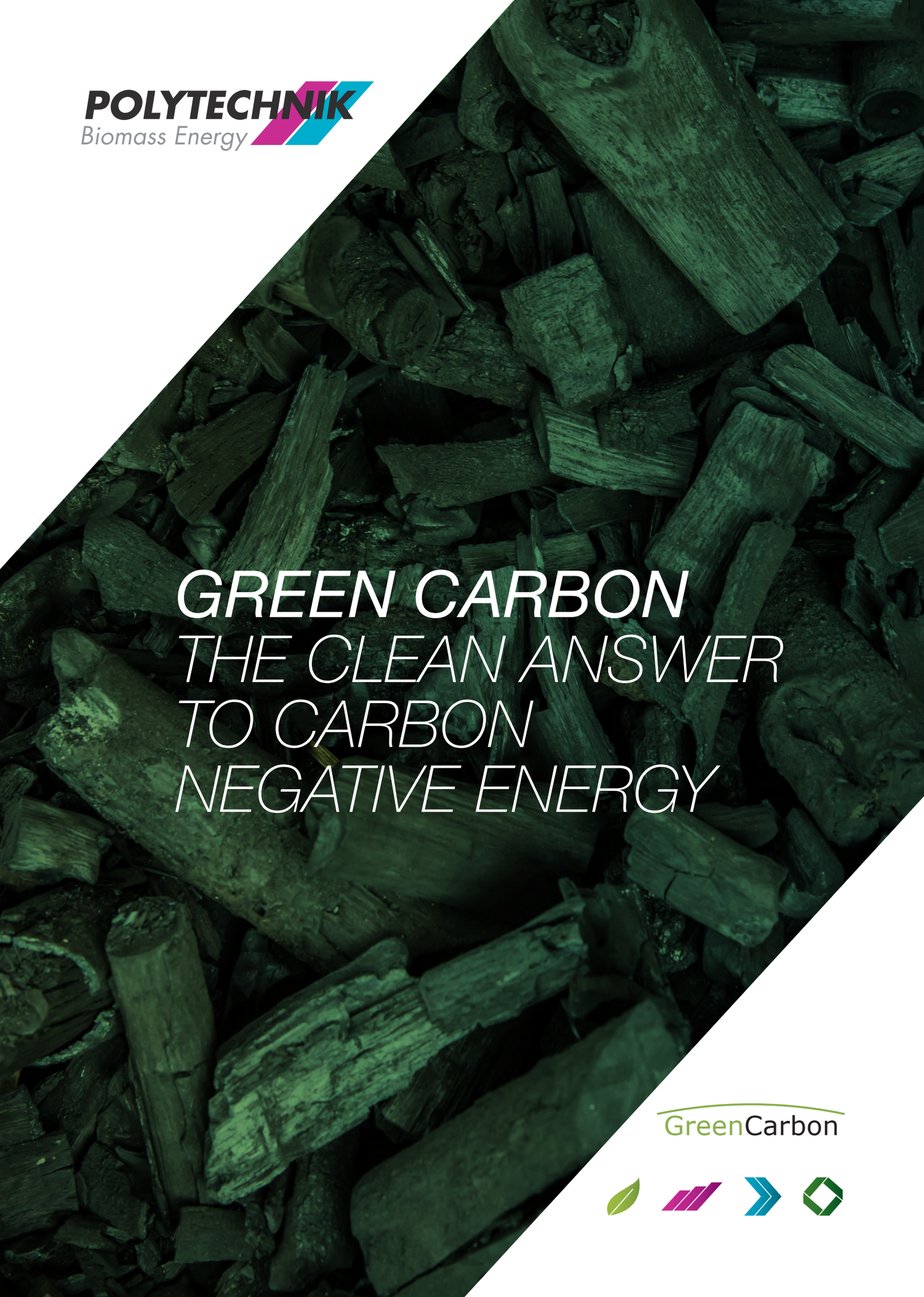
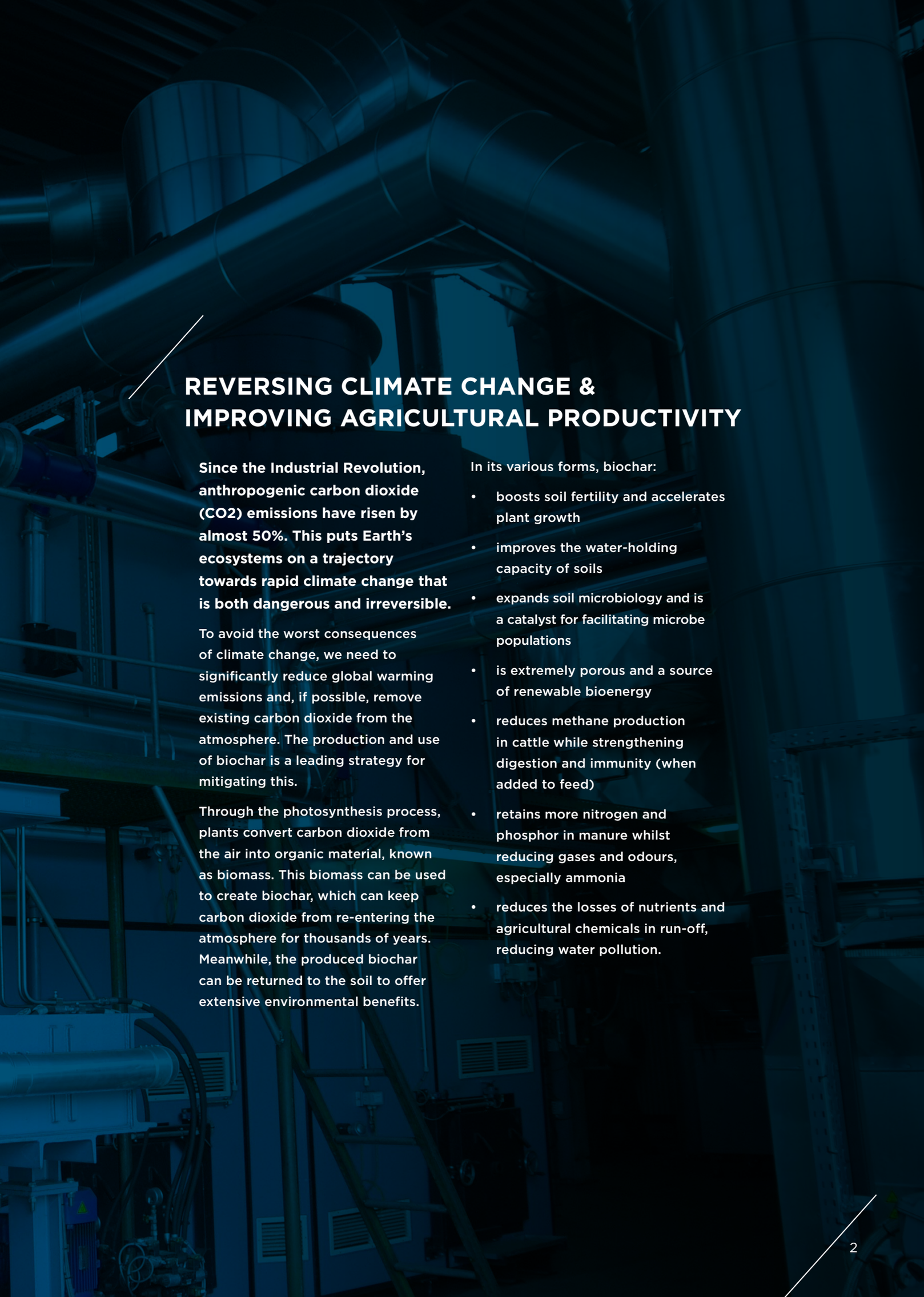
POLYTECHNIK
Biomass Energy



