Energize Your Waste

HYDROTHERMAL CARBONIZATION (HTC)
VAPORTHERMAL CARBONIZATION (VTC)
PYROTHERMAL CARBONIZATION (PTC)

KEY TECHNOLOGIES IN GLOBAL WASTE TREATMENT
TOWARDS A GLOBAL RENEWABLE ENERGY SECURITY

Alfons Kuhles, GRENOL GmbH

It’s a dirty job, but we made it!

KYOCERA Umweltpreis
KYOCERA
Gewinner 2012

Energy Globe
The world award for sustainability
National Energy Globe Award Germany 2016
1st place

- GRENOL GmbH was founded 2007 and is the **eldest company** in the market of HTC.
- Founding father & **CEO**: Dipl. Agrar Ing. **Alfons Kuhles**; seat Ratingen (Germany).
- GRENOL GmbH is founding member of the www.**BV-HTC.de** in 2011 and now president of the board.
- GRENOL GmbH makes **plant advancement** and identifies the **best periphery units** over the years.
- The **price winning** GRENOL company has a **dedicated, friendly team** and a wide range of support partners.


First Batch 2,5 l (2007)


Conti-Reactor 250 l (2008)


ZHAW Batch 25 l (2009)

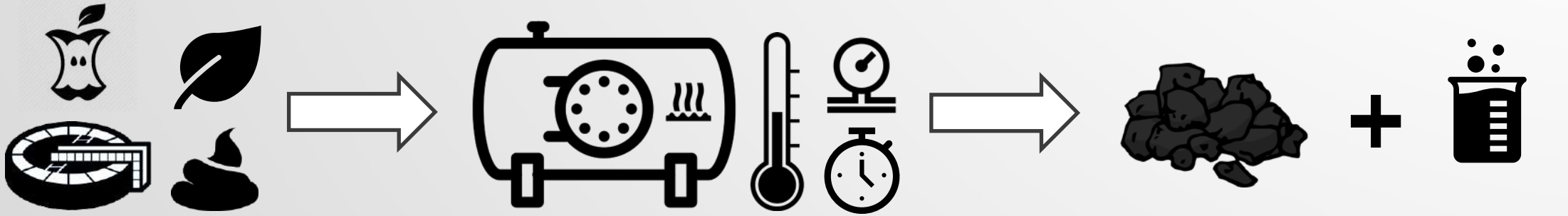

Demonstration Reactor 0,25 m³ (2010-2011)


Industrial HTC-Reactor 2,5 m³ (2012-2019)

What is the HTC / VTC Hydrolysis-Technology?

Hydrothermal/Vaporthermal Carbonization (HTC / VTC) is the conversion of biomass into coal and water in a closed system under conditions of pressure and heat within several hours, like in the earth for billions of years.

- HTC / VTC is conducted at a temperature of about **220 °C** and ca. **22 bar** pressure.
- HTC / VTC is a **physical-chemical procedure**, not a biological process and no pyrolysis at all.
- By breaking up the carbohydrate chains into carbon and water, heat is released (**exothermal process**).
- The carbonization process occurs within **short time (1-6 hours).**
- **HTC** uses **pumpable waste** materials (ca.< 30% dry matter (DM)) in a continuous process condition and
- **VTC** uses **solid waste** (ca.> 30% DM) in a batch process with hot steam in autoclaves.

