2024 NORTH AMERICAN BIOCHAR CONFERENCE

— USBI —

CALIFORNIA, USA

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Carbonization

A Future for the Disposal of Sewage Sludge

Robert Kovach, Chief Sales Officer

February 14, 2024


FROM
WASTE TO VALUE

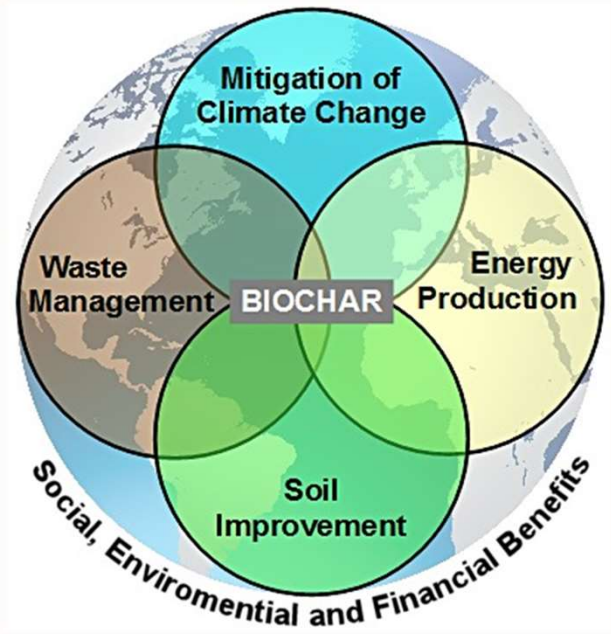
Why Carbonization Biosolids → Biochar?

- **Enhanced water contamination mitigation**
- **Improved nutrient and waste management**
- **Stormwater treatment / water quality**
- **Biochar Carbon Removal (BCR)**
- **Renewable energy objectives**
- **Positive economic impact for the WWTP industry**

Why Biochar?