GREEN CARBON
THE CLEAN ANSWER TO CARBON NEGATIVE ENERGY

GreenCarbon



REVERSING CLIMATE CHANGE & IMPROVING AGRICULTURAL PRODUCTIVITY

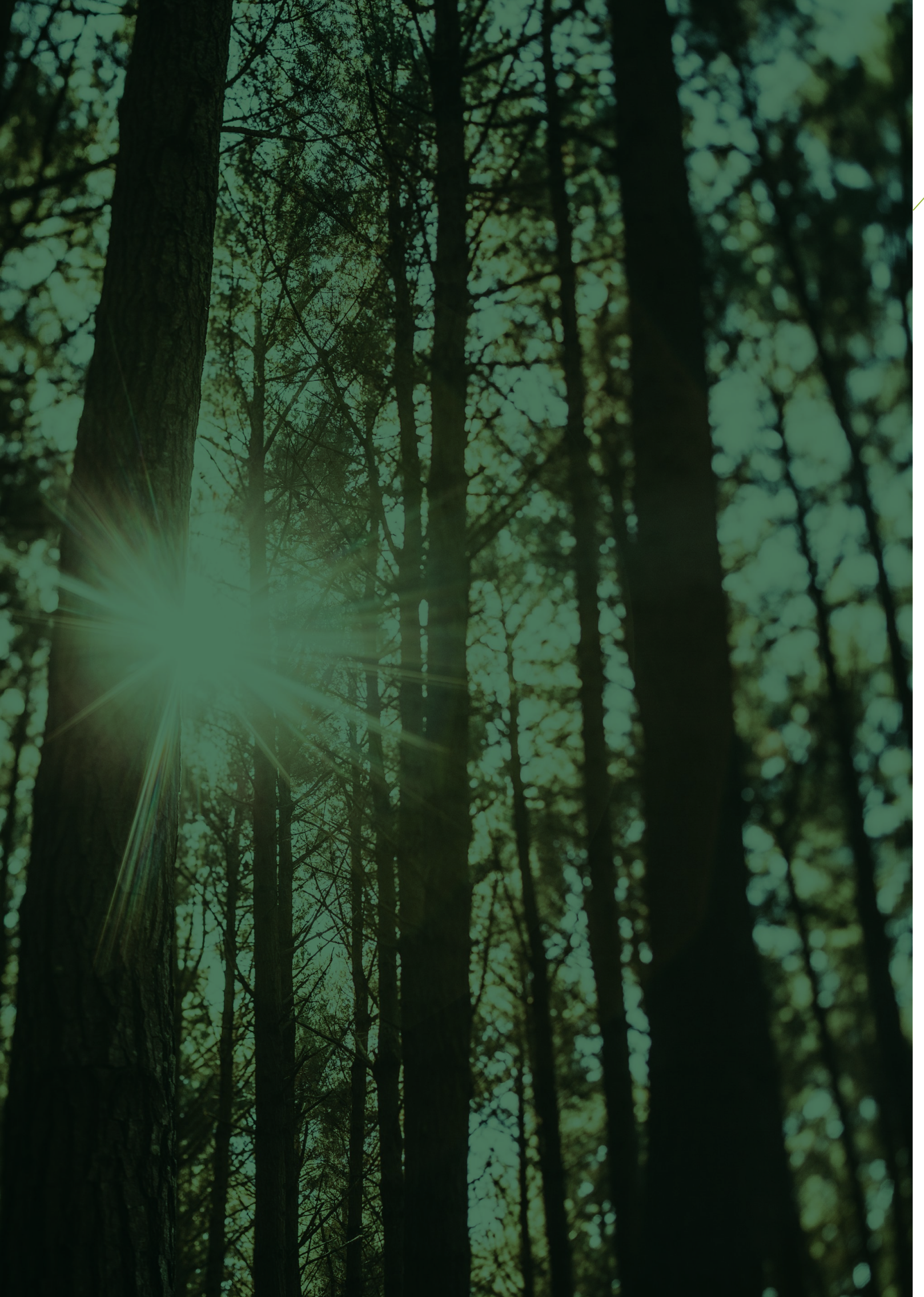
Since the Industrial Revolution, anthropogenic carbon dioxide (CO2) emissions have risen by almost 50%. This puts Earth's ecosystems on a trajectory towards rapid climate change that is both dangerous and irreversible.

