2,412.00**	**2,703.44**	**2,984.13**	**3,285.68**	**3,650.93**	**4,085.90**	**4,655.20**	**5,403.05**	**6,361.04**	**13.00%**

UK Market Forecast, By Technology

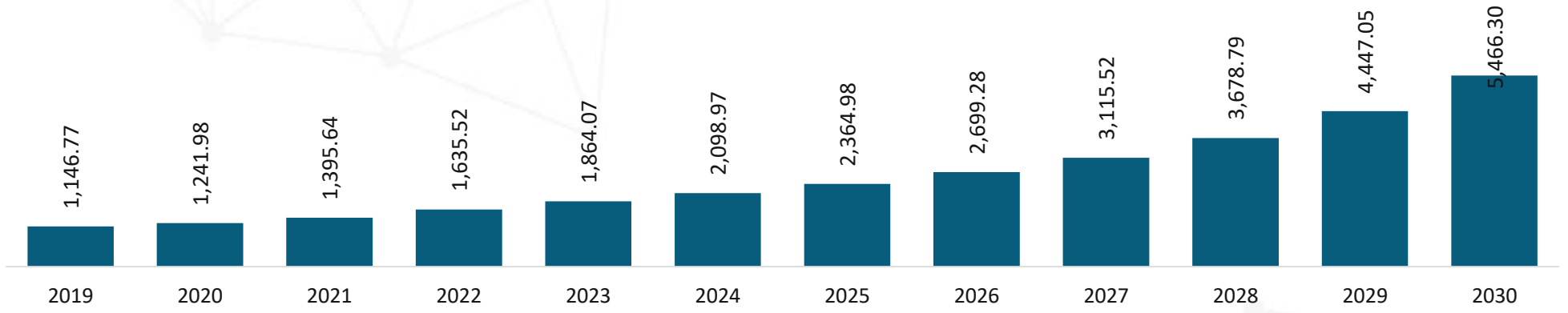
Table 02: UK Biochar Market Revenue (USD Thousands) Forecast, By Technology, 2019–2030

By Technology	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	CAGR (2023-2030)
Pyrolysis	1,146.77	1,241.98	1,395.64	1,635.52	1,864.07	2,098.97	2,364.98	2,699.28	3,115.52	3,678.79	4,447.05	5,466.30	16.61%
Gasification	267.21	285.77	305.39	325.11	346.22	370.69	398.42	429.27	464.09	503.25	546.20	593.19	8.00%
TOTAL	**1,413.97**	**1,527.75**	**1,701.03**	**1,960.64**	**2,210.29**	**2,469.66**	**2,763.40**	**3,128.55**	**3,579.61**	**4,182.03**	**4,993.25**	**6,059.49**	**15.50%**