Biochar is a central solution

Carbon Economy

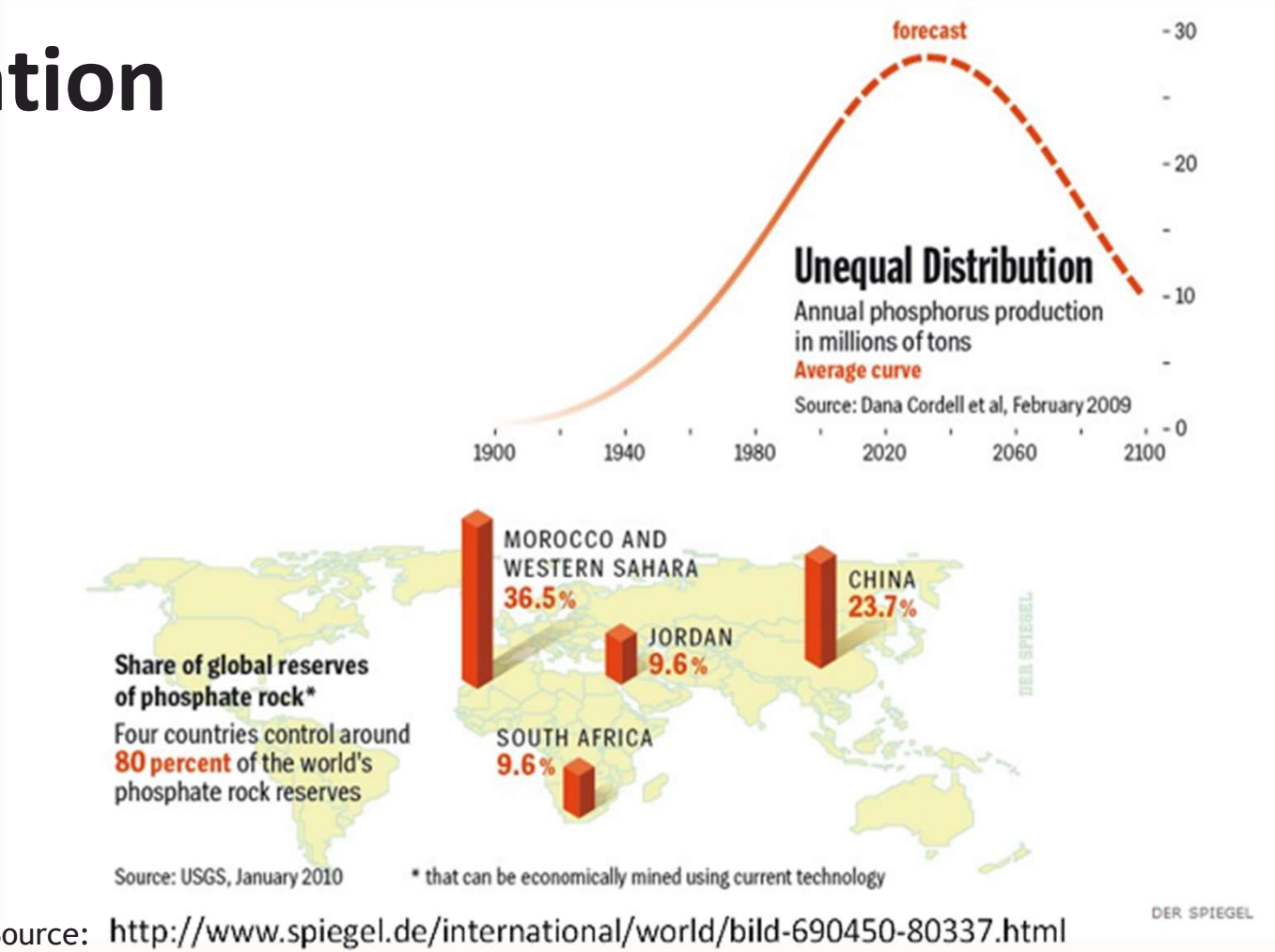


Circular Economy

New Energy Economy

Regenerative Ag Economy

Justification



Source: http://www.spiegel.de/international/world/bild-690450-80337.html

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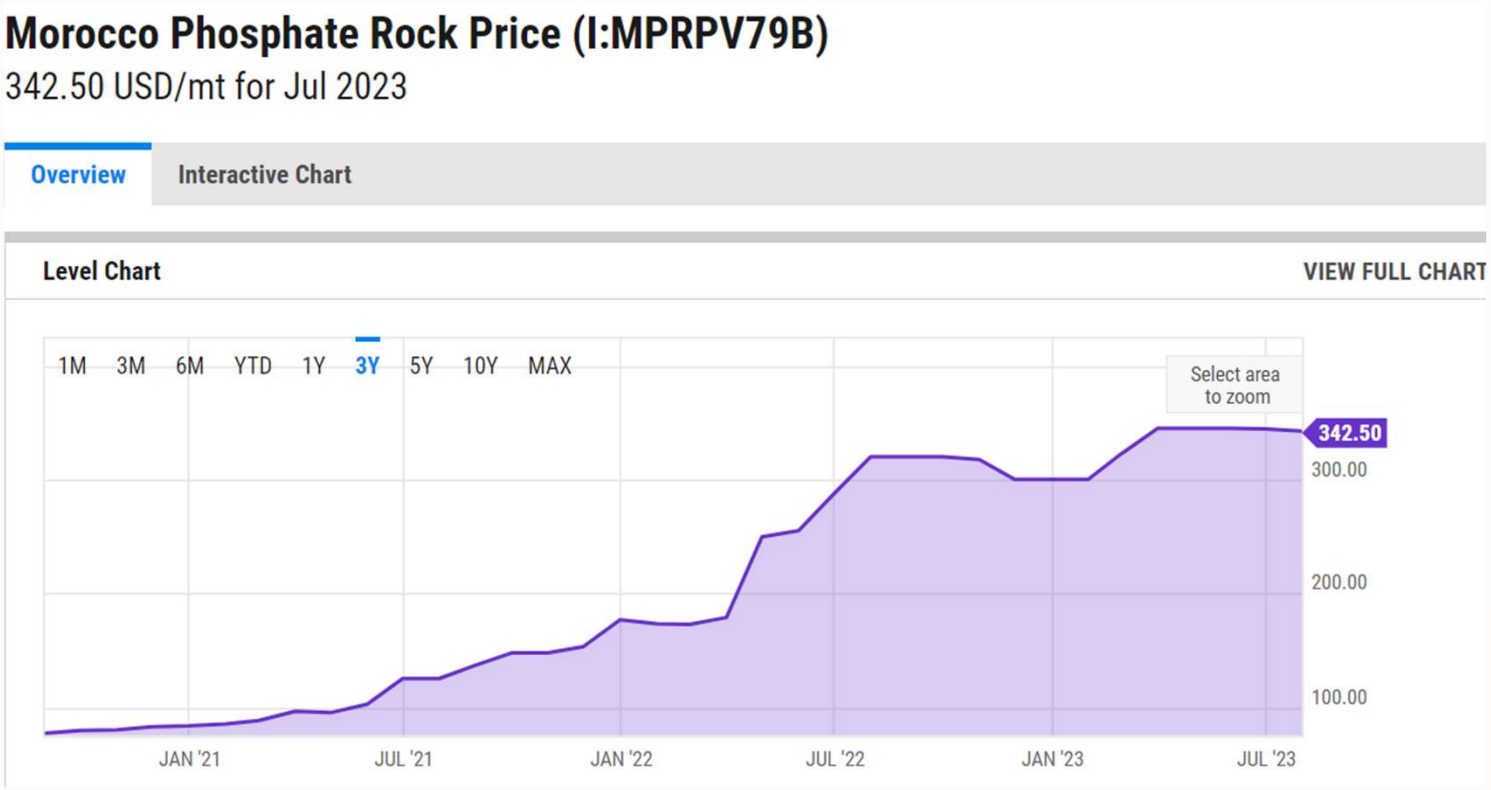


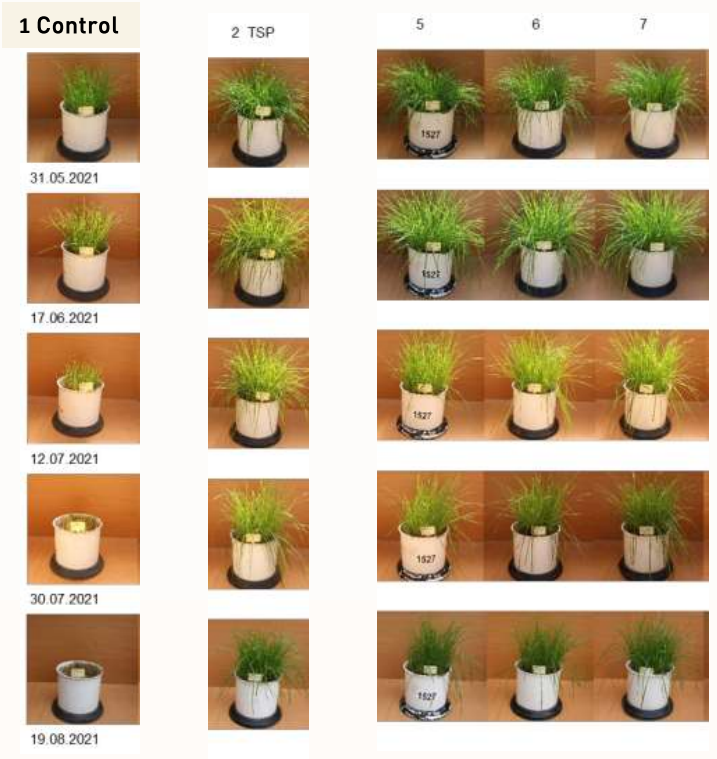
Recent Fertilization Trials (Oct. 2022)

Biochar from Biosolids achieve 90% of reference Triple Super Phosphate results (TSB=chemical fertilizer)

Biochar produced at 500°C
Fulfilment of EU heavy metal limits

Organic hazards (PFAS, PAH`s,...) below detection limits

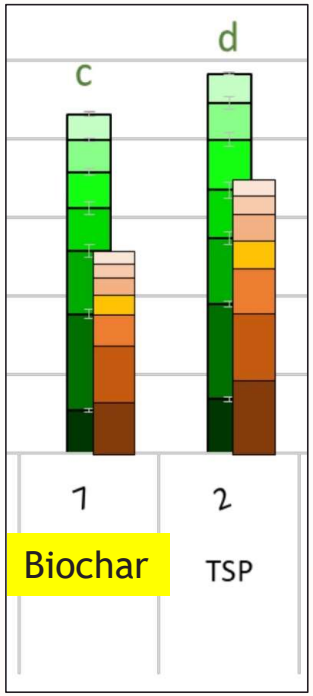
=> Full chemical compliance with EU legislation



