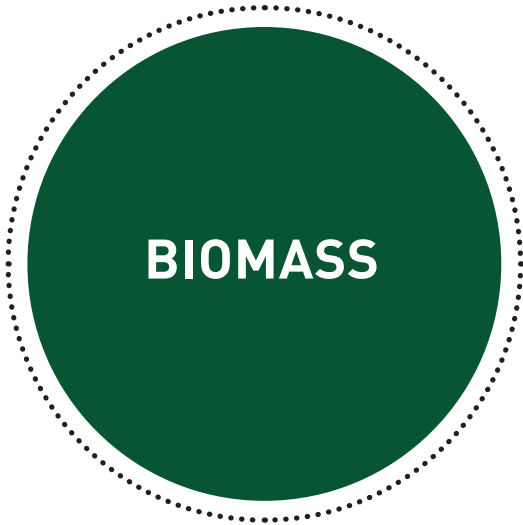


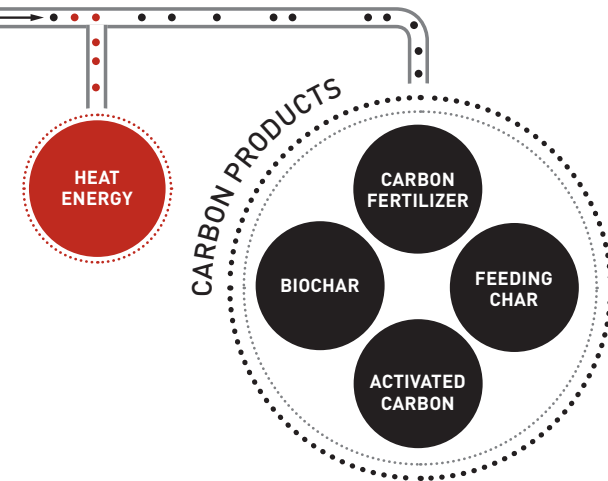
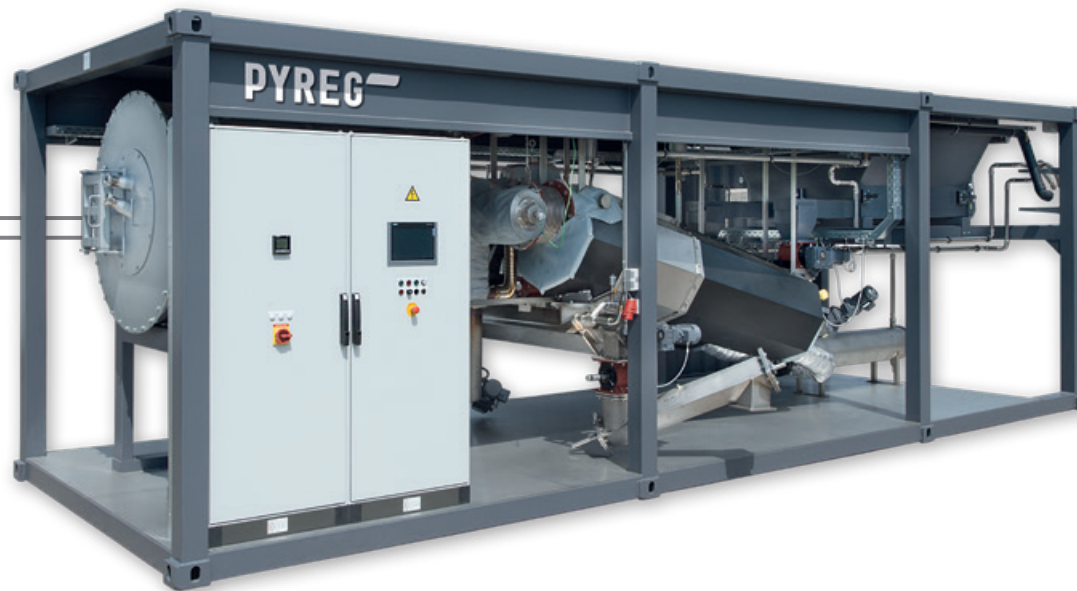
BIOMASS

PYREG™



BIOMASS

**PRESERVE
RESOURCES
PROTECT THE
ENVIRONMENT**



A clean solution	4		
Marketing biochar	6	The process	18
PYREG closes the cycle	8	The systems	20
Your benefits	10	Input/output material	22
benefits in the soil (Nature)	12	References	24
benefits for the climate (Climate)	14	The path to your PYREG system	28
benefits in the stable (Animals)	16	Service	31
		Your added value	32
		About PYREG	34

A CLEAN SOLUTION

PYREG CARBON PRODUCTS ...

4

... are obtained in defined quality levels:
biochar,
feeding char,
activated carbon ...

... are produced by gentle carbonization of different types of biomass. Often from regional renewable raw-materials ...

... are free from pathogenic organic pollutants such as antibiotics, pathogens and microplastics due to the thermal treatment ...

... are the consistent refinement of preferably natural biomass.

VERSATILE USE

PYREG CARBON PRODUCTS ARE MADE FROM NATURAL RAW MATERIALS AND ARE USED IN VARIOUS AREAS DEPENDING ON THEIR QUALITY.