UK Market Analysis and Insights, By Technology

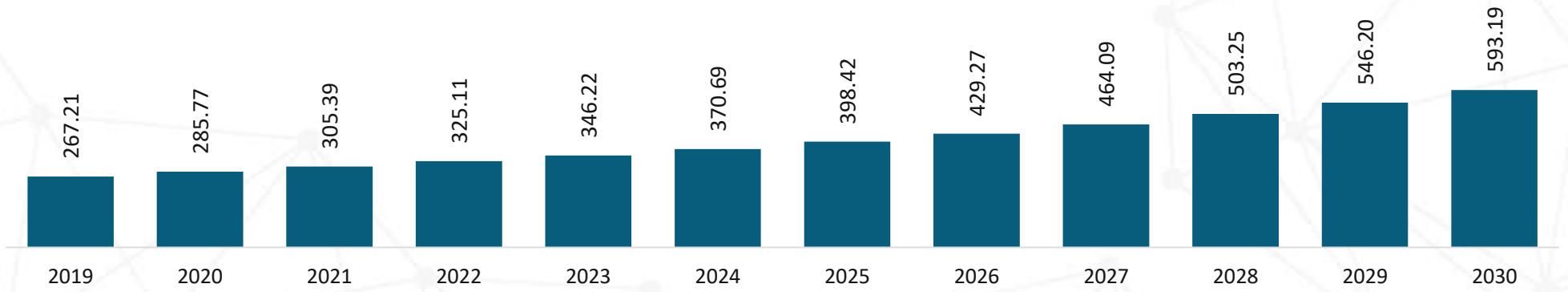
Pyrolysis

Figure 03: UK Biochar Market Forecast (USD Thousands),By Pyrolysis , 2019-2030



Gasification

Figure 04: UK Biochar Market Forecast (USD Thousands),By Gasification, 2019-2030



Market Analysis, Insights and Forecast – By Application

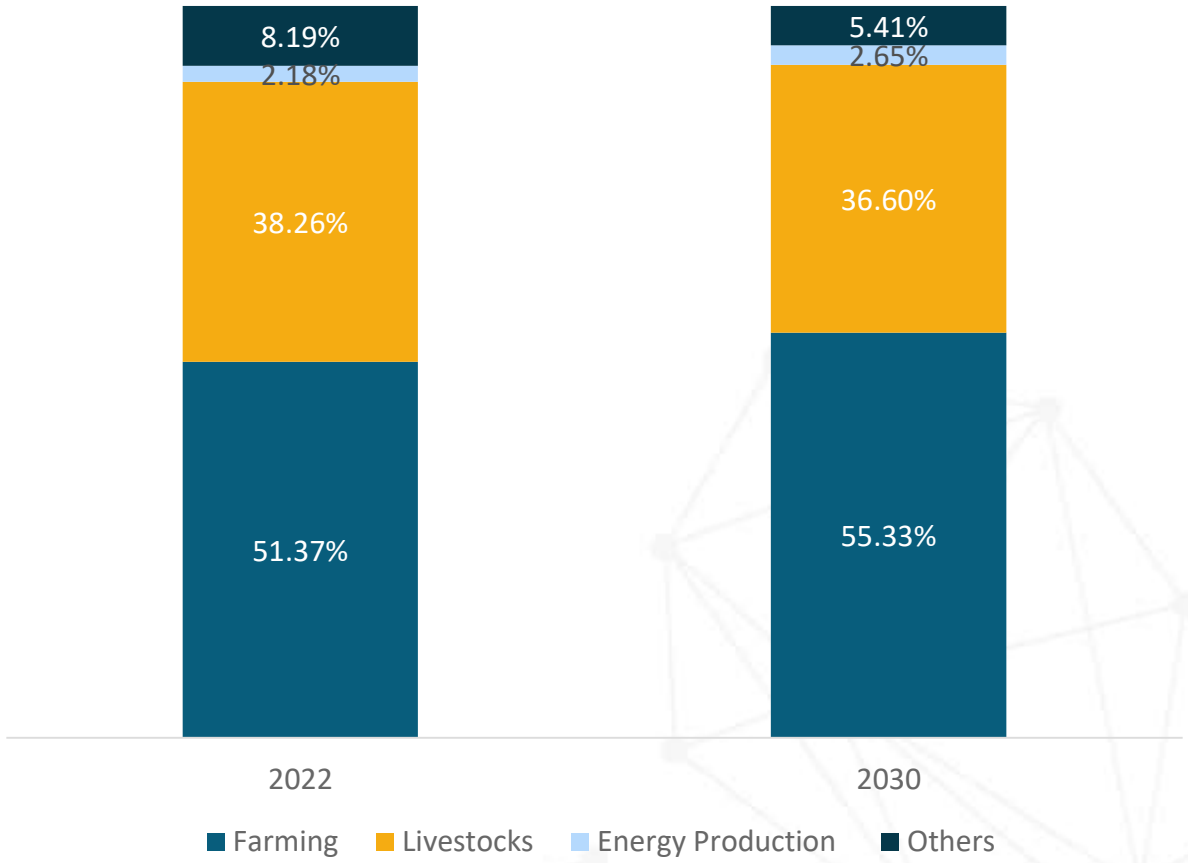
Section 5.3

UK Market Analysis and Insights, By Application

Analysis

- The market has been segmented based on applications like farming, livestock, energy production and others. The farming segment is estimated to lead the market during the forecast period. Biochar is widely used in farming owing to the various benefits it offers to the farming segment.
- It is used as a fertilizer to enhance natural carbon sequestration rates in the soil. Biochar is also known to reduce farming waste and serves the betterment of the environment. In addition to being a stable store of carbon, when used as a soil amendment, biochar can provide numerous benefits to agricultural production, such as increasing soil quality as well as water and nutrient retention. It remains stable in the soil for thousands of years.
- The livestock segment is also booming in the country. Biochar is widely used to feed livestock as it helps reduce waste, and it can be turn out to be utilized as feed for various animals. The demand from the livestock segment is growing at a rapid pace.