To avoid the worst consequences of climate change, we need to significantly reduce global warming emissions and, if possible, remove existing carbon dioxide from the atmosphere. The production and use of biochar is a leading strategy for mitigating this.

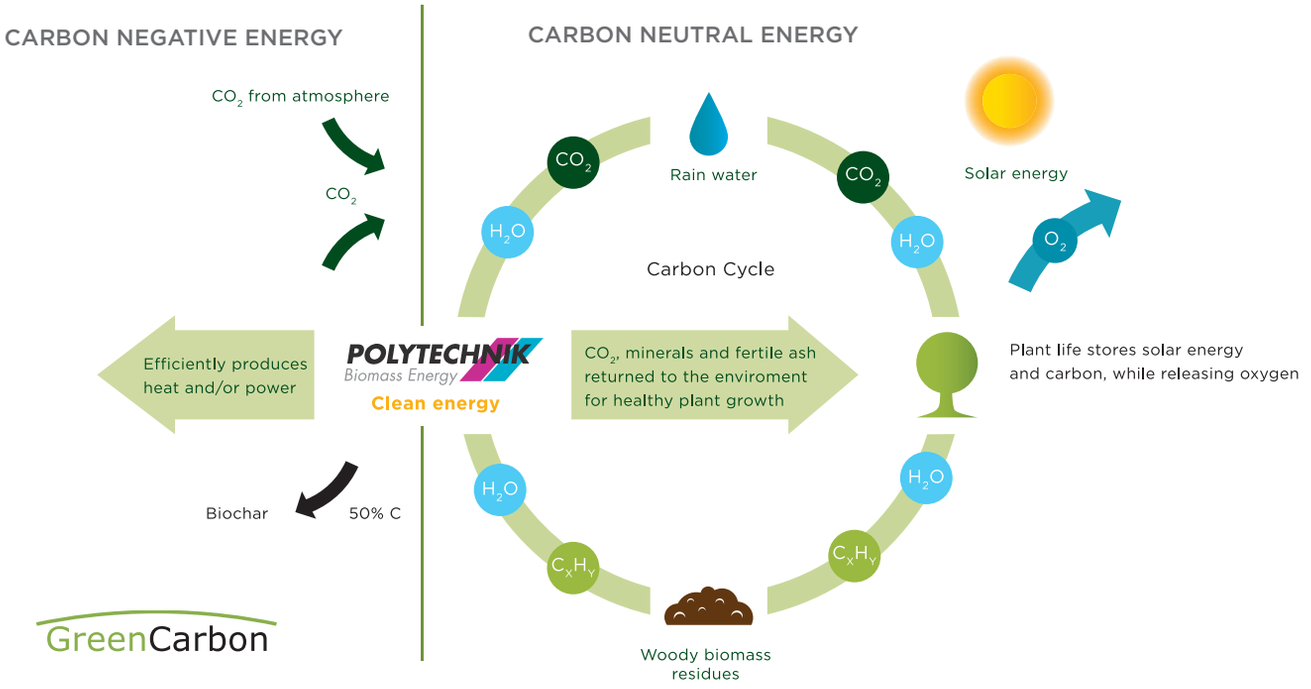
Through the photosynthesis process, plants convert carbon dioxide from the air into organic material, known as biomass. This biomass can be used to create biochar, which can keep carbon dioxide from re-entering the atmosphere for thousands of years. Meanwhile, the produced biochar can be returned to the soil to offer extensive environmental benefits.

In its various forms, biochar:

- boosts soil fertility and accelerates plant growth
- improves the water-holding capacity of soils
- expands soil microbiology and is a catalyst for facilitating microbe populations
- is extremely porous and a source of renewable bioenergy
- reduces methane production in cattle while strengthening digestion and immunity (when added to feed)
- retains more nitrogen and phosphor in manure whilst reducing gases and odours, especially ammonia
- reduces the losses of nutrients and agricultural chemicals in run-off, reducing water pollution.



CARBON NEGATIVE VS. CARBON NEUTRAL



*Fossil fuels, by contrast, release trapped carbon dioxide into the atmosphere, which fuels global warming.