**IMPROVEMENT OF ANIMAL
WELFARE (FEED, LITTER)**

**SUPPORT THE COMPOSTING
PROCESS**

**ADDITIVES IN BIOGAS
PRODUCTION**

**AIR FILTERS FOR INDUSTRIAL
EMISSIONS**

**SOIL CONDITIONERS AND
FERTILIZERS (AGRICULTURE
AND HORTICULTURE)**

WATER TREATMENT

**FILLERS, BUILDING AND
INSULATING MATERIAL FOR
INDUSTRIAL APPLICATIONS**

MARKETING BIOCHAR

Livestock farming
€ € €

Filtration
€ €

Biogas
€ € €

Activated carbon
€ € € € €

Medicine/
cosmetics
€ € € €

6

Market price €

VERY CLEAN BIOMASSES

WOOD CHIPS

NUT SHELLS + FRUIT STONES



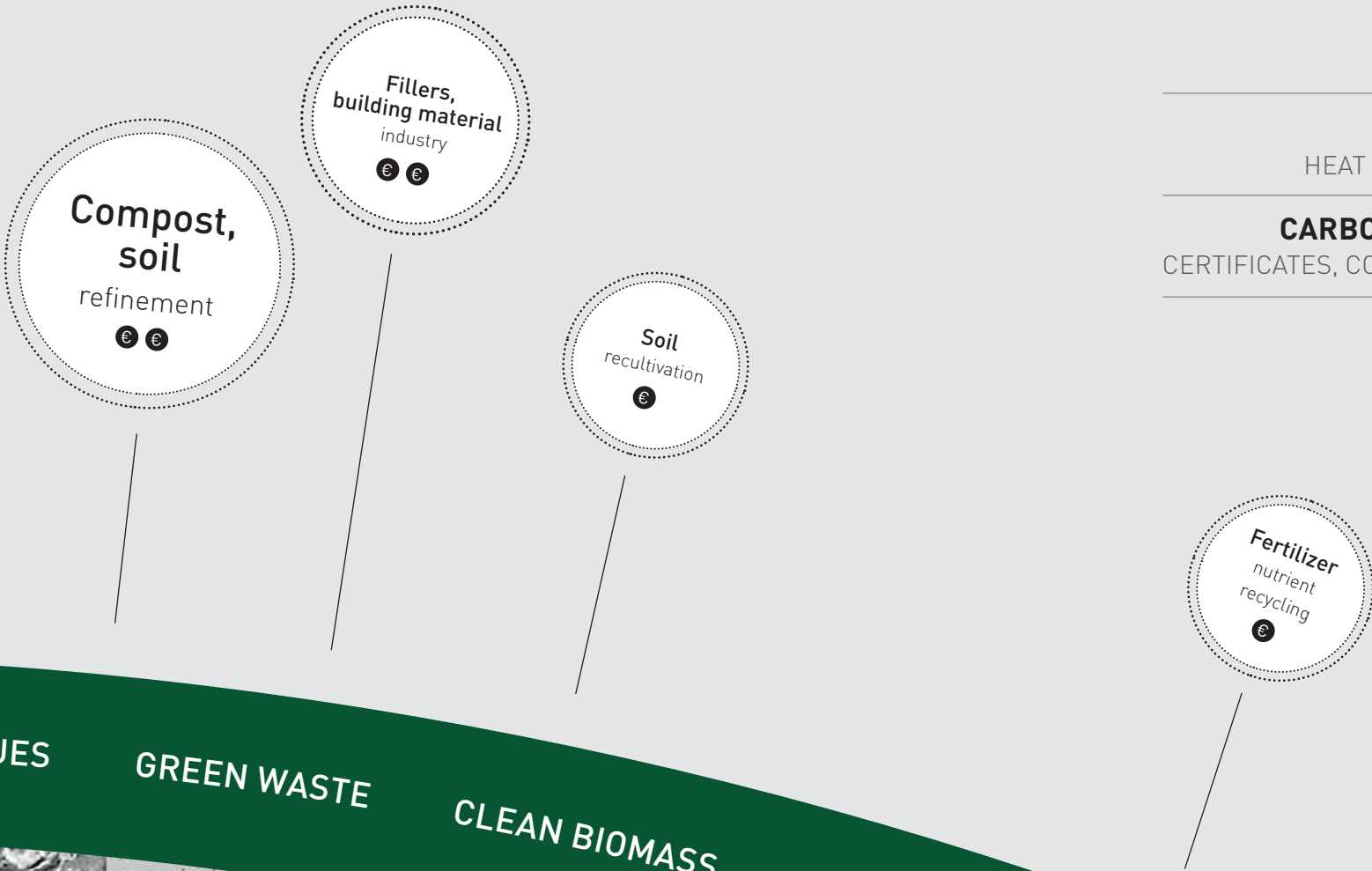


ENERGY

HEAT GENERATION

CARBON MARKET

CERTIFICATES, CO₂ FOOTPRINT



WOOD RESIDUES

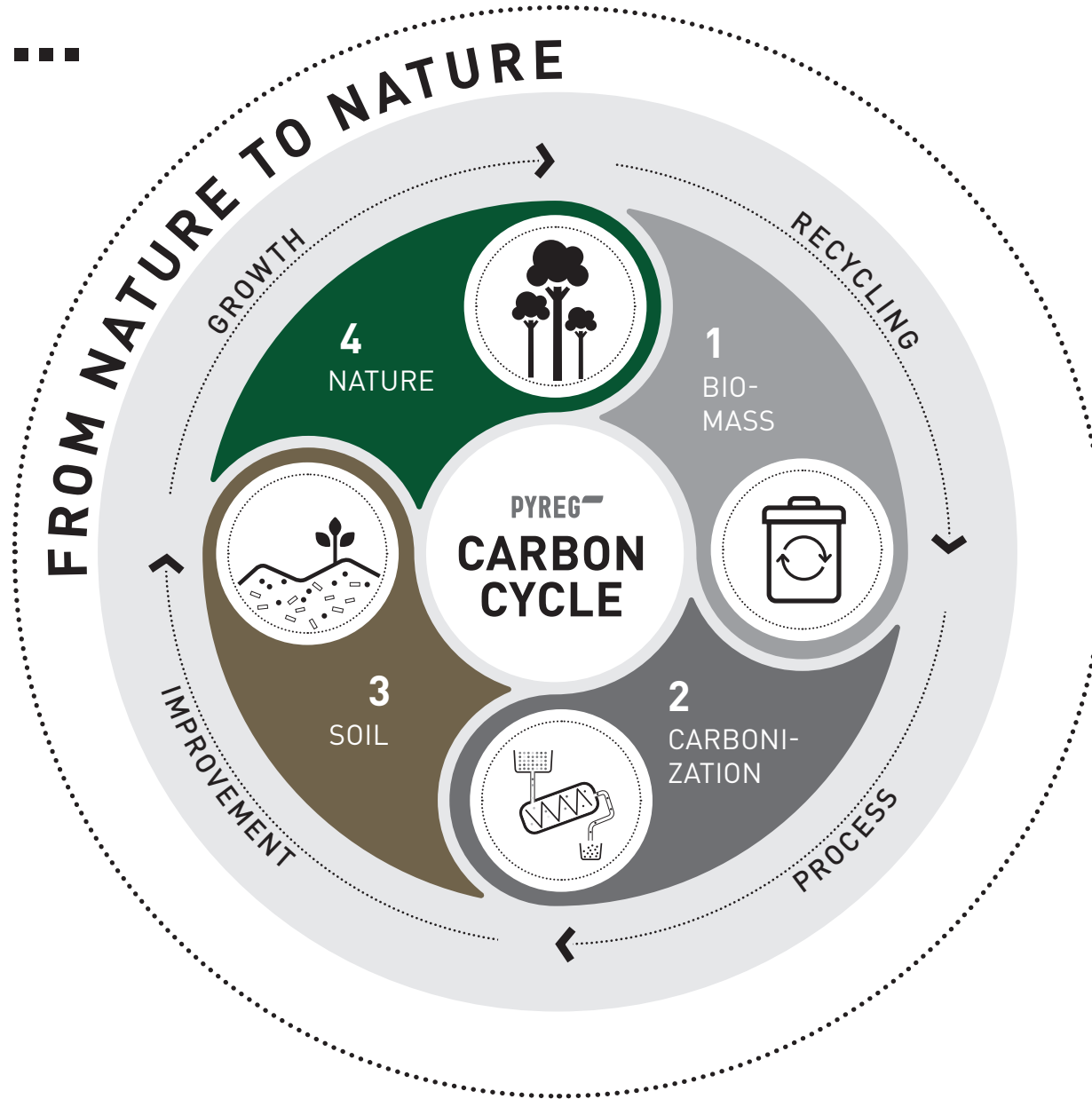
GREEN WASTE

CLEAN BIOMASS

SLURRY, MANURE, FERMENTATION RESIDUES



PYREG ...



...closes the cycle

UPCYCLING

MARKETING OF PREMIUM PRODUCTS, SUCH AS FEEDING CHAR FROM RESIDUAL BIOMASS.

MORE VERSATILE USE

FURTHER USE AS INPUT MATERIAL (DROP IN) IN OWN PRODUCTION/APPLICATION.

COMPLETE RECYCLING

THERE ARE NO RESIDUES LEFT TO BE DISPOSED OF.

DECENTRALISED SYSTEM

REDUCTION OF TRANSPORT EFFORT AND COSTS.

A CLEAN SOLUTION

SOLUTION TO YOUR WASTE PROBLEM THROUGH RECYCLING MANAGEMENT.