[P-Düngewirksamkeit von Klärschlamm-Rezyklaten
Abschlussbericht LHL Hessen, Koch, Schuman, Dr. Jacobi, Löber; Oktober 2022]

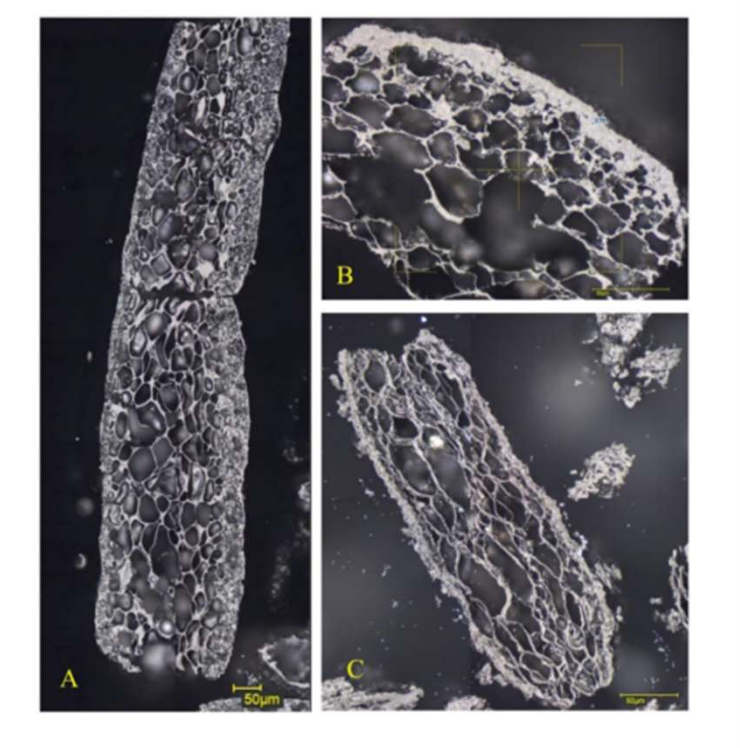
Recent Fertilization Trials (Oct. 2022)

Comparison between PYREG biochar from sewage sludge and highly effective chemical fertilizer reference Triple Super Phoshate (TSP) indicates a nominal difference in performance.
Biochar P-Fertilizer effect is approx. 90% of TSP in plant trial.



GREEN: Cumulative dry matter production of the individual cuts.
BROWN: Phosphorus uptake of the plants

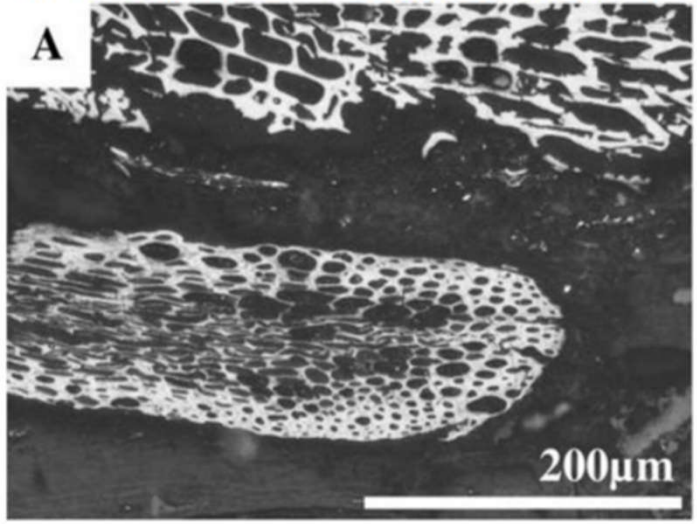
Sewage Sludge Biochar is a stable carbon sink!



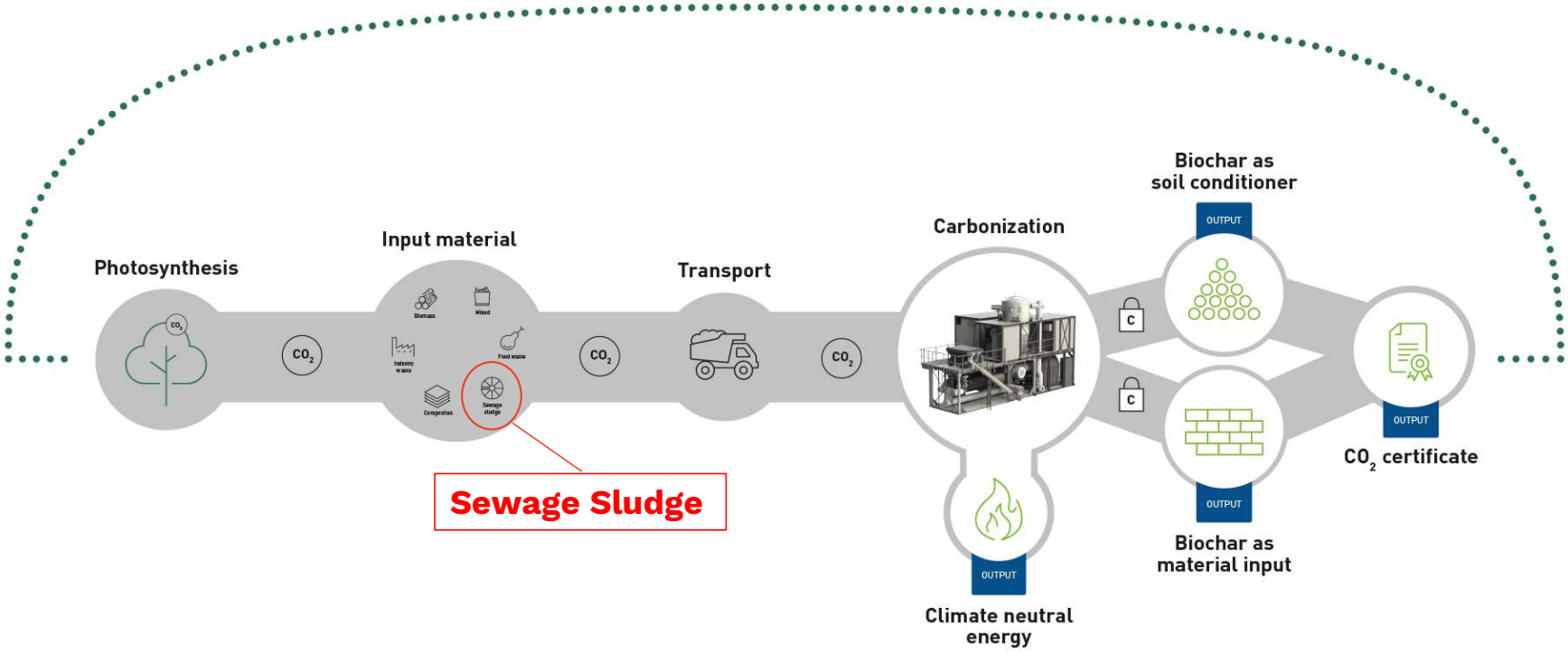
> 97% of carbon in Biochar stable in geological timeframes (> 1.000.000 years)