The movement of carbon, in its various forms, between the biosphere, atmosphere, oceans and Earth's crust is called the carbon cycle. Earth's natural balance includes carbon storage in plants and soil, but human activity has affected this balance.

CARBON NEUTRAL ENERGY FROM BIOMASS

As plants grow, carbon dioxide is removed from the atmosphere through photosynthesis. This carbon dioxide is converted and stored in the plant's biomass. This carbon is then released when plants die, decay or combust. In Polytechnik's high efficiency energy plants, we use forest and wood residues from sustainable sources and harvest the carbon released as a truly renewable, clean and carbon neutral form of energy.

CARBON NEGATIVE ENERGY

Polytechnik's Green Carbon Technology can transfer approximately 50% of a plant's carbon into an inactive carbon pool, preventing it from being released. This is done by processing plant waste through pyrolysis (see over page) in low-oxygen conditions. The remaining 50% of carbon can be used to produce heat or power - enabling you to produce biochar with over 97% carbon and carbon negative energy at the same time (provided sustainable sources are used).

MOST COMMON FEEDSTOCK


WOOD PELLETS


WOOD BRIQUETS


WOOD SHAVINGS


SAWDUST


WOOD CHIPS


PEELINGS


SHREDDED TIMBER


HOG FUEL


FOREST RESIDUES


BARK


BAMBOO


CONSTRUCTION & DEMOLITION WOOD

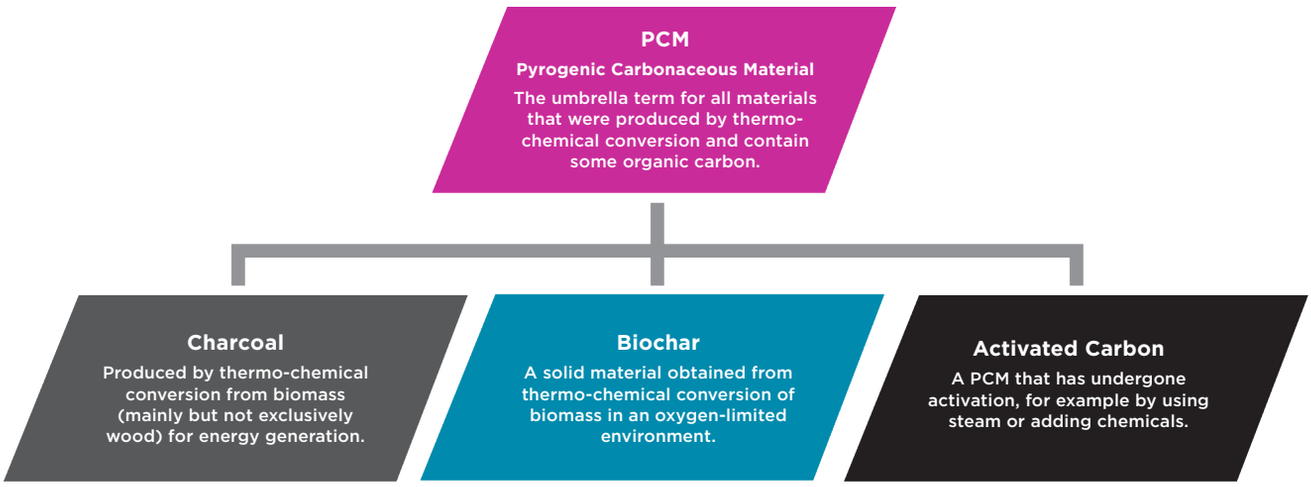

AGRICULTURAL RESIDUES


MISCANTHUS


NUT SHELLS


COCONUT FIBRE

WHAT IS BIOCHAR?



Carbon from agricultural residues is highly porous and depending on the raw material it can have a surface of up to 400 m^2/g.

All three forms of carbonaceous material are produced from pyrolysis - heating animal or plant matter in kilns, or purpose built carbonisation plants, under conditions of limited oxygen. These materials are also referred to as PCM - pyrogenic carbonaceous materials.

Charcoal has been one of civilization's basic materials for thousands of years. It is produced from pyrolysis and is used for cooking, heating and as a metallurgical fuel in the smelting and refining processes of iron ore, steel, pure silicon and ferrosilicon.

The charcoal market is projected to reach USD$6.5 Billion by 2023.

Biochar is made in low oxygen conditions to produce its unique agronomic and environmental management properties.

Thousands of years ago Pre-Columbian Amazonians are believed to have used biochar to enhance soil productivity. The result was Terra Preta - a very fertile soil amendment that binds minerals and nutrients, and keeps them in the soil for thousands of years.