ENERGY-EFFICIENT

AUTOTHERMAL PROCESS. FULL UTILIZATION OF THE ENERGY CONTAINED IN THE INPUT.

USABLE WASTE HEAT

USE AS AN ADDITIONAL ENERGY SOURCE.

CLIMATE POSITIVE PROCESS

IMPROVE YOUR CO₂ FOOTPRINT AND REPUTATION.



YOUR BENEFITS



Nature

Stabilizes plant growth and reduces crop failures

Improves soil quality

Reduces consumption of mineral fertilizers



Climate

Helps to achieve sustainability goals

Binds CO₂

Reduces nitrous oxide emissions and nitrate leaching



Animals

Improves milk quality and yield

Reduces medical costs

Feed additive: Improves animal health

Bedding: Improves stable hygiene



Nature

BIOCHAR FOR SOIL IMPROVEMENT

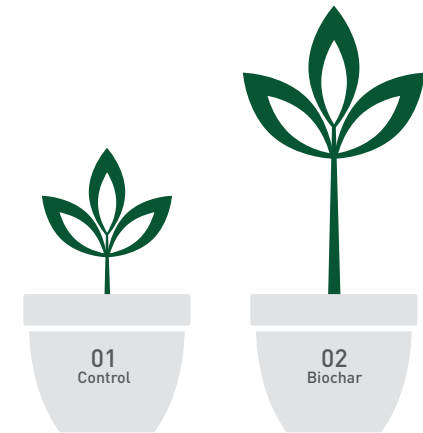
Thanks to its huge porosity, the internal surface of biochar amounts to more than 300 m²/g. Therefore, this material is able to resorb a quantity of water and solved nutrients, which equals the fivefold of its own weight (refer to Scheub et. al. 2015: Terra Preta).

12

Without previous treatment however, biochar is not yet able to improve the soil quality, so it first has to be loaded with nutrients and populated with microorganisms. "Loading" of the biochar can be performed by different methods, e.g. by composting.

300 m²
per gram

POSITIVE EFFECTS OF BIOCHAR IN SOIL



INCREASED **STORAGE** OF WATER AND NUTRIENTS.

STABLE **PLANT GROWTH** WITH REDUCED RISK OF CROP FAILURE.

THE QUANTITY OF NITRATE, WASHED OUT INTO **GROUNDWATER** IS REDUCED AS WELL.

ACTIVATION OF SOIL LIFE: MICRO-ORGANISMS FIND AN IDEAL ENVIRONMENT.

CLIMATE-DAMAGING EMISSIONS (E.G. NITROUS OXIDE) **ARE REDUCED.**

ACTIVE **CLIMATE PROTECTION** BY LONG-TERM CONSERVATION OF CARBON IN SOIL - FOR CENTURIES.



Climate

PYREG CARBON PRODUCTS MAKE A DIFFERENCE. THEY...

14

... **ACTIVELY PROTECT THE ENVIRONMENT**
IN CONTRAST TO LIGNITE AND HARD COAL.

... ARE PRODUCED ON AN INDUSTRIAL SCALE ACCORDING TO
EUROPEAN **ENVIRONMENTAL STANDARDS**.

... ARE BASED ON LOCALLY-SOURCED, **RENEWABLE**
RAW MATERIALS.

... **ARE CLIMATE POSITIVE**. THANKS TO GENTLE CHARRING
A LARGE PROPORTION OF THE CARBON IS FIRMLY BOUND IN THE
PRODUCT AND NOT RELEASED IN LARGE QUANTITIES AS
CLIMATE-DAMAGING CO₂.



REDUCE
CO₂
FOOTPRINT



Animals

MULTIPLE BENEFITS IN STABLES

16

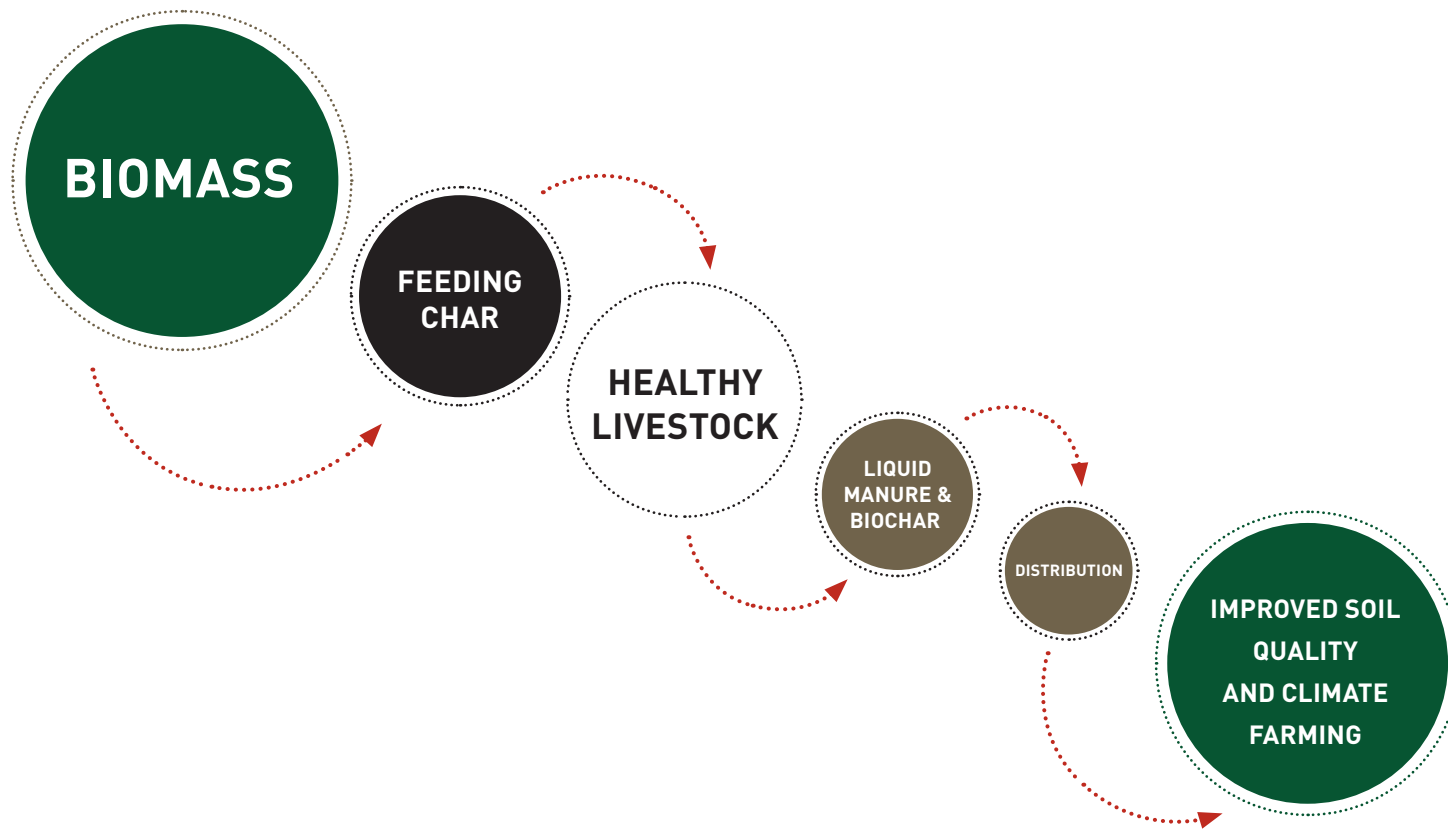
Biochar proves to be particularly useful in applications offering multiple benefits, e.g. in form of feeding char. It does not only improve the health state of animals themselves but reduces also odour nuisance originating from manure. Added to fertilizer in the fields, soil quality is enhanced and nutrients are prevented from being washed out. The whole process simultaneously protects the climate.