Vitrinite reflectance: ASTM method D2798-11

H.I. Pettersen, H. Sanai et. al 2023, International Journal of Coal Geology



Carbon Dioxide Removal (CDR) with Biochar



PYREG Technology

PYREG
NET ZERO TECHNOLOGY

Milestones:

- **1999**
  Helmut Gerber (CTO and founder) starts research project at TH Bingen
- **2009**
  Foundation of PYREG as a spin-off
- **2020**
  Development of new PX plant generation
- **2022**
  Foundation of first subsidiary PYREG Inc. (USA, ME)
- **Today**
  - More than 50 plants delivered worldwide
  - Over 100 employees

NOMINEE
German Sustainability Award 2022

WINNER OF THE
watt d'or 2022
BEST ACHIEVEMENT AWARD IN THE ENERGY SECTOR SPONSORED BY THE SWISS FEDERAL OFFICE OF ENERGY

NEW ENERGY CHALLENGE

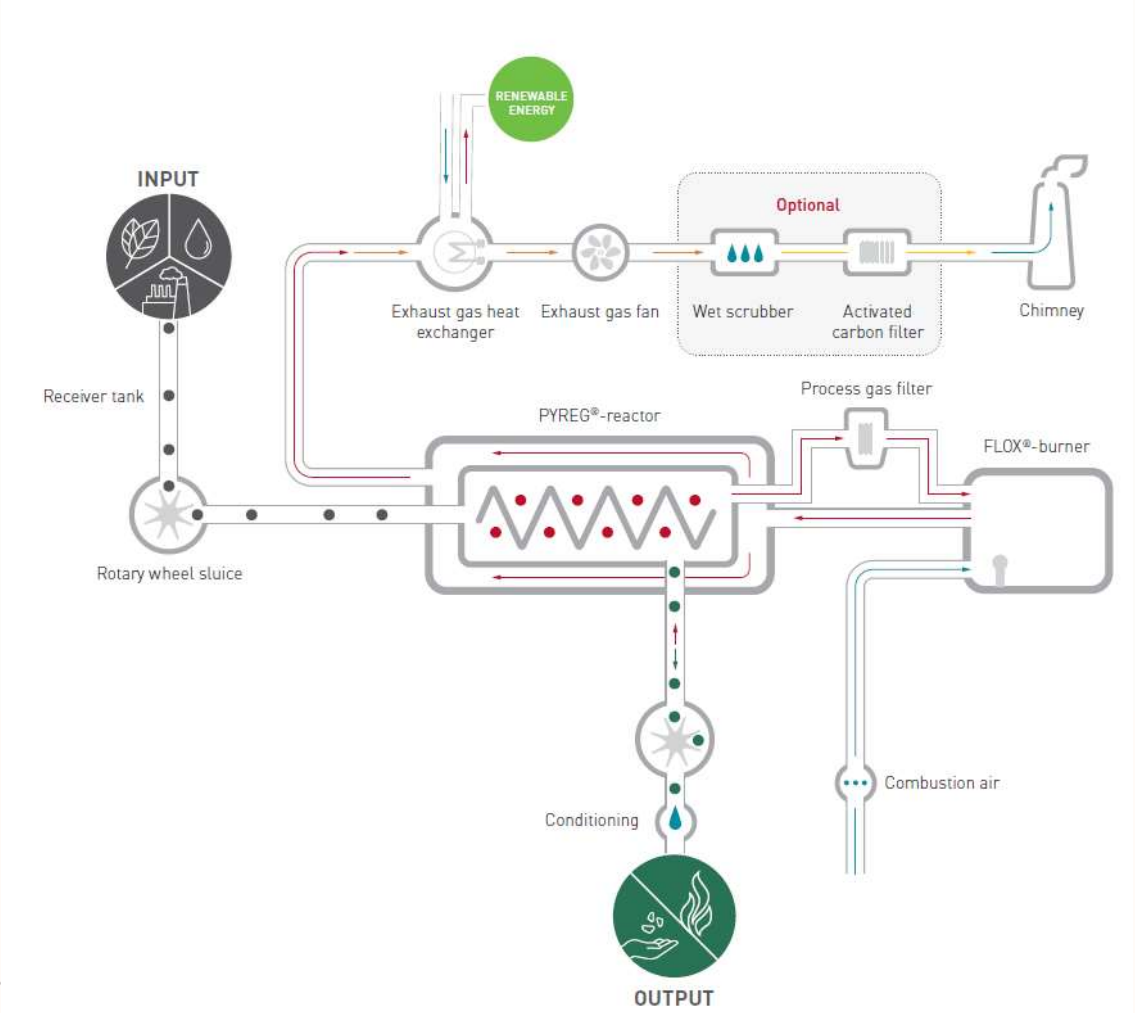
CERTIFIED BIOCHAR
EBC
EUROPEAN BIOCHAR CERTIFICATE (EBC)

PYREG
Technology Partner
The first recognized partner providing high-tech carbonization machines that meet the Puro Standard requirements for CORCs.
puro.earth

The PYREG process

Your advantages

- Sanitation
- Autothermal process
- Complete recovery / waste free
- Continuous 24/7 process
- Monitoring of process KPIs guarantees reliable product quality



Input Material Requirements

The PYREG system can recycle a wide range of heterogeneous waste materials.
Requirements for the input material:

3–30 mm
PARTICLE SIZE

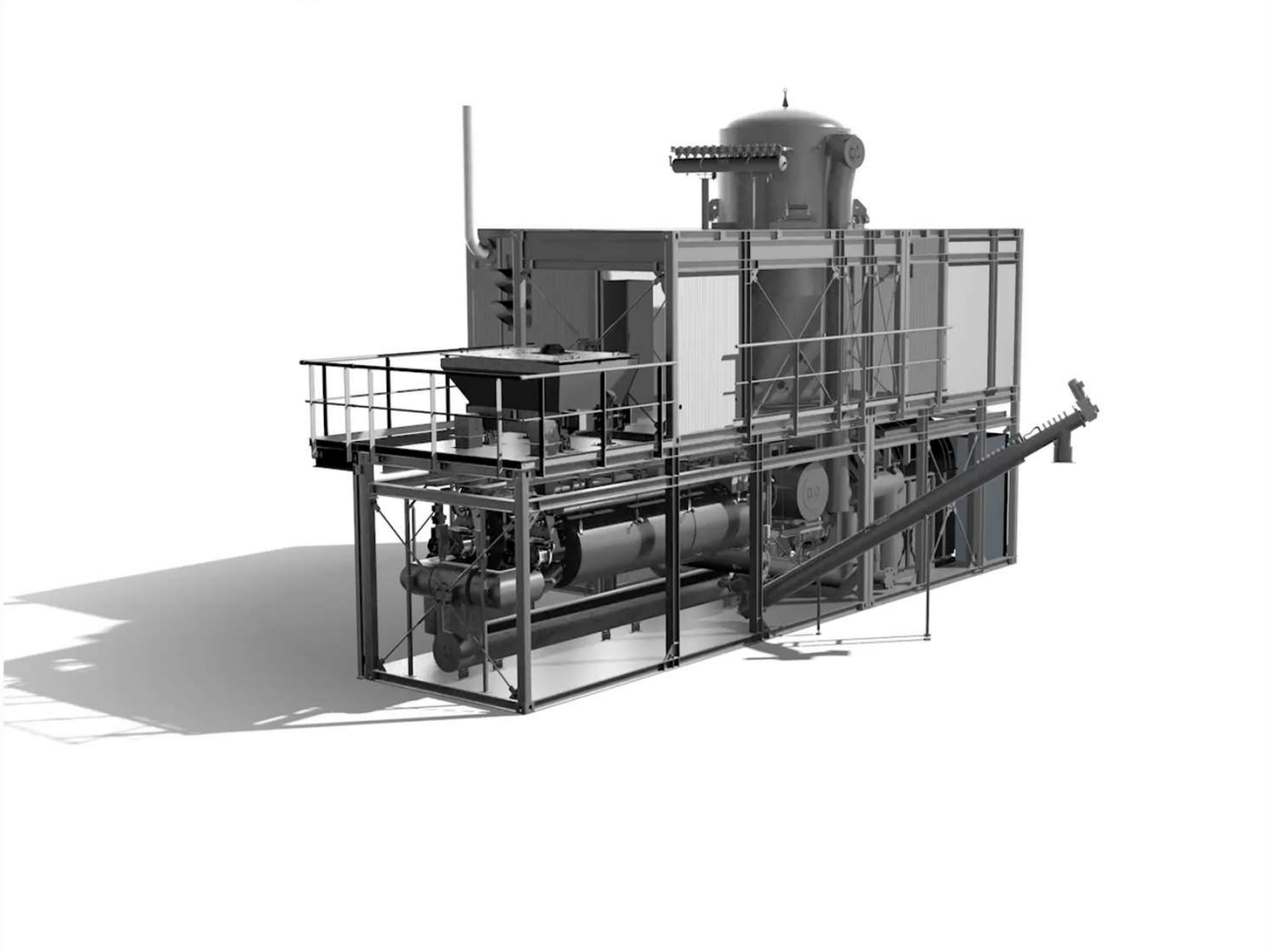
POURABLE
FREE FLOWING

>80%
DRY SUBSTANCE
CONTENT

10 MJ/Kg
MINIMUM
CALORIFIC VALUE

*Pay attention to acidic components (Cl, S, Br, F)
and solid contaminants (Glass, stones, metals)

The PYREG System – PX1500



PX Systems Sewage Sludge

	PX500	PX1500
Combustible rating	500 kW	1,500 kW
Annual throughput	Up to 1,300 t	Up to 3,900 t
Annual production	Up to 800 t	Up to 2,400 t
Carbon removal potential	Up to 600 t CO_2 eq	Up to 1,800 t CO_2 eq
Max. thermal energy per hour	Up to 200 kW_{th}	Up to 600 kW_{th}
Annual operation hours	8,000 h	8,000 h
Power consumption	16 kW_{el}	48 kW_{el}
Size	l **9,000** mm w 3,000 mm h 4,500 mm	l **13,000** mm w 3,000 mm h 7,800 mm
Additional Technology-Modul required	l 6,000 mm w 3,000 mm h 5,800 mm	l 12,000 mm w 3,000 mm h 5,800 mm
	Based on sewage sludge, 90% DS, ca. 13 MJ/kg DS, ca. 60% oDS	

PYREG USP`s

Experience

- >50 plants since 2009 (TRL 9)
- Scalability with PX500, PX1500
- EBC/WBC type certification
- Puro.earth technology partner

Sustainability

- Low energy consumption
- Surplus renewable energy
- Minimum pollutant emissions

Flexibility

- Multi-material capability
- Fast integration and adaptation on site
- Flexible energy decoupling

Quality

- Lifetime >15 years
- Reactor made of special alloys
- State of the art selection of components