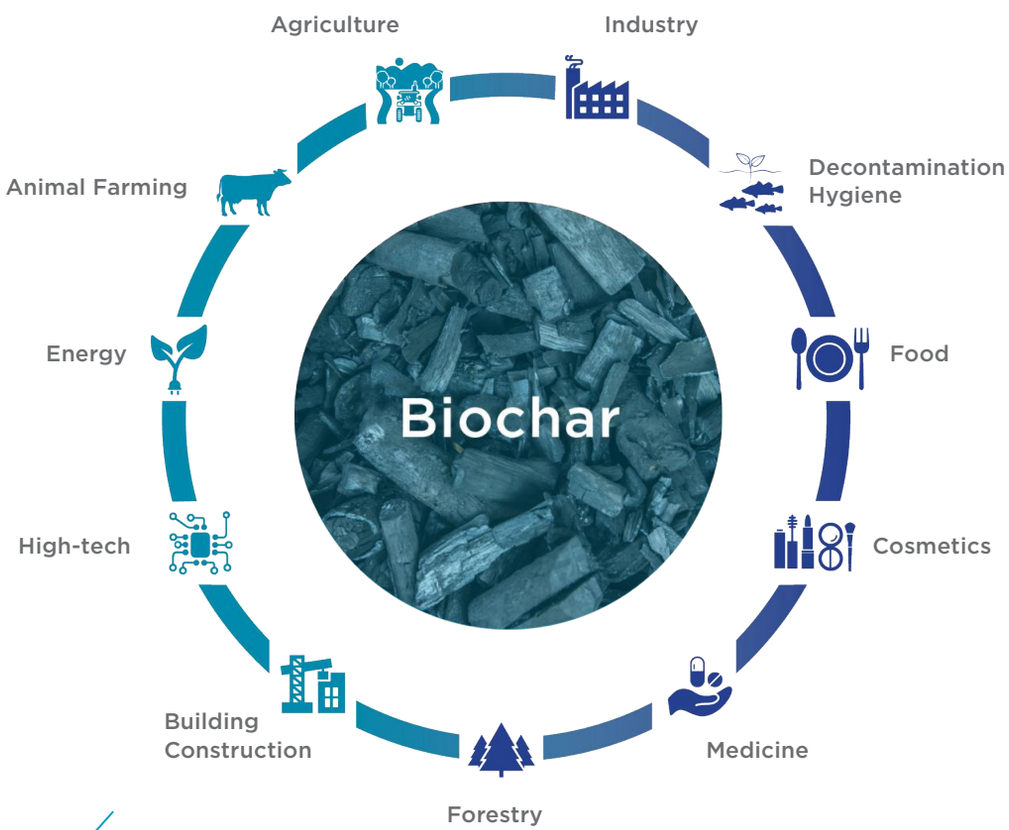
The global biochar market is expected to reach USD$3.1 Billion by 2025, driven by an increasing demand for organic food and a growing awareness of biochar's benefits.

Activated carbon, also known as activated charcoal, charcoal that has been treated chemically or physically to develop an interconnected series of pores inside it.

This greater surface area makes it highly porous, so it can be used for various absorption applications.

The global activated carbon market is projected to reach USD$8.12 Billion by 2021.

BIOCHAR MARKETS



Biochar has many applications, and offers affordable and environmentally sustainable solutions across a number of industries.

Carbon sequestration (and credits), soil conditioning and enhancement, water holding capacity and field nutrient loss mitigation are just some of its environmentally friendly properties.

High quality biochar has been quickly adopted in many industries for a range of uses:

- energy production
- animal farming
- livestock growth
- silage agent and feed supplement
- medicines
- food and its packaging
- treatment of drinking and wastewater for toxicant removal
- decontamination
- sanitation of human and kitchen wastes
- compost processing
- air cleaning and emission control systems
- building insulation
- protection against electromagnetic radiation
- textiles and cosmetics
- metallurgy
- additive on biogas plants
- absorber in functional clothing
- precursor in activated carbon production
- carbon electrodes in supercapacitors for energy storage

BENEFITS OF BIOCHAR

Biochar helps save the world - it traps carbon dioxide and keeps it from reentering the atmosphere for thousands of years. But that's just the tip of the iceberg.

Biochar offers high quality heat, noise and building insulation, regulating humidity and absorbing smells and toxins. Biochar also enhances the curing and hardening process for concrete mixtures, making the concrete stronger.

Biochar is a powerful soil substrate. It improves soil fertility by decreasing the soil's tensile strength and density. This allows roots to grow and penetrate the ground easier, and provides a habitat for soil microorganism and fungi for plant health. Biochar also stores water, increases fertiliser efficiency and absorbs nutrients and minerals - improving agronomic efficiency and increasing yields.

Its excellent adsorption means that it can be used for adsorbing pollutants and decontaminating groundwater, soil, and drinking and waste water. It can also act as a barrier for preventing pesticides and herbicides from getting into surface water.

As a feed additive biochar improves digestion and hygiene, increases immunity, feed and energy efficiency boosts growth rates. Meanwhile, it also reduces chronic botulism and methane production.

It can be used as an adsorbent for emission control systems, for carbon enrichment in metallurgy and producing carbides (e.g. Wolfram, Tungsten, Silicon, etc.), and as a carbon source for tyres, rubber and plastics.

Biochar reduces fertiliser requirements and the leaching of nutrients and nitrates into groundwater. It increases plant growth, soil microbial biomass, respiration and water handling/ storage characteristics, while suppressing methane emissions.

Biochar is a main source for producing pure carbon (e.g. for carbon fibre). It can also be used for electromagnetic shielding, 3D printing and as a source for activated carbon production.

Biochar in the form of charcoal is a high quality energy source. It can also be used as an energy storage solution (long term carbon sink), or in semiconductors, batteries and fuel cells.

9. HEAT AND POWER PLANT

The carbon neutral heat and power plant includes fully automated fuel storage and handling systems that feed the biomass into the combustion system of the plant.