ENSILING AGENTS IN FORM OF BIOCHAR PREVENT FORMATION OF MOLD AND FUNGAL ATTACK. TOXINS ARE ADSORBED, AND LACTIC ACID BACTERIA WORK MORE EFFICIENTLY. **HYGIENIC CONDITIONS ARE IMPROVED.**

HUMIDITY OF BEDDING DECREASES, **AMMONIUM AND OTHER TOXINS ARE ADSORBED** BY BIOCHAR. THIS IS FAVORABLE FOR THE BALLS OF FEET.

BIOCHAR IN THE DIGESTIVE TRACT OF ANIMALS RESORBS AND DESORBS ESSENTIAL NUTRIENTS, THUS ASSISTING INCREASED POPULATION BY BACTERIA. THANKS TO ENHANCED **FOOD CONVERSION**, SLAUGHTER WEIGHT **INCREASES.**

BIOCHAR INGESTED BINDS TOXINS IN THE DIGESTIVE SYSTEM AND **SUPPORTS ANIMAL HEALTH.** ALL OF THESE FACTS SIMULTANEOUSLY REDUCE VET AND MEDICAL COSTS.



The process

HIGHEST QUALITY



18

The PYREG process is a continuous method and uses the principle of dried carbonization. For that purpose, the biomass is not incinerated, but first degassed at a temperature of 500 - 700 °C and then, by admission of a well-defined air stream, carbonized. The material passes through the PYREG reactor, hauled by conveyor screws. As this process enables users to precisely adjust treatment parameters like temperature control, carbonization time and admission of primary air, the optimum quality of the final product can be achieved.

NO PROBLEMATIC SUBSTANCES



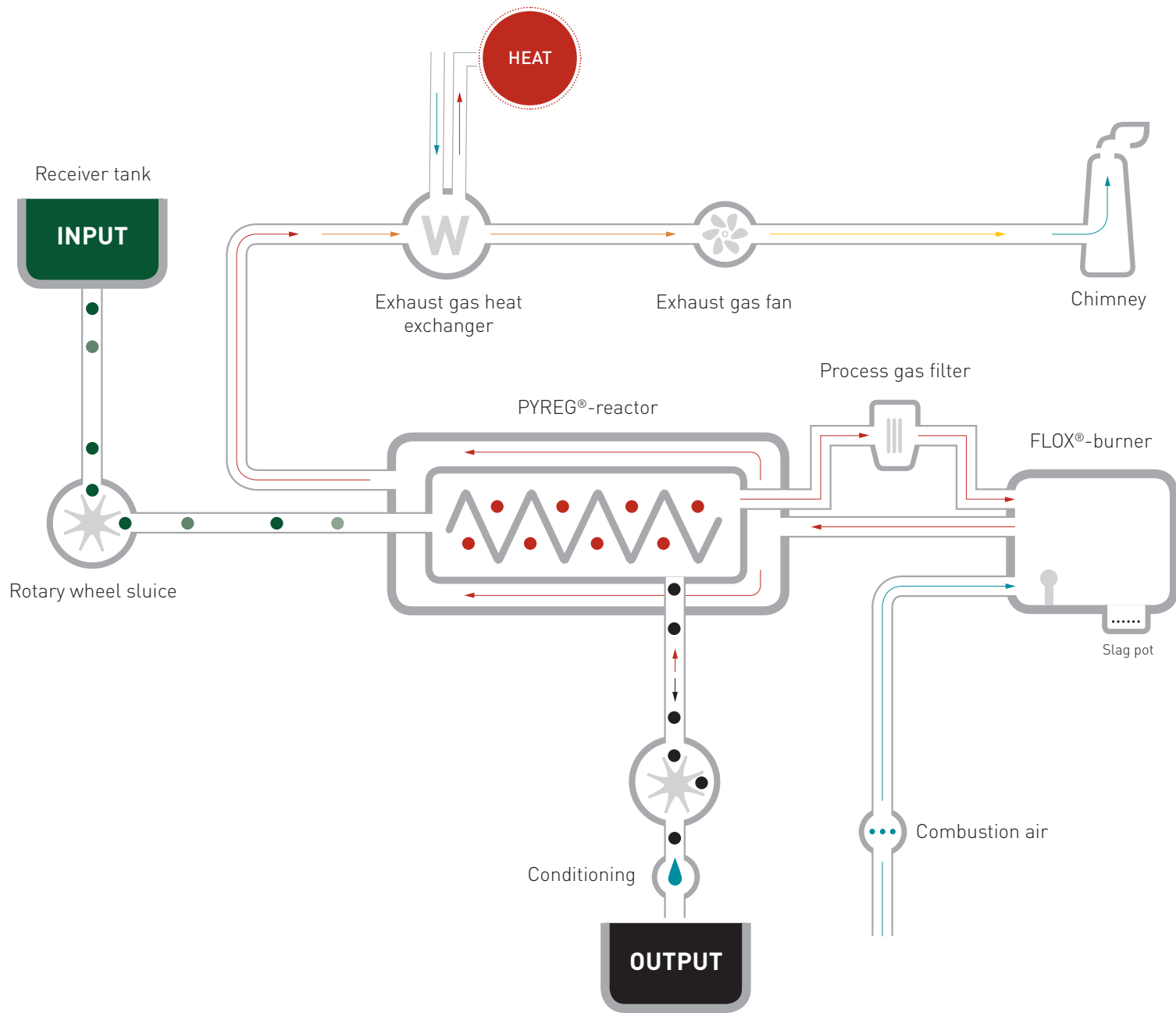
The process gas from the input biomass is separated from the material inside the PYREG reactor. It is cleaned from the dust by an automated process gas filter and finally burned at a temperature of 1,000 °C by the FLOX® burner (flameless oxidation) inside the separated combustion chamber. Consequently the formation of problematic substances like oils or tar is suppressed, because the carbonization gas is not cooled, but purified by complete oxidation in the combustion chamber.

USABLE ENERGY



600 kW_{th}

The entire process is self-sustaining; the only energy required to maintain the process, originates from the biomass itself. For that purpose, hot flue gas from the combustion chamber is directed into the outer jacket of the reactor, in order to support drying, degassing and carbonizing of the biomass. It is even possible to benefit from excess heat produced; an amount of up to 600 kW_{th} may be used for drying of humid biomass or for heating.