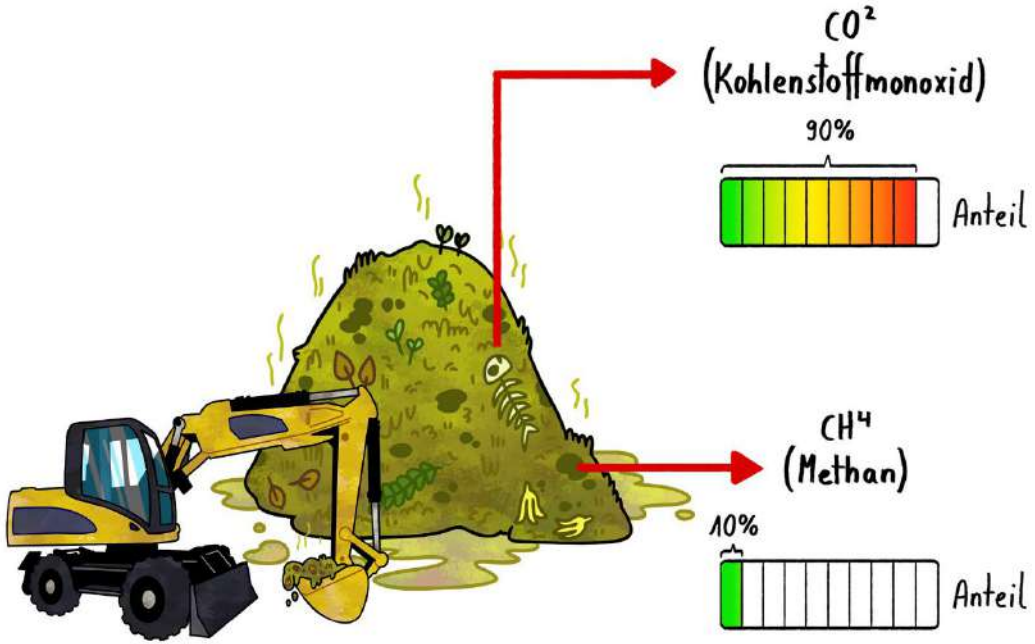


Organic waste | HTC / VTC-process | Bio-Coal | Process water

Why are biofuels climate neutral?

Biofuels are climate neutral because all plant matter decomposes after it dies, releasing methane and CO_2. This is only not the case if the dead plant is covered by mud or soil for a short period of time, thereby removing it from the influence of oxygen. This is how all fossil coal deposits were formed millions of years ago.

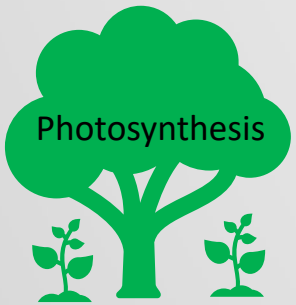
However, if the plants continue to be exposed to the atmosphere, they release all the bound carbon as CO_2 or methane as they decay.
But if we produce biofuel from the plant, we can use this carbon for energy without releasing additional CO_2 from fossil sources.



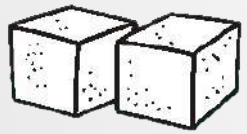
Where are the differences between HTC / VTC and other processes?

Energy

+ CO_2



+ H_2O



Biomass consists for the most part of carbohydrates like - **Sugar ($C_6H_{12}O_6$)**

+ oxygen

Combustion

Carbon efficiency = 0%

(6 H_2O + 6 CO_2↑)

Fermentation

Carbon efficiency = 65%

(2 C_2H_5OH + 2 CO_2↑)

Alcohol

Landgas process

Carbon efficiency = 50%

(3 CH_4 + 3 CO_2↑)

Methane

HTC / VTC-process

Carbon efficiency = 100%

(6 C + 6 H_2O)

Coal

What are the benefits of HTC / VTC / PTC-Technology?