Automation

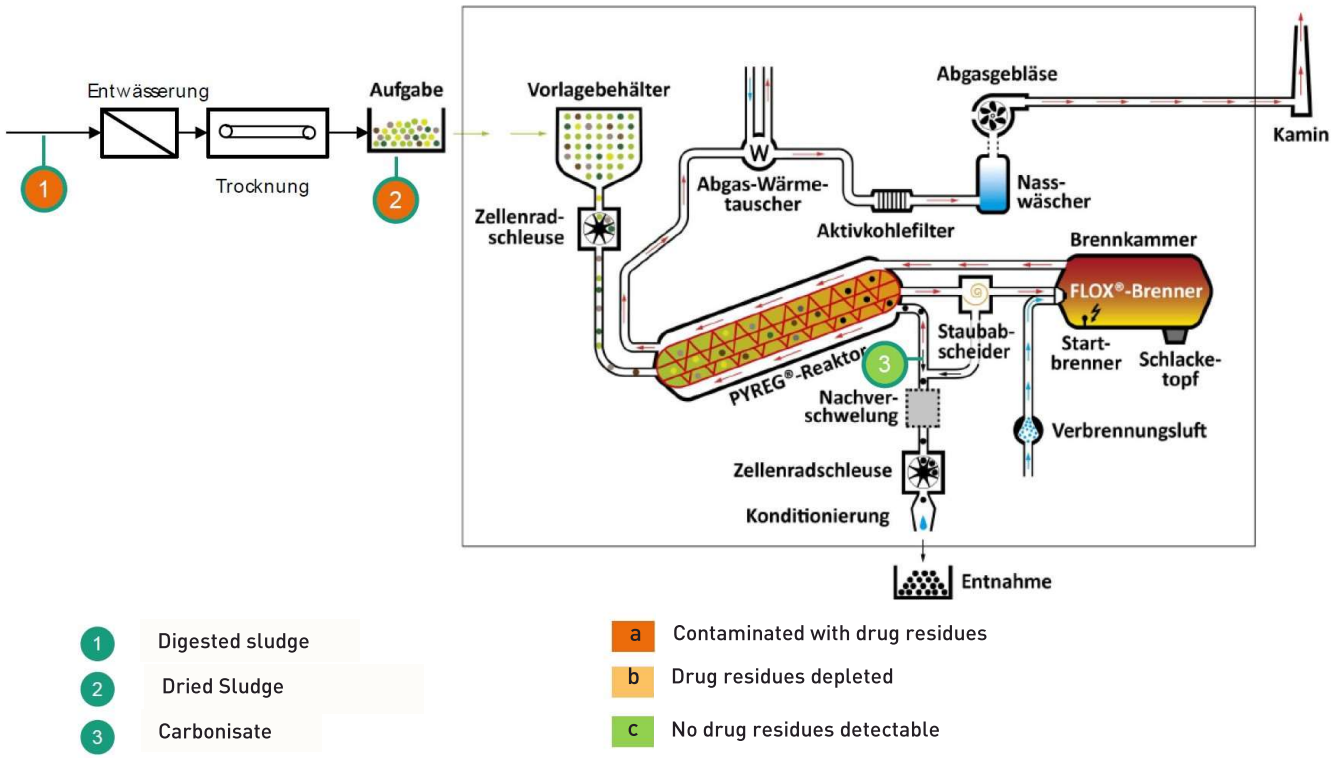
- Automated process with >200 sensors
- Remote control via IoT Software
- UPS-backup in case of emergency

Service

- Worldwide service
- Network of partners
- Short reaction time
- Spare and wear parts package

Is the Technology Proven?

Feedstock pollutant degradation: Pharmaceuticals/Microplastics



Trials on Pharmaceutical reduction in a PYREG plant were carried out by a research group of UBA (Umweltbundesamt) at PYREG plant located at Waste Water Treatment Plant in Unkel, Germany.

No Pharmaceuticals detectable after processing polluted sewage sludge with a PYREG plant.