The systems

20

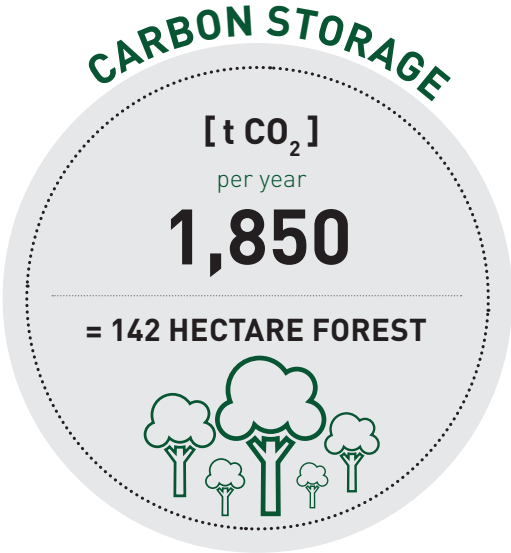
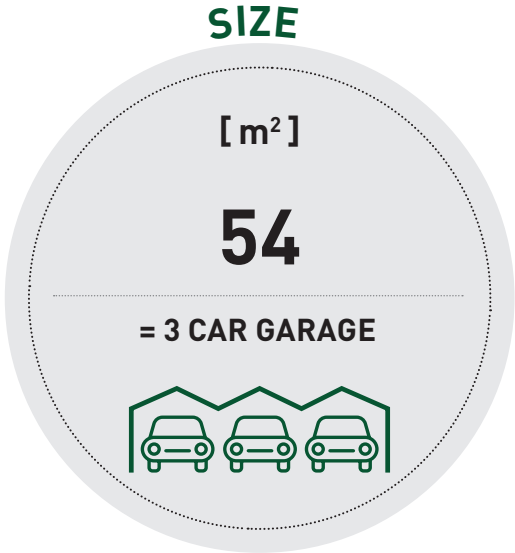
COMPACT AND DECENTRALISED

PYREG plants are compact, container based and can easily be integrated into existing infrastructures and material cycles. The thermal process is based on the principle of dry carbonization and generates a surplus thermal energy of up to 4.5 million kWh per year that can be used for other purposes (e.g. local heating network).

Please note: The adjacent system data are model values to give you an initial idea. Exact system data can only be determined together with you, after a detailed analysis of the location and a material test. Please feel free to contact us.

	P500	P1500
Size	l 9,000 mm w 3,000 mm h 5,800 mm	l 12,000 mm w 3,000 mm h 5,800 mm
Combustible rating	500 kW	1,500 kW
Annual throughput <small>DS, dry substance</small>	approx. 750 t per year	approx. 2,250 t per year
Yearly production	up to 190 t	up to 560 t
Excess thermal energy	approx. 150 kW _{th}	approx. 600 kW _{th}
Operating hours	up to 7,500 h/a	up to 7,500 h/a
Power consumption	approx. 10 kW _{el}	approx. 20 kW _{el}
Additional technology module	l 3,000 mm w 3,000 mm h 2,800 mm	l 6,000 mm w 3,000 mm h 5,800 mm

Based on 92 % DS agropellets



Input

REQUIREMENTS FOR SAFE AND ECONOMICAL TREATMENT USING THE PYREG PROCESS

ANALYSIS

On the basis of your input material, we make an initial assessment as to whether it is suitable for carbonization and how high the quality of your carbon product is likely to be.

22

DRY-
> 65%
SUBSTANCE

MINIMUM
CALORIFIC VALUE
10
MJ/kg

PARTICLE-
< 30 mm
SIZE

POURABLE
AND
FREE
FLOWING

Output

WE LAY THE GROUNDWORK: THE SEAL FOR PREMIUM QUALITY



The demand for biochar is growing and every year new biochar producers enter the market. However, the carbon products they produce differ considerably in terms of quality and environmental sustainability. For this reason, biochar producers can have their products certified by an independent inspection body since 2012: The European Biochar Certificate (EBC) is a voluntary industry standard that controls and certifies the quality of biochar throughout Europe

www.european-biochar.org

CERTIFIED MANUFACTURERS LIKE OUR SUBSIDIARY COMPANY NOVOCARBO GMBH ARE DUTY BOUND TO MAKE USE EXCLUSIVELY OF BIOGENIC MATERIAL FIGURING IN A POSITIVE LIST.

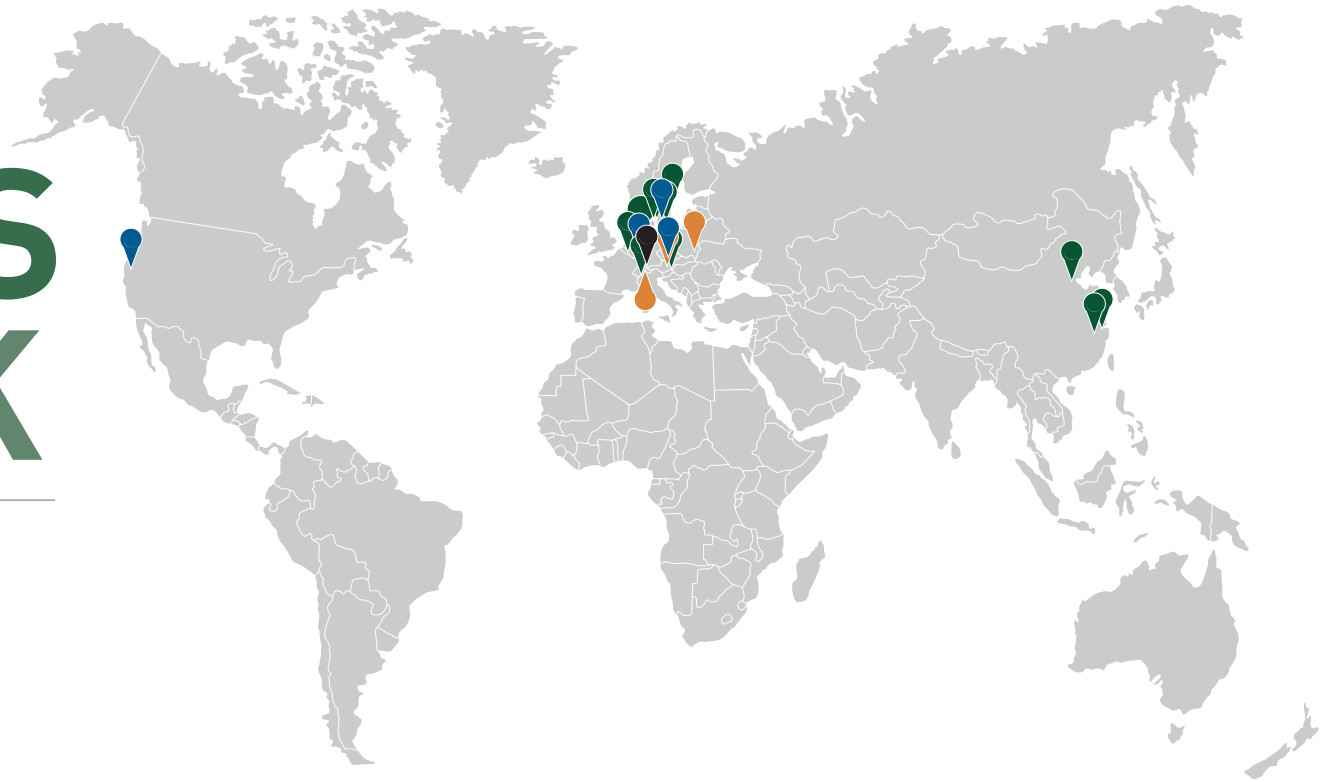
PRODUCTION OF BIOCHAR MUST TAKE PLACE IN AN ENERGETICALLY AUTONOMOUS PROCESS.