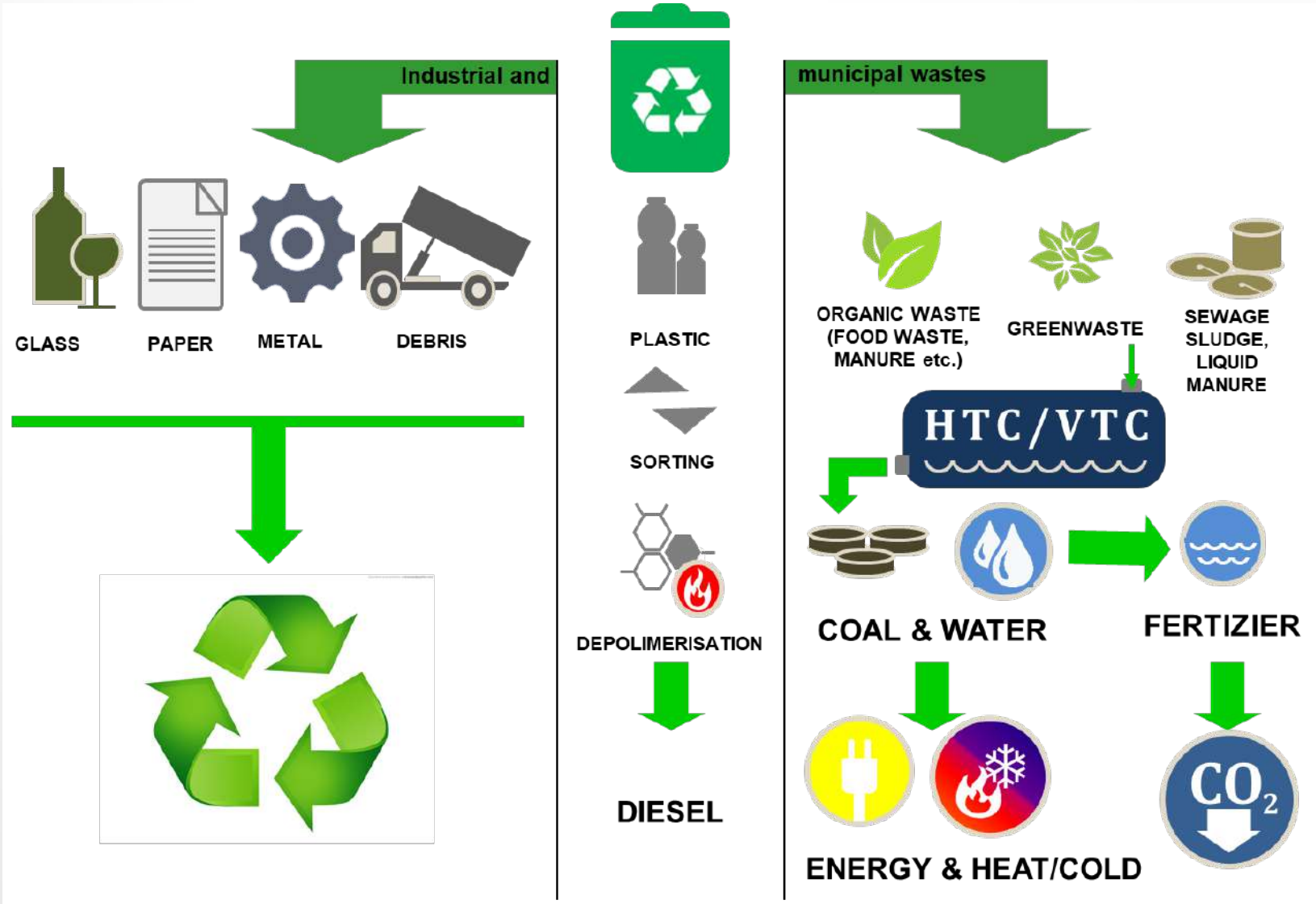
- Any kind of **wet** and **dry** biomass or **plastics** can be used, also as **mixture**.
- The coal is **CO_2-neutral**, **storable** and has a **high energy content** (up to 23 MJ/kg).
- **$^2/_3$ of the energy** from the biomass is **conserved** within the coal and can be used in wood or coal gasifiers to produce syngas and in combination with a CHP to produce **energy and heat at the same time**.
- The process water can be used for a concentrated **fertilizer** or to **boost methane production** in fermentation plants or directly, without any treatment, for **irrigation**.
- **Disinfection** of the input material, destroying of pathogens, antibiotics, hormone, pesticides and even microplastic and PFAS.
- **Easy handling** of the plant, **space saving** and **decentral** technology solution.

Why should we use the HTC / VTC / PTC-Technology?

Answer:
To close the cycle of waste management, worldwide.