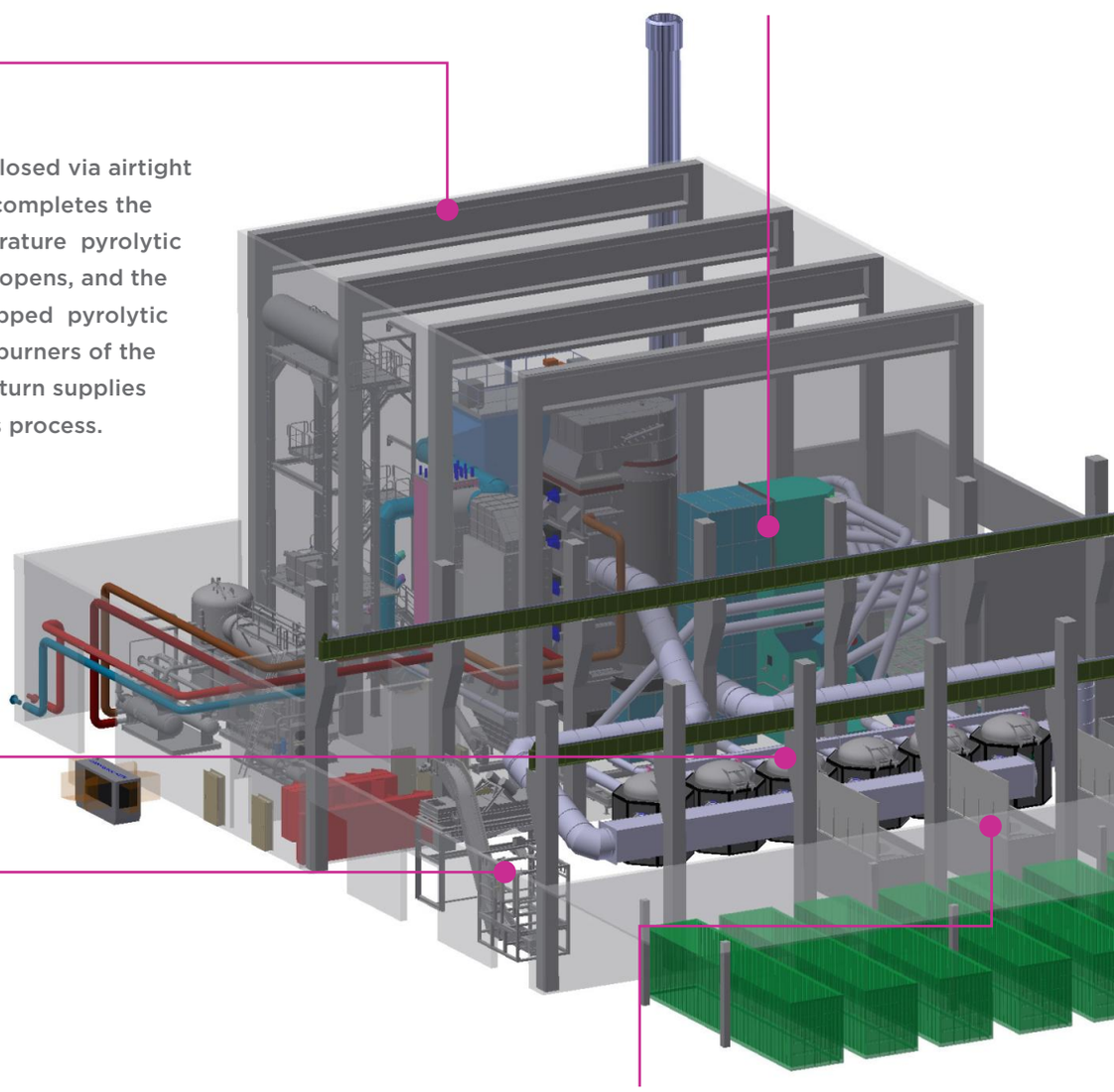
The pyrolytic gases and biomass are fully combusted and the released energy is used to heat up a heat transfer medium, which provides high temperature energy to a power generation unit. Advanced emission control systems guarantee lowest emissions.

5. FURNACE

The pyrolysis station's energy supply comes from a purpose-built combustion system, with a water cooled reciprocating grate for combustion of the automatically fed feedstock. The combustion of pyrolytic gases occurs in a specially designed combustion chamber via gas burners. Advanced controls, primary and secondary air systems and an adiabatic combustion chamber ensure the complete oxidation of both biomass fuel and pyrolytic gases - hence high efficiency and low emissions.

6. REACTOR

After preheating retorts are closed via airtight covers. As soon as a reactor completes the carbonisation - no low temperature pyrolytic gases remaining- the reactor opens, and the crane removes the retort. Trapped pyrolytic gases are transported to the burners of the combustion system, which in turn supplies clean energy for the pyrolysis process.



8. DISCHARGING

At the end of the process cold retorts are transported to an enclosed unloading station where a conveyor transports the charcoal to a screening and/or crushing station, allowing customers to produce different product sizes. It is then passed on to a packaging station (bulk bags).

3. PREHEATING

To prepare the raw material for carbonisation, the filled retorts are automatically transported to an enclosed preheating station. Here the feedstock is heated with hot air to 100-120°C. This reduces the time needed in the pyrolysing station, and increases the output of the plant.