EBC-CERTIFIED BIOCHAR MUST DISPOSE OF A CARBON CONTENT OF AT LEAST 50 % OF DRY MASS, WITH A MOLAR H/CORG-RATIO LOWER THAN 0.7.

THE EBC-LIMITS FOR HEAVY METALS, POLYCYCLIC AROMATIC HYDROCARBON ODIOXINS ARE DETERMINED ON THE BASIS OF THE DIRECTIVES ON SOIL PURITY VALID IN GERMANY AND SWITZERLAND, REGULARLY TO BE CONTROLLED.

IN THE CASE OF FEEDING CHAR, THE CORRESPONDING EBC CERTIFICATE DOES NOT ONLY REPRESENT A WARRANTY WITH RESPECT TO EU LIMITS OBERSEVED, BUT ALSO FOR SUSTAINABLE PRODUCTION AND APPLICATION.

PYREG SYSTEMS AT WORK



- 22 Biomass systems
- 6 Sewage sludge systems
- 2 Activated carbon systems
- 4 Laboratory systems

 Stockholm, Sweden

PYREG SYSTEM P500

RECYCLING OF BIOMASS AND
PRODUCTION OF BIOCHAR

In operation since: 2016

Combustible rating 500 kW

Annual throughput approx. 750 t
DS, dry substance
biomass per year

Yearly production approx. 190 t biochar

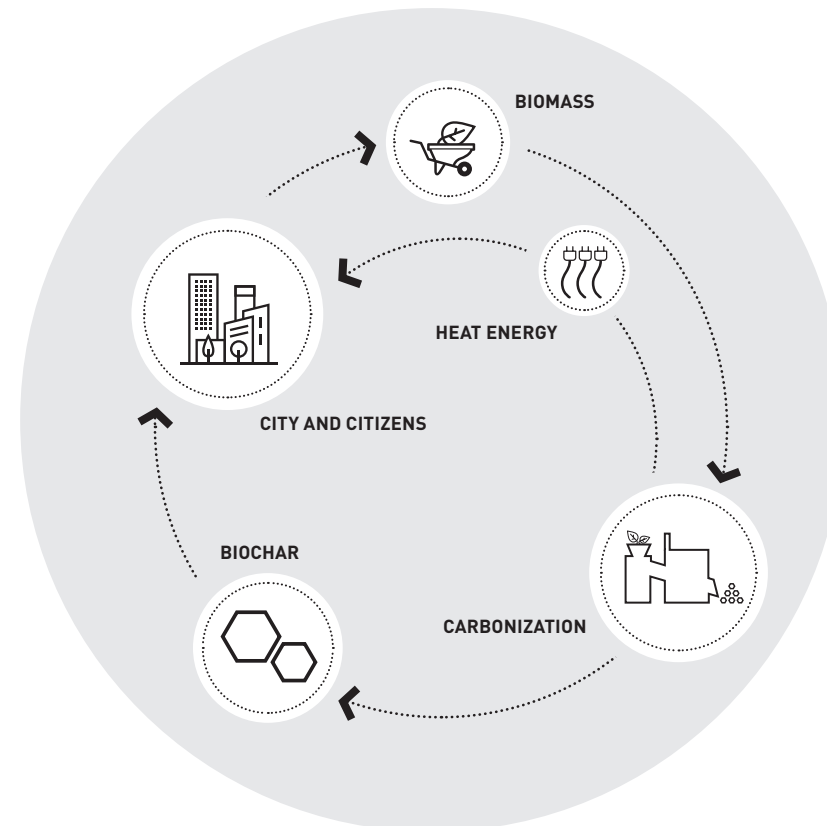
Excess thermal energy approx. 150 kW_{th}


Operating hours up to 7,500 h/a

www.stockholmvattenochavfall.se

CITY AND CITIZENS PRODUCE AND USE BIOCHAR

HOW IT WORKS



 Buchen, Germany

PYREG SYSTEM P500

RECYCLING OF BIOMASS AND PRODUCTION OF BIOCHAR

In operation since: 2016

Combustible rating 500 kW

Annual throughput approx. 600 t biomass
DS, dry substance

Yearly production approx. 200 t biochar

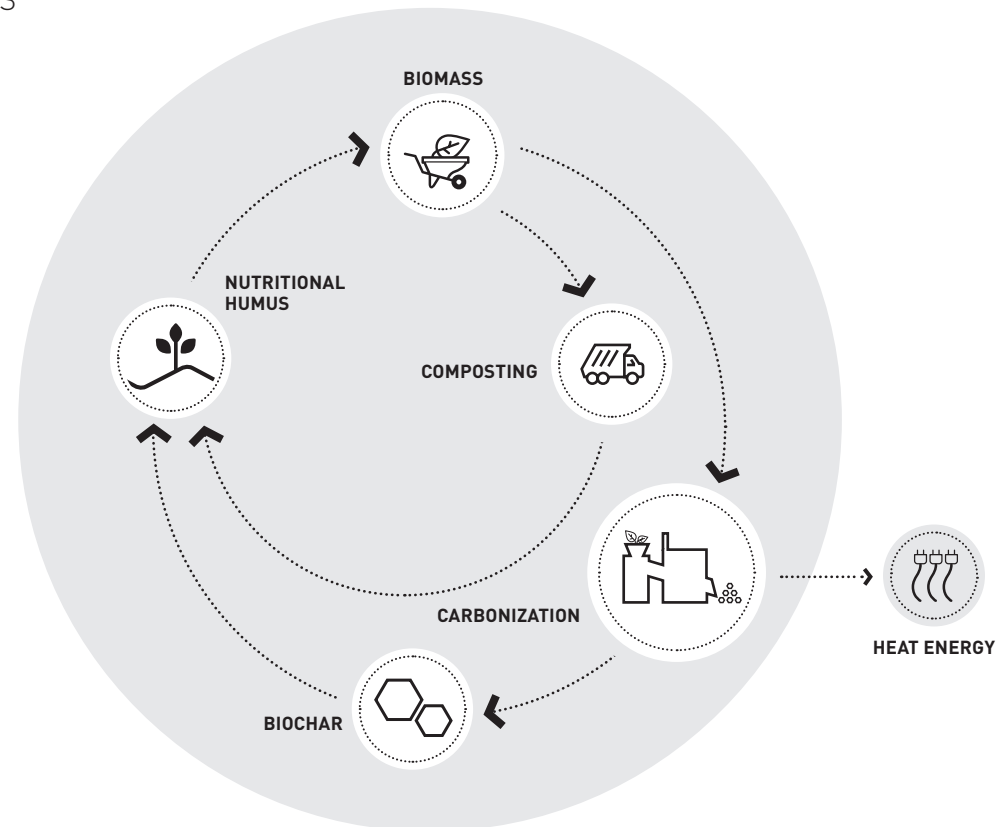
Excess thermal energy approx. 150 kW_{th}

Operating hours up to 7,000 h/a

www.awn-online.de/biomassezentrum

NUTRITIONAL HUMUS FROM THE REGION FOR THE REGION

HOW IT WORKS



Hammenhög, Sweden

PYREG SYSTEM P1500

RECYCLING OF BIOMASS AND PRODUCTION OF BIOCHAR

In operation since: 2019

Combustible rating 1,800 kW

Annual throughput approx. 3,000 t agricultural biomass residues
DS, dry substance