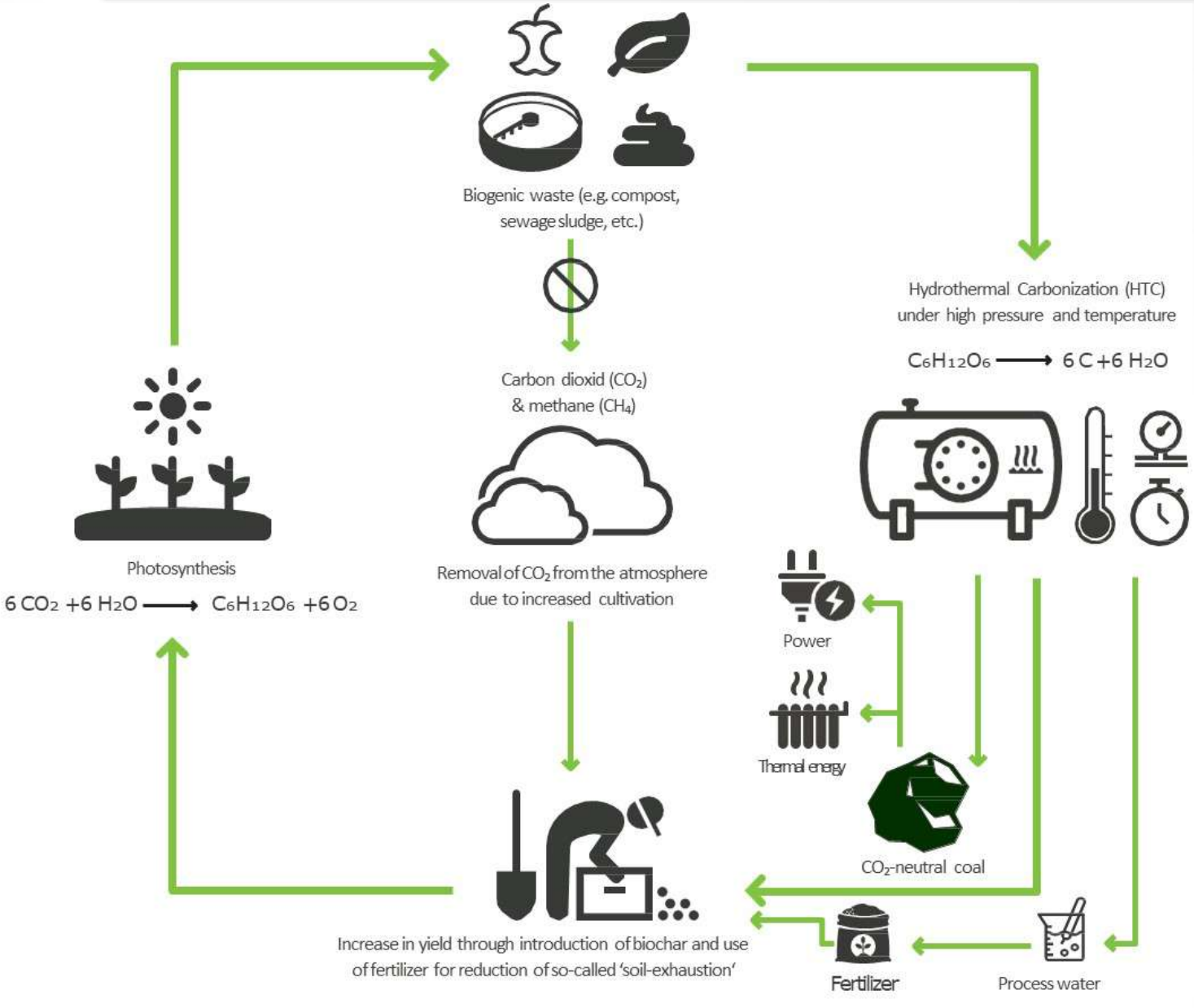
Currently organic waste and plastics are not used wisely.

Along with the conventional methods of biomass conversion, there is always a discharge of the climate damaging carbon dioxide (CO_2), methane (CH_4) and a bad carbon efficiency.