Figure 05: UK Biochar Market Value Share (%), By Application, 2022 & 2030



UK Market Forecast, By Application

Table 03: UK Biochar Market Revenue (Tons) Forecast, By Application, 2019–2030

By Application	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	CAGR (2023-2030)
Farming	885.58	962.82	1,078.37	1,251.11	1,415.80	1,577.71	1,753.57	1,966.76	2,221.51	2,554.32	2,991.69	3,553.93	14.05%
Livestock	689.37	737.40	812.62	927.67	1,033.00	1,132.80	1,239.06	1,367.68	1,520.42	1,720.64	1,983.56	2,319.36	0.12
Energy Production	25.84	28.79	33.02	39.21	45.41	51.77	60.92	72.05	85.51	102.98	125.97	155.90	0.19
Others	157.35	163.70	175.22	194.01	209.23	221.85	232.12	244.43	258.46	277.26	301.84	331.85	6.81%
Total	**1,758.15**	**1,892.70**	**2,099.23**	**2,412.00**	**2,703.44**	**2,984.13**	**3,285.68**	**3,650.93**	**4,085.90**	**4,655.20**	**5,403.05**	**6,361.04**	**13.00%**

UK Market Forecast, By Application

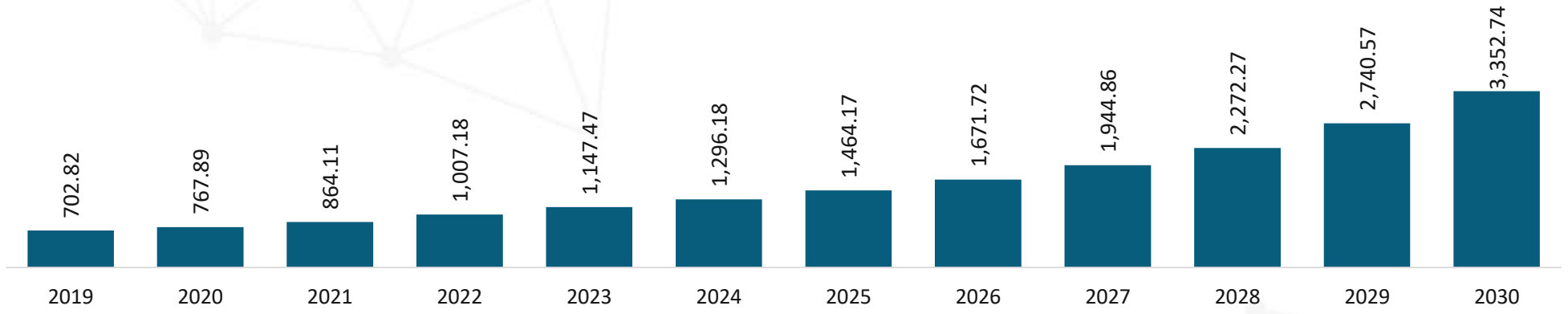
Table 04: UK Biochar Market Revenue (USD Thousands) Forecast, By Application, 2019–2030

By Application	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	CAGR (2023-2030)
Farming	702.82	767.89	864.11	1,007.18	1,147.47	1,296.18	1,464.17	1,671.72	1,944.86	2,272.27	2,740.57	3,352.74	16.55%
Livestock	549.62	590.90	653.31	750.15	840.87	939.88	1,050.29	1,179.67	1,328.16	1,551.75	1,835.29	2,217.88	14.86%
Energy Production	27.09	30.81	35.21	42.66	49.32	52.78	60.98	68.08	86.44	101.00	126.56	160.80	18.39%
Others	134.45	138.15	148.41	160.65	172.62	180.82	187.96	209.07	220.14	257.02	290.83	328.07	9.61%
Total	**1,413.97**	**1,527.75**	**1,701.03**	**1,960.64**	**2,210.29**	**2,469.66**	**2,763.40**	**3,128.55**	**3,579.61**	**4,182.03**	**4,993.25**	**6,059.49**	**15.50%**