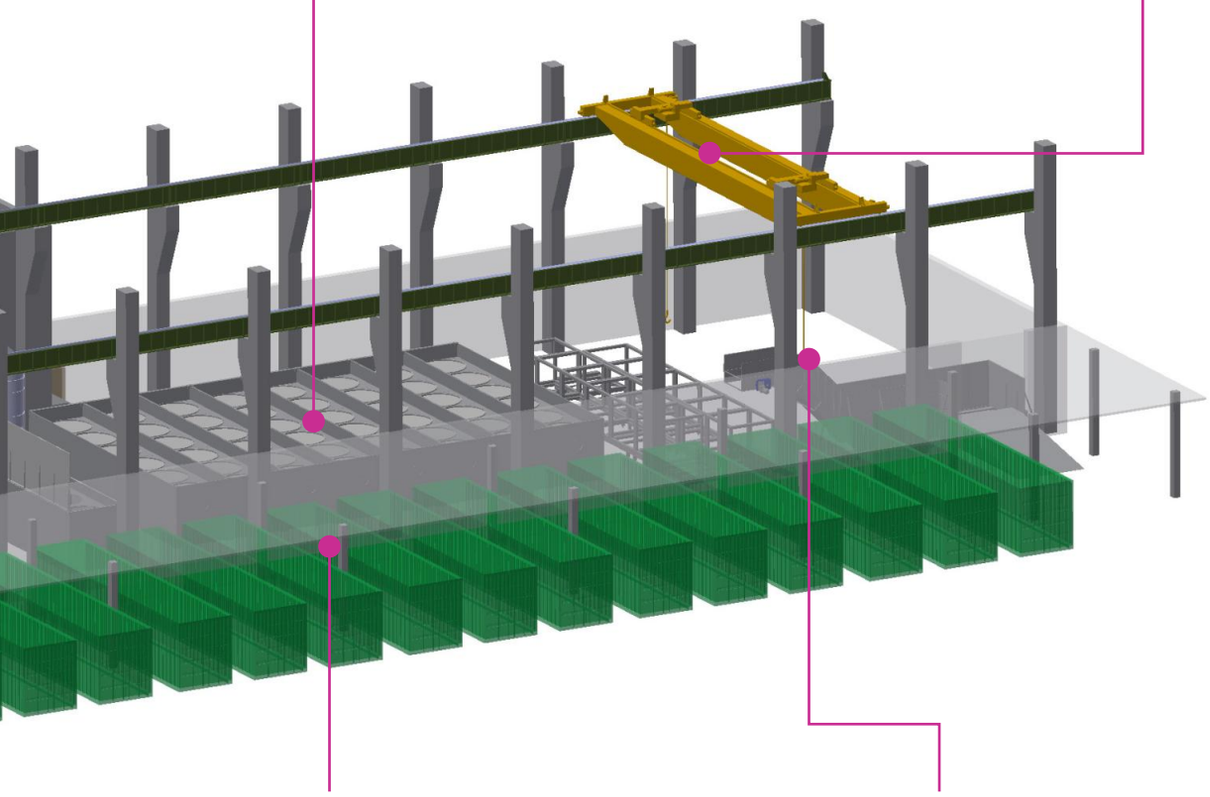
GREEN CARBON PROCESS

7. COOLING

After pyrolysis the hot retorts are placed in a cooling station for a day, where cool air brings them down to ambient temperatures. To avoid any further oxidation of the produced charcoal, retort openings are sealed with sand.

4. AUTOMATED MATERIAL TRANSPORT

An indoor crane, equipped with two independently operated lifting devices, safely and quickly transports retorts from station to station. Movements of material are optimised to ensure the energy plant and pyrolysing station can continue operating efficiently. Advanced automation ensures flexibility of batch supply.