Closed substance cycle waste management by GRENOL-Patent:

- CO_2 neutral energy
- Tradable residual materials
- Nutrients back to the soil
- CO_2 - sink via inert biocoal
- Closing the CO_2-cycle
- Closing the mineral-cycle
- Closing the water-cycle



HTC-Base Module – Converts your poo into coal

Tube reactor type (14.000 t/a Input) 2019-now

- continuous system (24/7)
- **< 30 %** dry matter content

Since December 2013 working in Kalkar/NRW →

← since December 2019 continuous operation with liquid manure and sewage sludge, Chur/Schweiz

Input capacity:
15-50 t/d fresh biomass
with ca. **5-30 %** dry matter content

Screw reactor type (5.000 t/a Input) 2012-2019

- for **pumpable** organic waste: sewage sludge, liquid cow & swine manure, biogas-digester, food waste etc.

VTC-plant is a technology for dirty jobs with lumpy material

VTC-Batch system

- Batch-system, discontinuous
- **> 30 %** dry matter content
- No problem with impure materials
- Usable for **solid, lumpy materials**
- For example: the municipal organic waste bin, green waste, solid manure, compost etc.
- Running in Germany with solid biological waste

Municipal organic waste incl. plastic

Coal yield after carbonisation

Plant Design VTC

VTC-Plant for treatment of around
300.000 t/a Biomass > ca. 30 % DM

Blackwaterdleaning: Anaerob

Fermenter I

Fermenter II

Biomass-storage

Flashcontainer

Biocoaldrying

4 Carbonisation
Reactors

Pelletting

Vibrating sieve

Steamboiler
with Pressurestorage

space for extention to a yearly
capacity of 600.000 t

GRENOL

The GRENOL concept and its possibilities

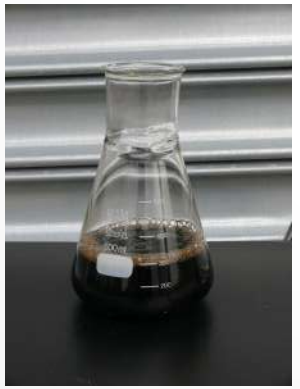
Organic waste

HTC-Reactor (< 30% DM) or VTC-Reactor (> 30% DM)

Coal/Water Separation

HTC/VTC Biocoal

+



Process Water

Step 1

The GRENOL concept and its possibilities

HTC/VTC Biocoal

Drying/Briquetting

Biocoal-sale

Carbon Nano Tubes

Electricity & Heat

by CHP

Hydrogen (H_2)