Feedstock pollutant degradation: PFAS

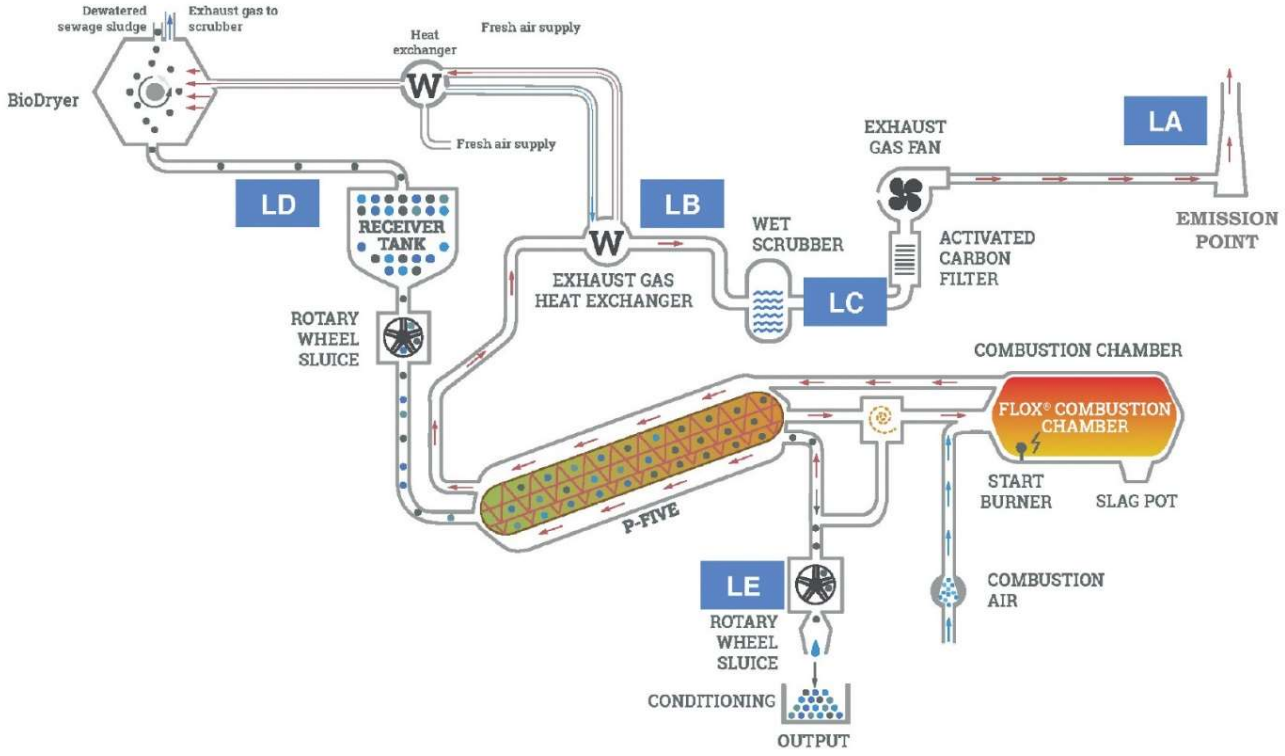
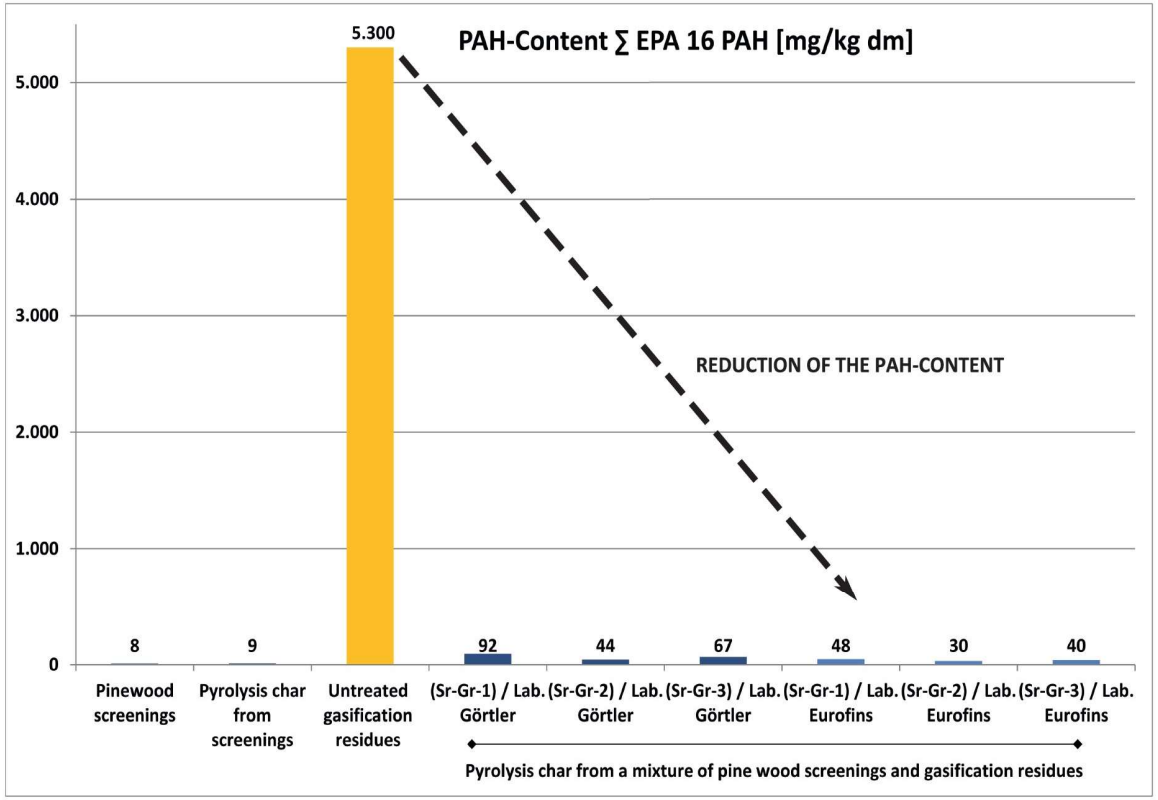


Figure 1. Schematic of pyrolysis unit with air emission and solids/liquids sampling locations: (LA) air sampling at stack, (LB) air sampling after clean water (W) heat exchanger, (LC) air and scrubber water sampling, (LD) input biosolids sampling, and (LE) output biochar sampling.

In August 2020, US-EPA completed a PFAS (per- and polyfluoroalkyl substances) survey of a commercial-scale biosolid pyrolysis operation at the SVCW WWTP (PYREG plant, BioForceTech, Silicon Valley, CA) and found that target **PFAS compounds present in the input biosolids were removed from the produced biochar and were also largely absent from the emission control scrubber water.**

Feedstock pollutant degradation: PAH



Graph 1: Overview of the total PAH-content of the trial samples

Trials on PAH (Polycyclic Aromatic Hydrocarbons) reduction in a PYREG plant were carried out by a research group of RWTH Aachen and University Halle in 2013/2014. The feedstock was highly PAH polluted.

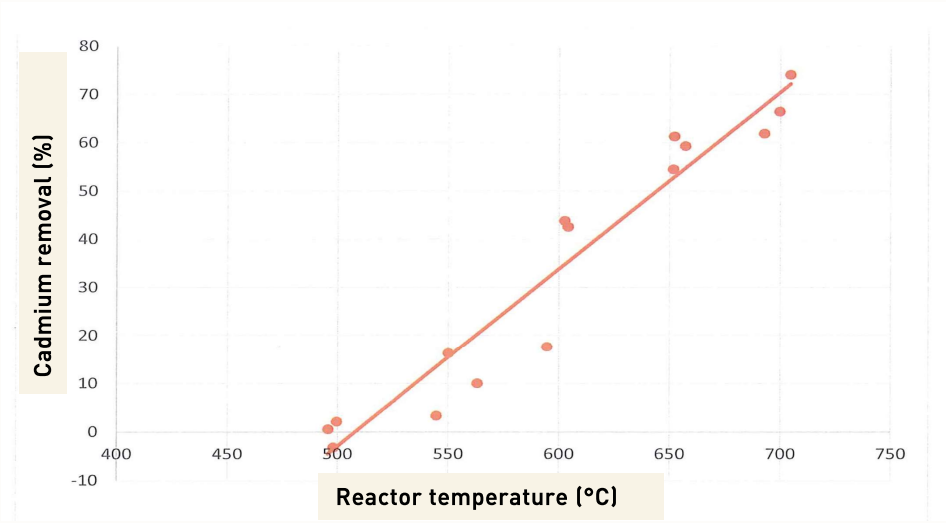
The result is a 99% PAH reduction through the PYREG carbonization process