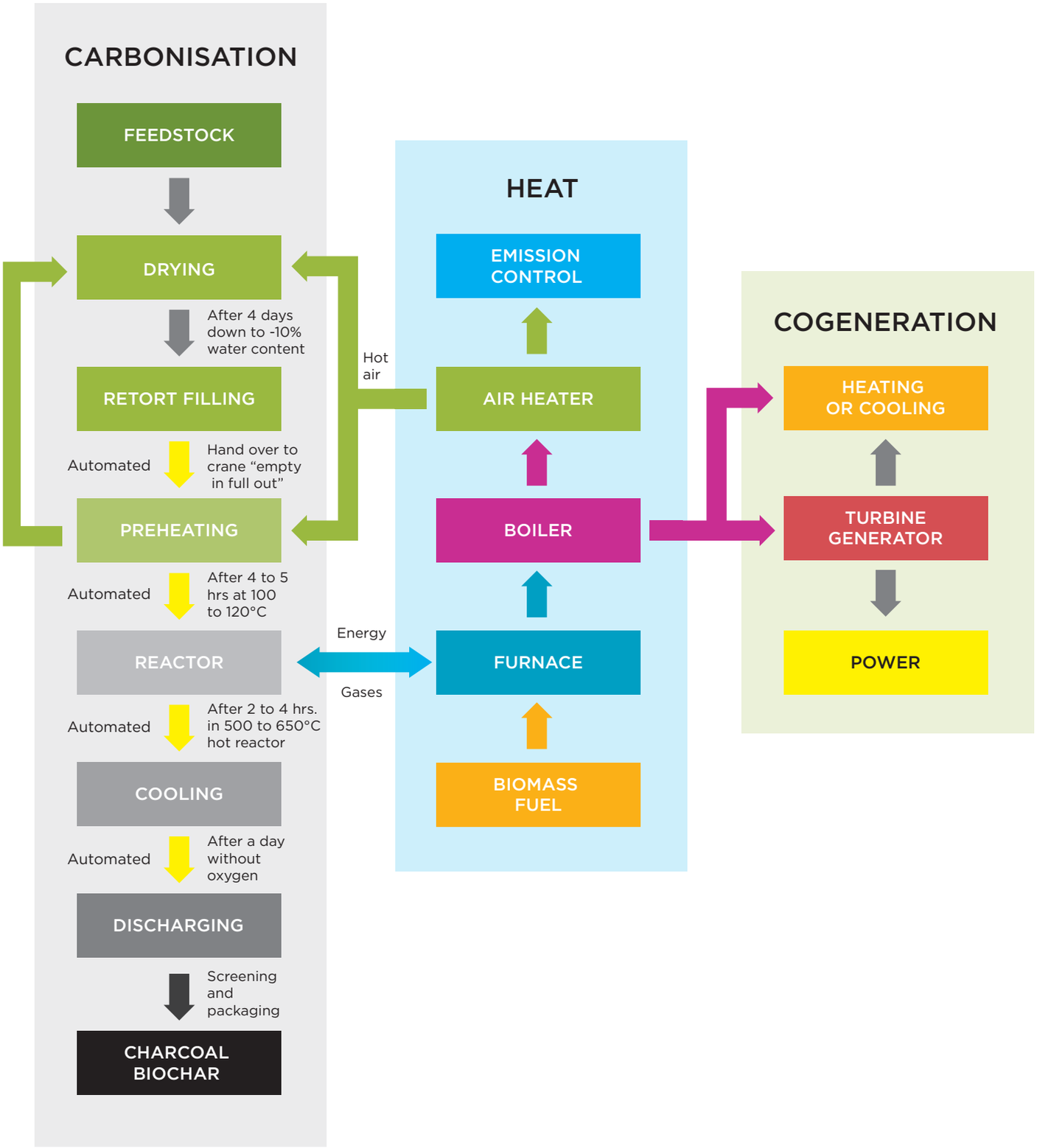
1. DRYING

Containers are filled with raw organic material and dried with heated air.

2. RETORT FILLING

After the drying, the raw material (feedstock) is tipped into a reception hopper and transported to the retort filling station where an empty retort waits. Buffer stations in this area offer an opportunity to remove any produced charcoal or excess raw material while the rest of the pyrolysis plant continues operating.

GREEN CARBON PROCESS



CARBON NEUTRAL CHARCOAL

Charcoal is the most popular and most natural fuel for grilling food throughout the world.

As it can be easily transported and stored, charcoal is becoming increasingly available. However, it often comes from thousands of kilometers away. It's important that charcoal is produced locally from sustainable sources to reduce illegal deforestation and help protect our planet. High quality charcoal lights fast and produces hot glowing coals that burn hotter than wood. It also produces less smoke and ash, and flavours food.

Charcoal products are also in demand within the health and beauty industry, as its excellent adsorption can remove toxins from the body. Products include charcoal pills, toothpaste, soap, face masks and deodorant.

Charcoal has increasingly been used as a regular feed additive for pets and in animal farming. It is able to improve animal health and has positive effects on toxin adsorption, digestion, blood values, meat quality, odour control, GHG emissions, feed use efficiency and livestock weight gain.

Pictured is a fully operational industrial scale carbonisation plant, based in Uelitz, Germany. It produces 3,000 tonnes of charcoal a year, and meets the stringent emission limits and high air quality standards of Germany.

HIGH TECH PYROLYSIS PLANT

Polytechnik's pyrolysis plants offer great flexibility - different types of feedstock can be used to continuously produce large amounts of high quality charcoal products. At the same time the plant also produces carbon-neutral heat and power (CHP).

The world's first fully automated and controlled retort plant not only produces high quality and certified carbon products out of biomass waste - it also supplies energy with air emissions that are well below the stringent limits of the European Union.

One of the possible technologies which can be combined with the Green Carbon Process are Polytechnik's ORC (Organic Rankine Cycle) plants for heat and power, as visualized in the 3D-graphic.

The CHP plant includes fully automated fuel storage and handling systems which feed the biomass into the combustion system of the plant. The biomass is fully combusted and the released energy is used to heat up a heat transfer medium (thermal oil), which provides high temperature energy to an ORC unit.

The ORC unit's generated electricity can then be supplied to the local grid and the thermal oil/hot water can be used for heating.

The whole process is fully automated and can be controlled and accessed remotely by owners and operators - as well as by Polytechnik's global experts.

POLYTECHNIK
Biomass Energy

FOR TURNKEY SOLUTIONS INCLUDING FRONT-END ENGINEERING, DESIGN, SALES, DETAIL ENGINEERING, MANUFACTURING, SUPPLY, INSTALLATION AND COMMISSIONING.

Our world-leading energy and carbonisation plants offer you unprecedented control and data access at any time, and from anywhere through secure internet access. Fuel, load, oxygen, temperature, combustion and other control systems monitor, analyse and continuously optimise all relevant parameters for the most efficient operation and lowest possible emissions.

Highly satisfied customers around the world are proof of our competence and experience as a main component supplier, as well as an EPC contractor for turnkey energy and carbonisation plants.

KEEPING THE BALANCE

COST EFFECTIVE

GLOBALLY LOCAL

DRIVING CHANGE

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