Wet gas cleaning unit

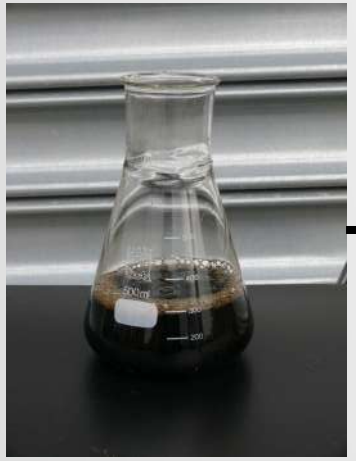
Entrained flow carburettor

Wood / Coal Gasifier

Step 2A

Activated carbon

The GRENOL concept and its possibilities



Process Water

Fertilizer production

Fertilizer sale

Distilled water

Methane Booster

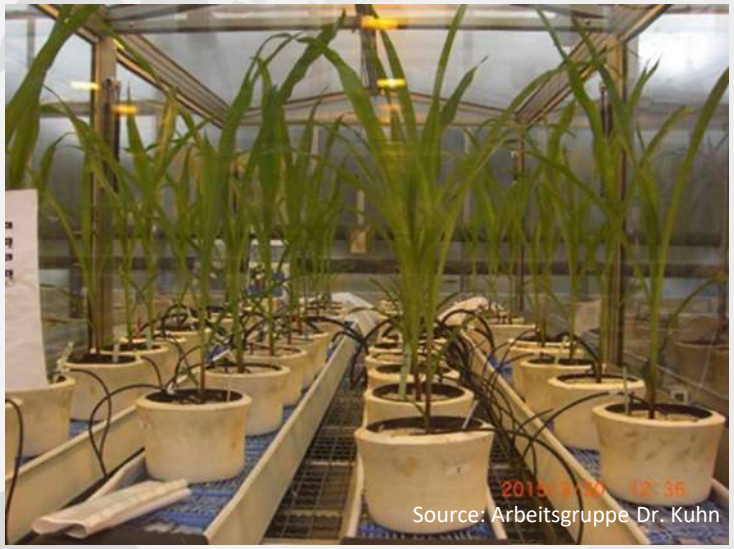
Greenhouse solution/irrigation

Step 2B

Further advantages:
Biochar from digestate, as soil optimizer on barren soils

In long-term cooperation with Dr. A. Kuhn (IBG-2: Plant Sciences, FZ Jülich), many agricultural studies have been carried out in recent years.

- Comparisons with different soil optimizers (hydrochar & pyrochar) with/without fertilizer use.
- Comparisons with different plant species (corn, lettuce, strawberries and carrot plants).
- Analyses of eco-physiological soil and plant parameters.


Source: Arbeitsgruppe Dr. Kuhn


Source: Arbeitsgruppe Dr. Kuhn

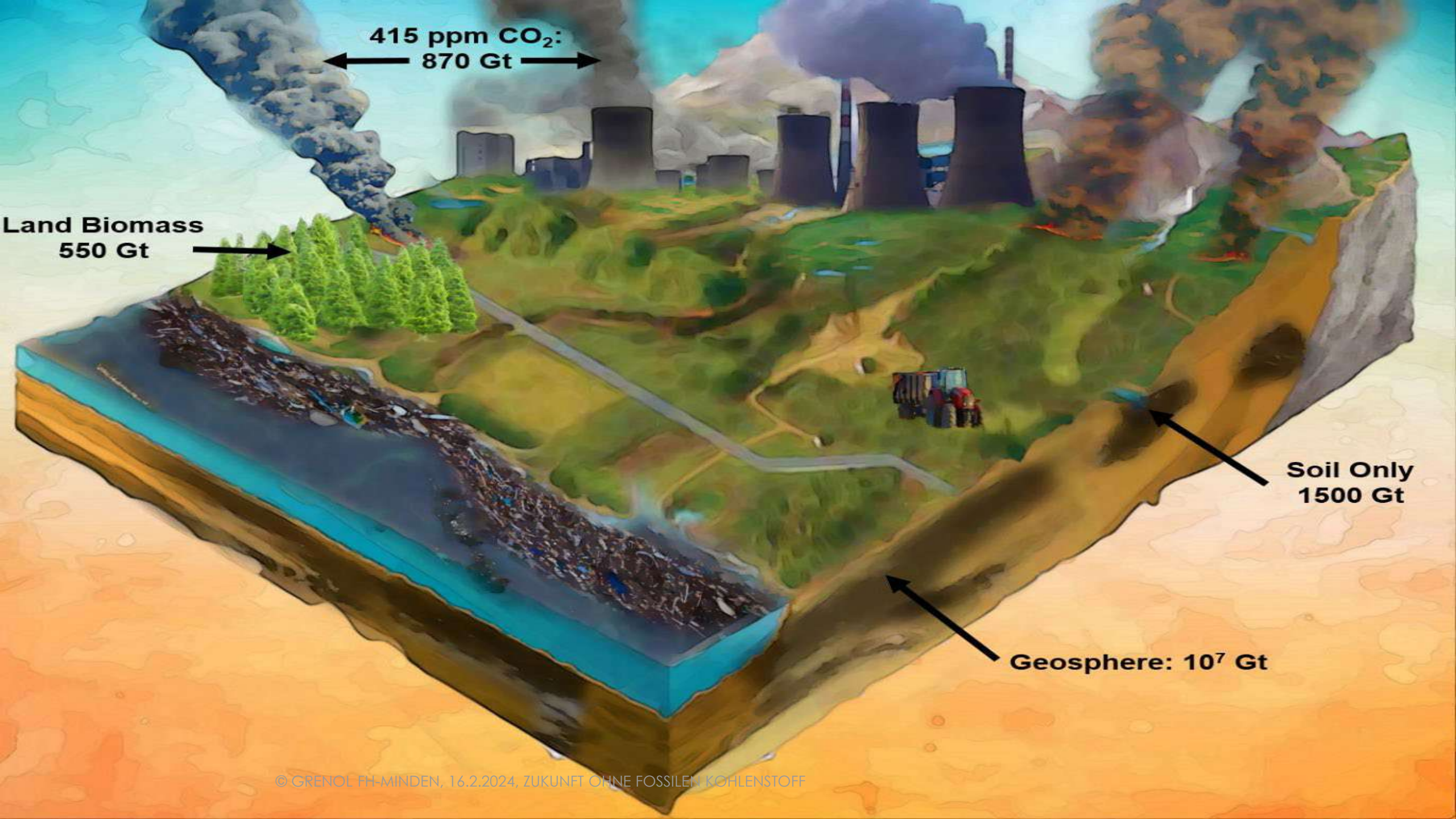
MAKE CAP VERDE GREEN AGAIN !