Yearly production approx. 760 t biochar

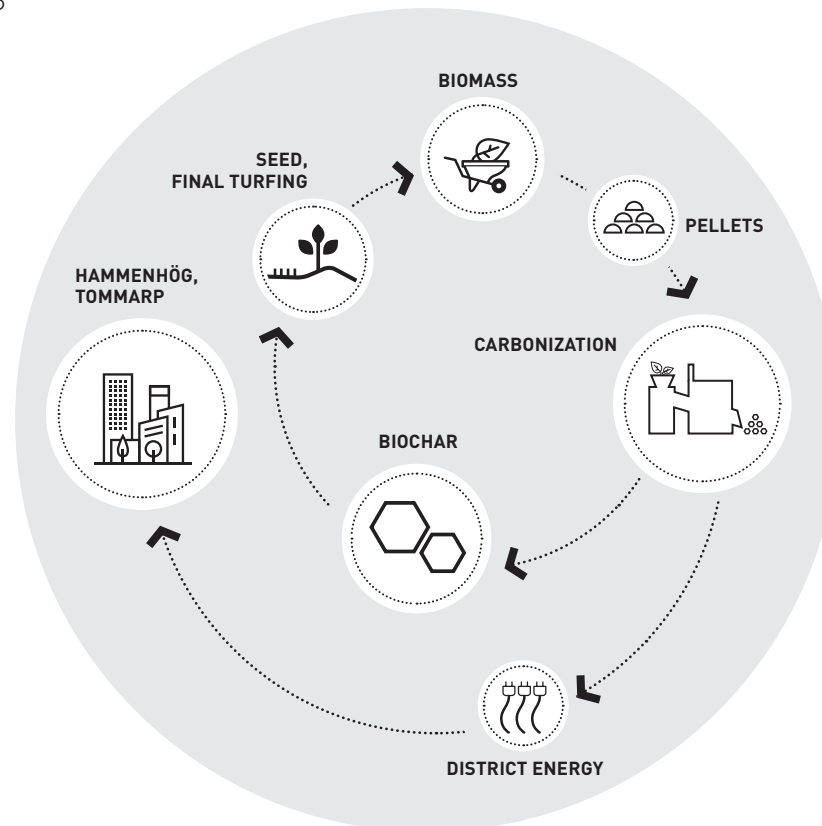
Excess thermal energy approx. 750 kW_{th}

Operating hours up to 7,500 h/a

www.skanefro.se

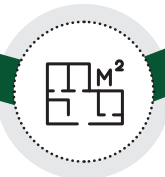
CLIMATE-FRIENDLY PRODUCT RANGE WITH UPCYCLING OF RESIDUAL BIOMASS

HOW IT WORKS



The path to your PYREG system

28



ANALYSIS

We analyse your recycling problem: Is it worthwhile for you to start carbonizing? We will help you to find an answer to this question. We evaluate the quantity and quality of your input material and give you a realistic assessment so that you can make a safe decision.

LOCATION

We analyse the structural conditions: Even at this early stage, we check the licensing conditions on site.

PLANNING

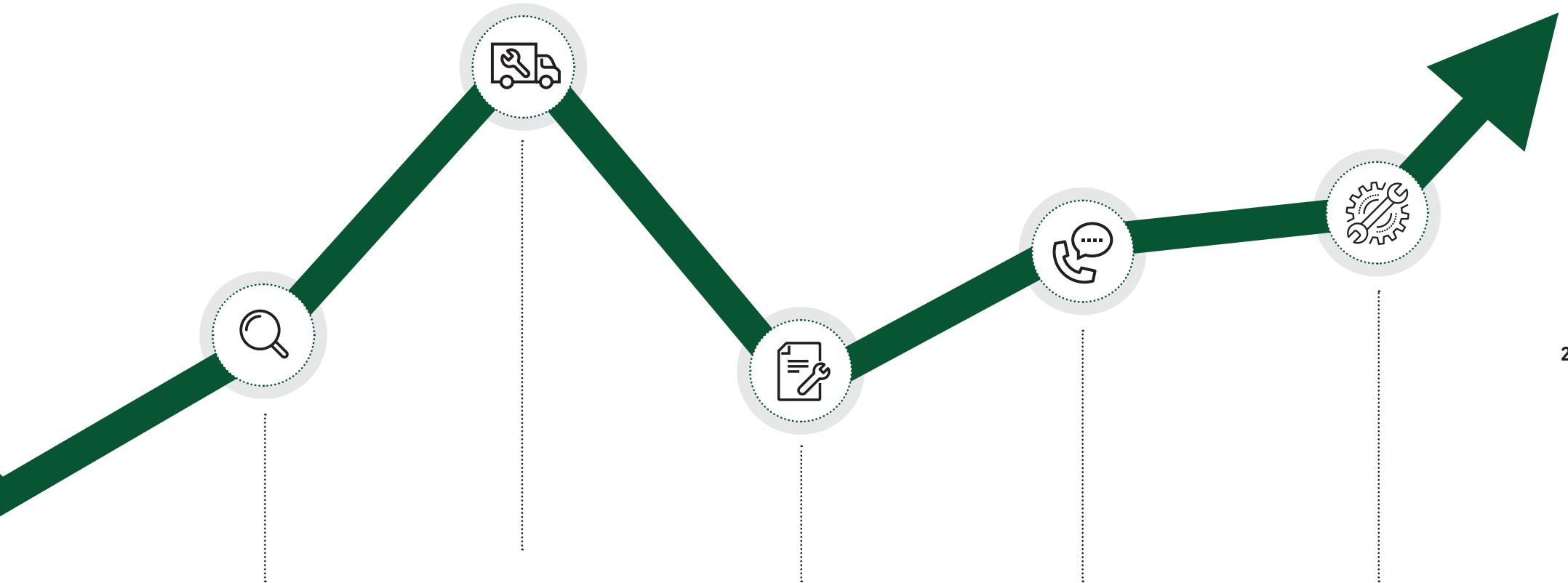
Draft planning and EIA screening: On the basis of a careful site analysis, we design the most suitable plant for your operation. On request, we can also configure any additional technology you may require.

AUTHORITIES

Coordination of a preliminary design with the competent authorities: We create the basis for approval and construction of the plant. We coordinate the draft with the employees of the responsible offices.

APPROVAL

We accompany you through the approval process and prepare the necessary plant and process data for you.



DETAILS

The detailed planning of the plant begins: The individual modules are manufactured and the plant is going to be built.

PRODUCTION & ASSEMBLY

We keep you fully informed about the individual production steps. As a plant manufacturer, we have been developing and manufacturing high-quality carbonization plants in tested quality and „Made in Germany“ at our company facilities in Dörth for more than 10 years.

ACCEPTANCE

Acceptance and commissioning: We organise the official acceptance of the finished plant, commission the plant and support you during the running-in process.

SERVICE

We monitor the operation of your plant online.
Around the clock.

MAINTENANCE

Plant maintenance management: We develop an individual maintenance plan for your plant and implement it on request with our on-site service and in-house service personnel.



Service

OUR EXPERIENCE

As a company for mechanical engineering and environmental technology, we are active in the development and manufacturing of compact carbonization systems in proven quality for more than 10 years. Our PYREG systems are used worldwide.