UK Market Analysis and Insights, By Application

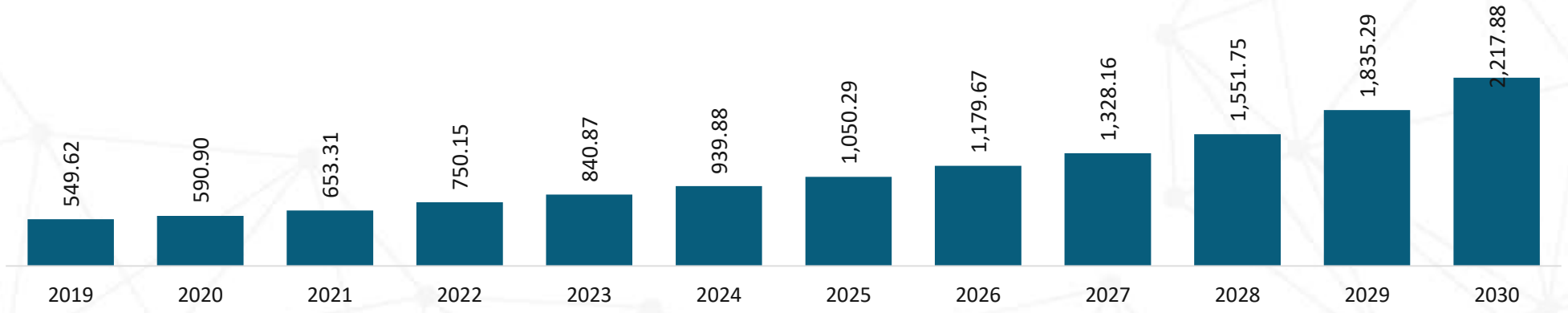
Farming

Figure 06: UK Biochar Market Forecast (USD Thousands),By Farming, 2019-2030



Livestock

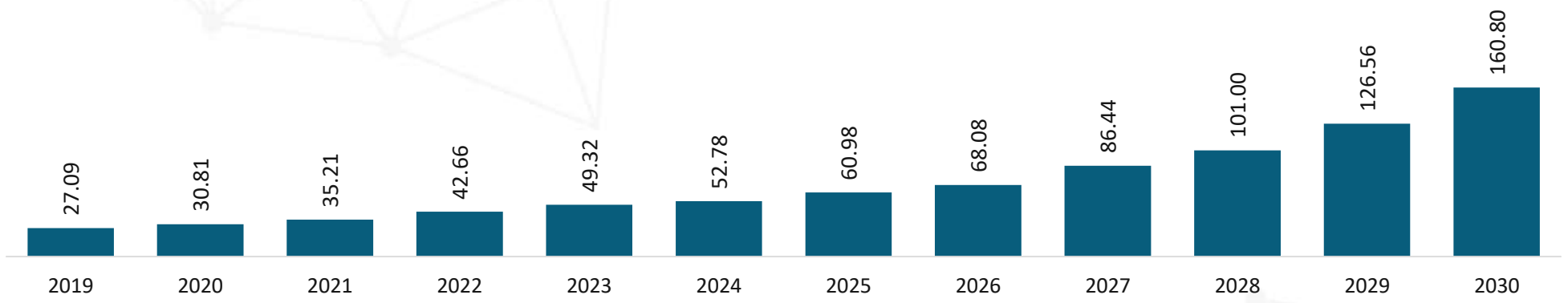
Figure 07: UK Biochar Market Forecast (USD Thousands),By Livestock, 2019-2030



UK Market Analysis and Insights, By Application

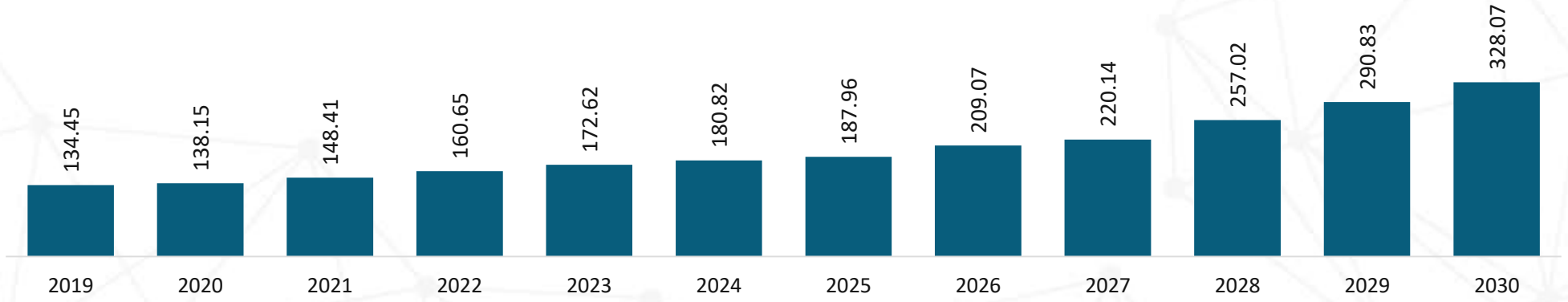
Energy Production

Figure 08: UK Biochar Market Forecast (USD Thousands),By Energy Production , 2019-2030