With the concept of GRENOL+WeGrow: www.wegrow-croptec.com

In GER

Plus =>

In CV



Pyrolytic Thermic Carbonisation PTC/Pyrolysis

1. Production of a climate-neutral biofuel: Diesel
2. Preservation of recyclable materials through plastic recycling, no prior sorting necessary
3. Implemented in a batch process
4. Energy-optimized and without moving parts
5. Low requirements for input material quality
6. Low maintenance costs, high availability
7. Process automation and scaling possible
8. Constant CHP parallel energy production

- **Situation:**
  More than 46 % of 190.434.000 Escudos are Energy imports => **lost** money **from CV**!!!

- **Problem/Chance:**
  The increasing demand for energy cannot be met by existing renewable energy sources alone - especially not during the summer because of less wind!

- **Solution:**
  - Production of a CO2-neutral, storable, and renewable energy source (biochar) all over the year in CV
  - Using that source when needed in CV (=> Dunkelflaute;-)) or export the biochar and sell **CO_2 certificates**

The pricing for these CO2 certificates will be in Europe as follows:

2021 €25/t CO2
2022 €30/t CO2
2023 €35/t CO2
2024 €45/t CO2
2025 €55/t CO2

From 2026 €55 to €65/t CO2

From 2027, certificates will be auctioned without a price limit.

This means that fuel prices in the coal sector will soon rise two to threefold.

How you can make money with Digestate? – an example

Biogas digestate

100 MWh/a Energy

600 MWh/a Heat

750t/a Bio-Coal

Gasifier

~ 1.240 MWh/a Energy

~ 2.500 MWh/a Heat

~ 5.000 t/a Biogas digestate with 22-27 % dry matter

HTC-Reactor

- **Earnings** from the disposal up to **10-25 Euro/t** manure in Europe
- **Hygienisation** of the input material
- **Easy handling**

Biogas plant

or

Back into the digester tower to **optimize** the **methane** production

or

Process water

~ 340t/a N,P,K-Fertilizer

Conclusion

The GRENOL HTC-/ VTC-/ PTC-procedures are new alternative methods to process all kinds of waste in an environmentally friendly manner, and to close the cycle of nutrients and the carbon cycle in waste management.

The GRENOL HTC-/ VTC-/ PTC-technologies offer a very convenient and cost-saving method for processing of any organic waste material and at the same time the possibility to sell CO_2-certificates.

The GRENOL HTC-/ VTC-/ PTC-reactor is the key element of GRENOL's integral concept for the decentral production of both electrical and thermal energy, as well as activated carbon, hydrogen, different fertilizers and clean water.

Thank you for your attention!

For further detailed information, planning and calculation studies, please contact us via phone or E-mail at info@GRENOL.de

National Energy Globe Award Germany 2016
1st place

Contact adress:

GRENOL Group
Artzbergweg 6
40882 Ratingen / Germany
Fon: ++49 2104 2145153
Fax: ++49 2104 2145155
Internet: www.GRENOL.de

KYOCERA Umweltpreis
Gewinner 2012