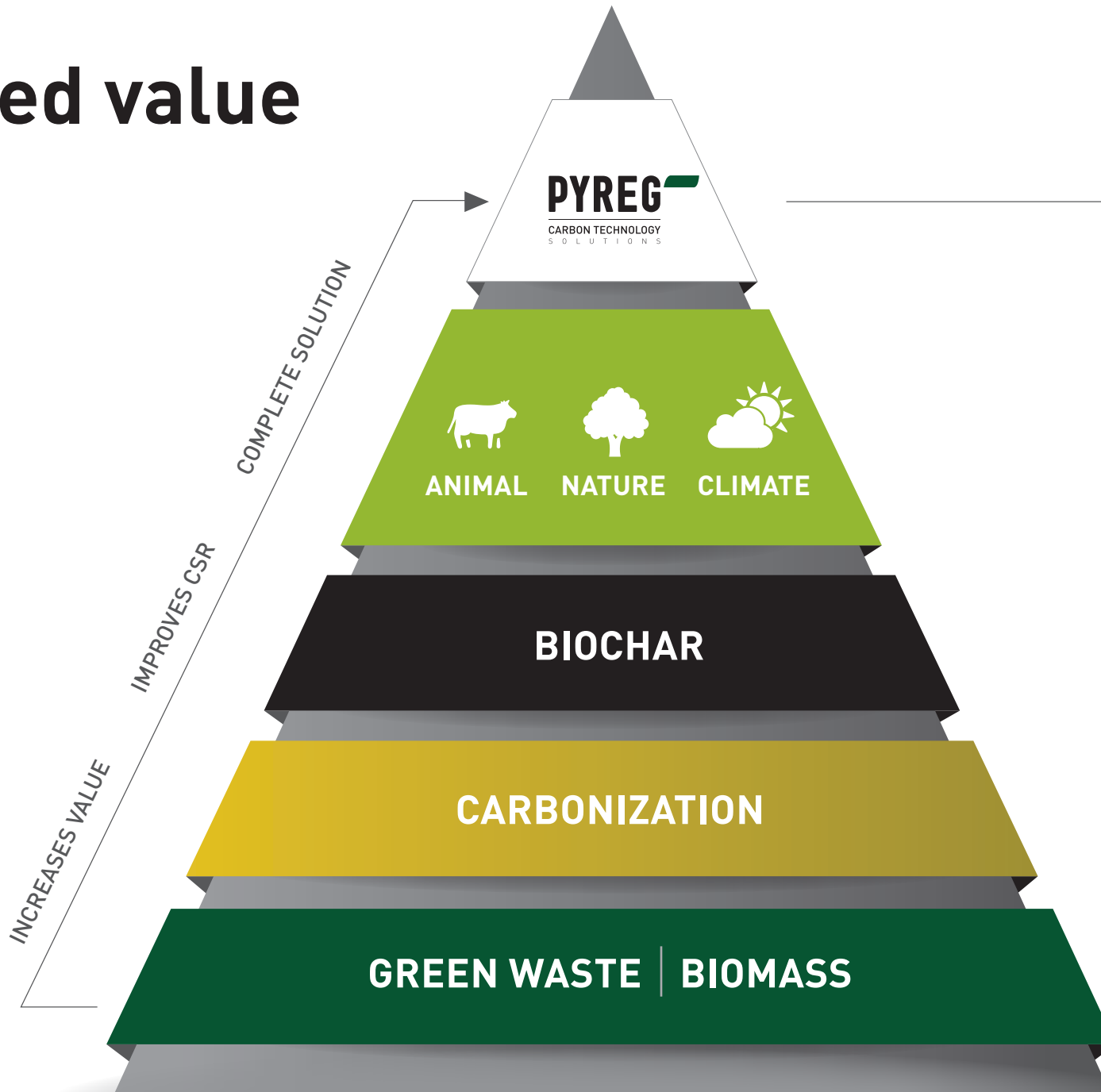
ADDITIONAL SERVICES

To ensure that the PYREG technology fits optimally into your recycling cycles, we offer you a wide range of optional additional services. This includes, for example, a selection of different conveyor technology, storage technology and integration into the heat concept at the site.

ON-SITE SERVICE

Once your PYREG system is up and running, you also benefit from our comprehensive support. This includes remote monitoring and diagnosis as well as on-site service from our technicians.

Added value



▶ VALUE PROPOSITION. BENEFIT FROM THE MARKET LEADER.

PURCHASE

WE PUT TOGETHER A TAILOR-MADE INVESTMENT SOLUTION FOR YOU AND HELP YOU WITH FINANCING NEGOTIATIONS WITH THE BANK.

OPERATOR MODEL*

YOU ONLY PAY FOR THE USE OF OUR TECHNOLOGY. THE OPERATING COMPANY IS RESPONSIBLE FOR THE OPERATIONAL READINESS. THE COSTS ARE EXACTLY CALCULABLE.

MARKETING

WITH OUR PARTNER COMPANY NOVOCARBO, WE DETERMINE THE MARKETING POTENTIAL OF YOUR BIOCHAR AND TAKE OVER THIS PROCESS STEP FOR YOU.

PRODUCT DEVELOPMENT

WE DEVELOP A SYSTEM BASED ON CUSTOMER NEEDS, LEGAL RECYCLING REQUIREMENTS AND CO₂ BINDING CONCEPTS.

PREMIUM PRODUCTS

ONLY HIGH-QUALITY CARBON PRODUCTS ARE IN LONG-TERM DEMAND AT ATTRACTIVE PRICES ON THE MARKET (EBC-CERTIFIED, FEED QUALITY).

ACTIVE PARTICIPATION

IN INTERNATIONAL RESEARCH PROJECTS IN AGRICULTURAL, MUNICIPAL AND INDUSTRIAL SECTORS.

*For large companies and municipalities

About

34

MARKET LEADER



Thanks to permanent innovation and further technical development, PYREG meanwhile has turned out to be one of the most important pioneers in environmental technology. Particularly in the sector of phosphorous recycling from sewage sludge and the resulting production of valuable biochar, feeding char and activated carbon, we are one of the market leaders worldwide.

AWARDED



Winner of Success-Technology award, innovation award of Rhineland Palatinate, inventor award of Rhineland Palatinate ...

Nominated for Diesel Medal, Start-Green-Award, Energy-Award, ...

Technology supplier for winners of Bloomberg Philanthropies Majors Challenge (Stockholm), winner of Austrian Climate Protection Award (Gerald Dunst) ...

EXPERIENCED



Proven method: More than 30 units are currently in service worldwide.

Worldwide presence: D/A/CH-region, USA, China, Sweden, Belgium, Czech Republic, ...

Clientele in several sectors: Municipal companies, manufacturers of compost and garden soil, agricultural enterprises, recycling companies, WWTPs, food and pharmaceutical industry as well as waste management companies make use of our systems.

2011 until today

Entry of further shareholders (state of Rhineland-Palatinate, German Startup Group, ELIQUO WATER GROUP/SKion, Abacus Alpha/KSB, Hevella Capital)

2010

Entry of PYREG Beteiligungsgesellschaft and establishment of PYREG GmbH in Dörth/Rhineland Palatinate

2009

Spin-off of PYREG GmbH from the joint research project

1999-2009

Dipl.-Ing. Helmut Gerber and Prof. Dr.-Ing. Winfried Sehn develop the PYREG process at the University of Applied Sciences Bingen

PYREG GmbH
Trinkbornstr. 15-17
56281 Dörth
Germany
Telephone +49.6747.9 53 88 0
info@pyreg.de

pyreg.de

CARBON TECHNOLOGY
S O L U T I O N S