Others

Figure 09: UK Biochar Market Forecast (USD Thousands),By Others, 2019-2030



Company Profiles

Section 06

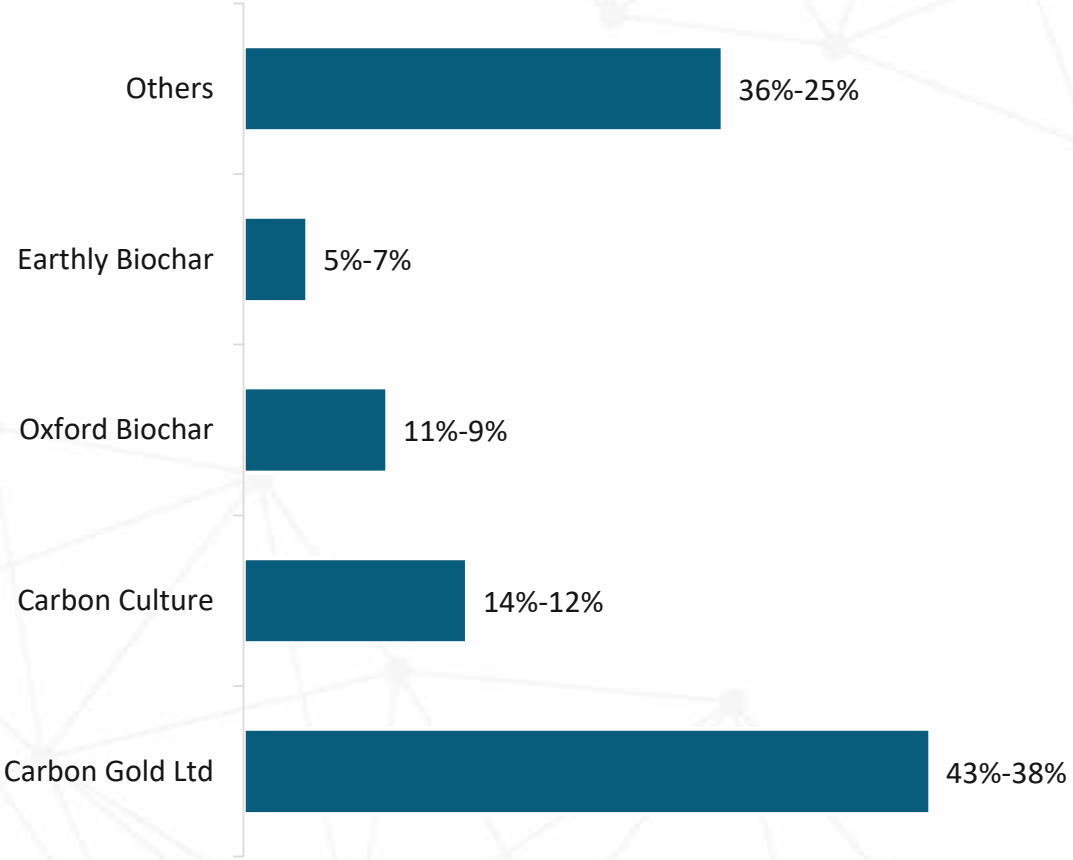
Company Market Share Analysis

Section 6.1

FORTUNE BUSINESS INSIGHTS

Company Market Share Analysis (2022)

Figure 10: Company Market Share Analysis (%), 2022



Analysis

- UK biochar market is fragmented with a some medium-scale country players delivering a wide range of products across the value chain. Carbon Gold is expected to account for a significant market share owing to its extensive range of product portfolio along with the strong brand value. Furthermore, the company is also focused to enhance its sales, distribution, and marketing channels through partnerships with different local associates to fortify its product reach across the UK. Carbon Gold is the one of the leading biochar company. They produce and supply high-quality biochar products for use in agriculture, horticulture, and environmental applications.
- Additionally, other key participants operating in the industry include Circular Carbon GmbH, carbon culture, Oxford Biochar, Carbon Hill, among others, leading in providing various biochar across different verticals.
- Companies are also focusing on product development, technology and collaborating with industry players, including network providers, product improvement, and end-users, allows companies to access new market and enhance their market share. Strategic partnerships and alliances is providing companies with a broader customer base and improved market reach.

Company Profiles

Section 6.2

Carbon Gold Ltd

Company Name
Carbon Gold Ltd

Year of Establishment
2007

Headquarters
Clevedon, UK

Revenue
~ USD 0.95 Million (2022)

Director
Susan Ann Rawlings

Employee Strength
~25 (2022)

Website
www.carbongold.com

Company Overview

- Carbon Gold is the world's leading biochar company. Manufacturers and supply high-quality biochar products for use in agriculture, horticulture, and environmental applications.
- Carbon Gold is a B-Corp certified company that is committed to making a positive impact on the world.
- The company have worked with Premier League football clubs, major race and golf courses, as well as the Royal Parks and Gardens in the UK.
- The products are 100% free from peat and synthetic chemicals, Soil Association approved for organic growing, and Made in Britain certified.

Business Overview

Business Segments	Products & Services
Biochar	Biochar Additives
	Fertiliser
	Peat-Free Compost
	Soil Improver

Circular Carbon GmbH

Company Name
Circular Carbon GmbH

Year of Establishment
2018

Headquarters
Straubing, Germany

Revenue
~ USD 2.67 Million (2022)

Managing Director
Peik Stenlund

Employee Strength
~30 (2022)

Website
www.circular-carbon.com

Company Overview

- Circular Carbon produces biochar, which is extremely effective in many areas and can restore the natural balance of microbiological habitats.
- The company plan, develop and operate carbonization plants for the production of biochar. They enable the use of residues for the circular economy.
- When charring, the company also generate renewable energy. In Hamburg the company have installed the largest charring plant in Germany.
- Circular Carbon GmbH is a part of the econnext group, which, as a sustainability holding company, is the strong partner for implementing the common mission of promoting the circular economy.

Business Overview

Business Segments	Applications
Biochar	Floor application
	Biochar for animals
	Product development

Carbo Culture

Company Name
Carbo Culture

Year of Establishment
2018

Headquarters
Clevedon, UK

Revenue
~ USD 1.5 Million (2022)

CEO & Co-Founder
Henrietta Moon

Employee Strength
~35 (2022)

Website
www.circular-carbon.com

Company Overview

- The company got started in 2018 with initial funding and the R1 reactor prototype assembly.
- Carbo Culture has developed a proprietary carbon removal technology called Carbolysis™. The technology is more efficient and carbolysis process uses a patented pyrolysis method to convert waste biomass into solid biochar through high temperatures and pressures with unique control methods.
- Most permanent methods of carbon removal are limited by their technological scalability.
- At Carbo Culture have leveraged natural processes with advanced engineering to create a rapidly scalable solution.

Business Overview

Business Segments	Applications
Biochar	Agriculture
	Urban landscaping
	Construction materials

Carbo Culture

Recent Developments

- **In August 2023 -** Carbo Culture's first industrial pilot facility opens near Helsinki, Finland, demonstrating efficient and scalable biochar carbon removal. The facility, named 'R3, or Reactor 3,' is funded by the European Innovation Council and it uses a method called biochar carbon removal (BCR) to permanently remove carbon dioxide (CO2) from the atmosphere.
- **In March 2023** - Carbo Culture joins the NextGen CDR facility portfolio. NextGen's portfolio would establish the market best practice for project standard certification. All projects will be certified and verified under standards endorsed by the International Carbon Reduction and Offset Alliance (ICROA) to ensure an independent third-party assurance that the projects are of the highest environmental integrity and benefit local communities.

Oxford Biochar

Company Name
Oxford Biochar

Year of Establishment
2013

Headquarters
Faringdon, UK

Revenue
~ USD 0.29 Million (2022)

Director
Jonathan Chappell

Employee Strength
~30 (2022)

Website
www.oxfordbiochar.org

Company Overview

- Oxford Biochar is the sister company to the world-renowned The Oxford Charcoal Company, who have been manufacturing Sustainable Charcoal since 2013.
- The Biochar is produced from pure biomass, and its source is certified by Grown In Britain (GiB) and the European Biochar Certification (EBC). It's not mixed or enhanced with foreign materials so you can be confident it's safe to use as animal feed and to grow food too.
- The Biochar is produced from green wood, not waste. Its made in the UK or EU and actively used in real project in the following verticals; Farming, Horticulture, Animal Feed, Water Filtration and Medical Applications.

Business Overview

Business Segments	Applications
Biochar	Soil Improver and Composting
	Farming, Animal Husbandry
	Biochar in Building Materials
	Water Filtration

Carbon Hill

Company Name
Carbon Hill

Year of Establishment
2021

Headquarters
Welshpool, UK

Revenue
NA

Director
JONES, Frederick Michael

Employee Strength
NA

Website
NA

Company Overview

- Carbon Hill is a biochar company owned by the Jones family located in Caebardd farm, near Welshpool in mid-Wales, UK. The company has changed its named from Karbon Capture Limited to Carbon Hill on 25th January 2023.
- The company has developed a proprietary pyrolysis thermal combustion system that utilizes new and existing technologies to produce biochar with minimal emissions.
- Carbon Hill sources two types of waste woody biomass for their biochar production: hedgerow cuttings from farm fields and Green Waste Over Size (GWOS) from local parks and gardens. These feedstocks are largely underutilized in the UK and are typically either left to biodegrade or burn, leading to carbon loss

Business Overview

Business Segments	Applications
Biochar	Agriculture
	Retail
	Land remediation

Earthly Biochar

Company Name
Earthly Biochar

Year of Establishment
2018

Headquarters
Welshpool, UK

Revenue
~ USD 0.25 Million (2022)

Director
Charlotte Hawkins

Employee Strength
~22 (2022)

Website
www.earthlybiochar.com

Company Overview

- Earthly Biochar are UK biochar suppliers, committed to combating climate change through making high-performance, sustainable products accessible at affordable prices.
- The biochar kilns are handmade to order in the Welsh countryside supporting rural communities. Every part of kilns is made in the UK.
- The clean burning technology makes it easy and economical for domestic gardeners to make their own powerful soil amendments in just one hour, with the process optimized to create carbon neutral heat over harmful smoke.
- The company is becoming a driver for the movement in UK, with more carbon-conscious individuals wanting to explore alternatives, and discover its potential applications.

Business Overview

Business Segments	Product Segments
Biochar	Biochar Kiln
	Biochar with Inoculant Powder

List of Potential Equipment Supplier

Section 07

List of Potential Equipment Supplier (1/2)

Name	Headquarter	Website
SYNCRAFT	Schwaz, Austria	www.en.syncraft.at.com
Biomacon GmbH	Rehburg, Germany	www.biomacon.com
PYREG	Dörth, Germany	www.pyreg.com
Carbon Technik Schuster GmbH	Neresheim, Germany	www.ct-schuster.de
Vow ASA	Lysaker, NORWAY	www.vowasa.com
SOLER Group	Gyé-sur-Seine , France	www.carbon-centric.com
CARBOFEX	Kaarnakatu 1, Finland	www.carbofex.fi.com
Aquagreen	Roskilde, Denmark	www.aquagreen.dk.com
Next Generation Elements GmbH	Feldkirchen, Austria	www.nge.at.en.com
PyroCore	Bristol BS11 8AP, United Kingdom	www.pyrocore.com
PERPETUAL NEXT	Amsterdam, Netherlands	www.perpetualnext.com
XYLERGY	Belgium	www.xylergy-group.com
Carbonauten	Giengen, Germany	www.carbonauten.com

List of Potential Equipment Supplier (2/2)

Name	Headquarter	Website
Stiesdal	Aarhus, Denmark	www.stiesdal.com
CARBOFORCE	Preetz, Germany	www.carbo-force.de/en/home
Meva Energy	Hisings Backa, Sweden	www.mevaenergy.com
EQTEC	London, UK	www.eqtec.com
Haffner Energy	Rue Saint-Augustin, Paris	www.haffner-energy.com
Mash Makes	København, Denmark	www.mashmakes.com
Beston Group Co., Ltd.	CHINA	www.bestongroup.com
PyroPower GmbH	Germany	www.pyro-power.com
GUNTAMATIC HEIZTECHNIK GMBH	Peuerbach, Austria	www.guntamatic.com
Clayton Deutschland GmbH	UK	www.claytonsteam.com
BBS GmbH	Germany	www.bay-boiler.com
Alfa Laval	Sweden	www.alfalaval.com

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