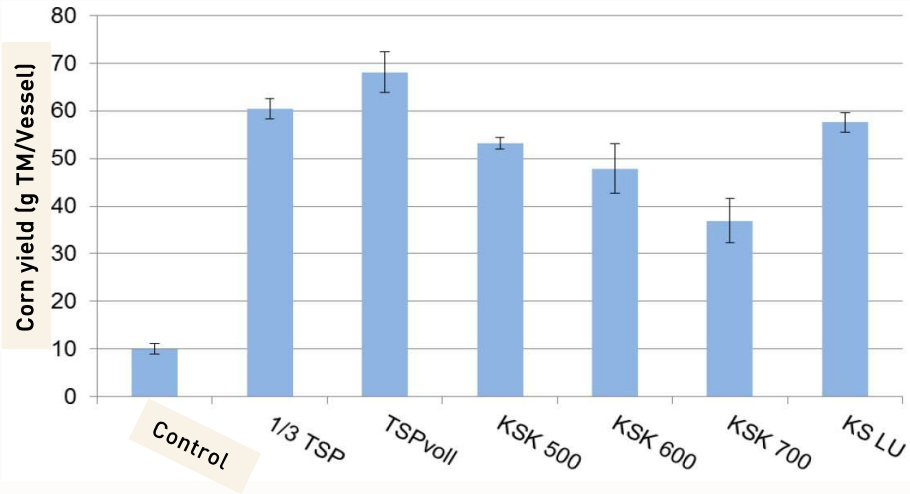
Feedstock pollutant degradation: Dioxin

Trials on Dioxin reduction in a PYREG plant were carried out by a research group of Leuphana University Lüneburg at the PYREG plant in Dörth.
Dioxin polluted grass from the banks of river Elbe was treated with pyrolysis. (Soil pollution 250 ng TEQ kg)

Dioxin was reduced by 95% during treatment with a PYREG plant.

Heavy metals reduction: Example Cadmium



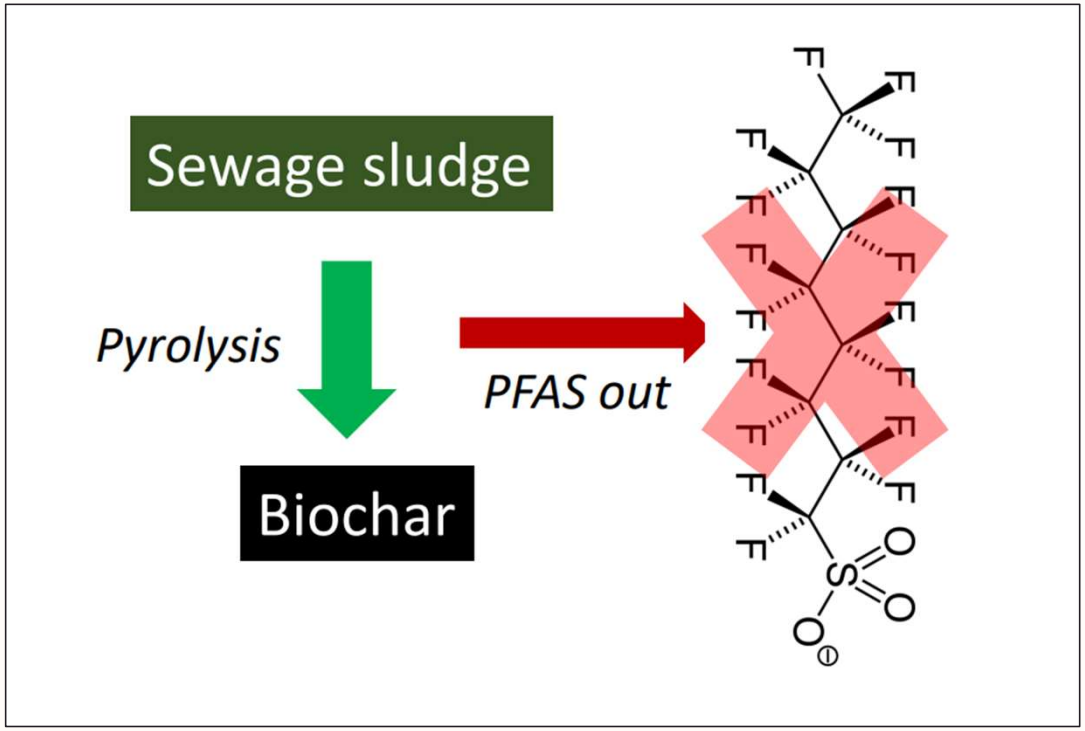


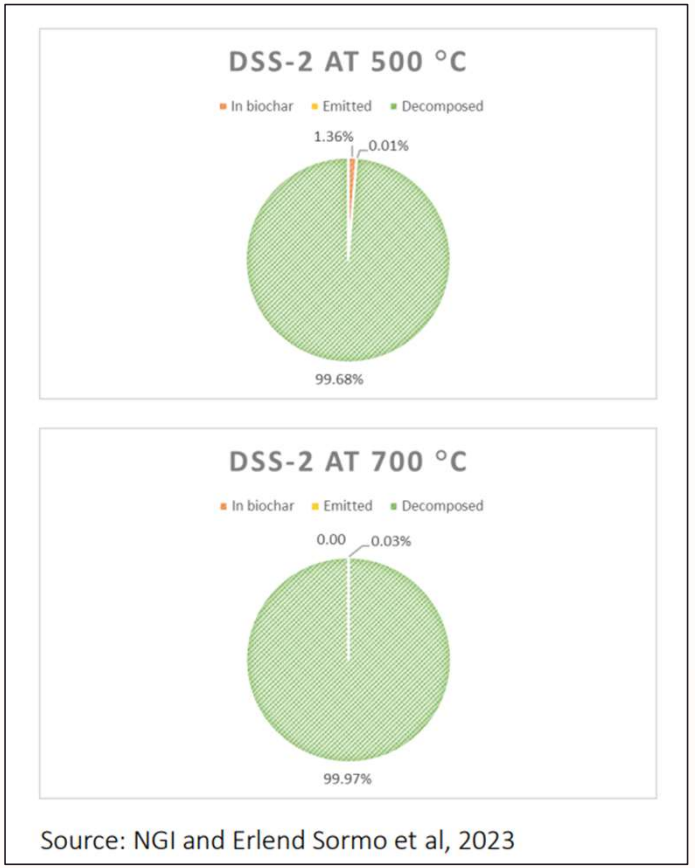
Higher temperatures remove more Cadmium, but also low temperatures can produce biochars far below limits depending on the sludge.

– BUT: With higher temperatures there is less Phosphorus for plant availability
(Plant trial with maize, 55 days growth, TSP: Triple Superphosphate, KSK: Sewage sludge Biochar, KS: Sewage sludge)

PFAS treatment and sorbent production

Pyrolysis between 500°C to 700°C destroys PFAS

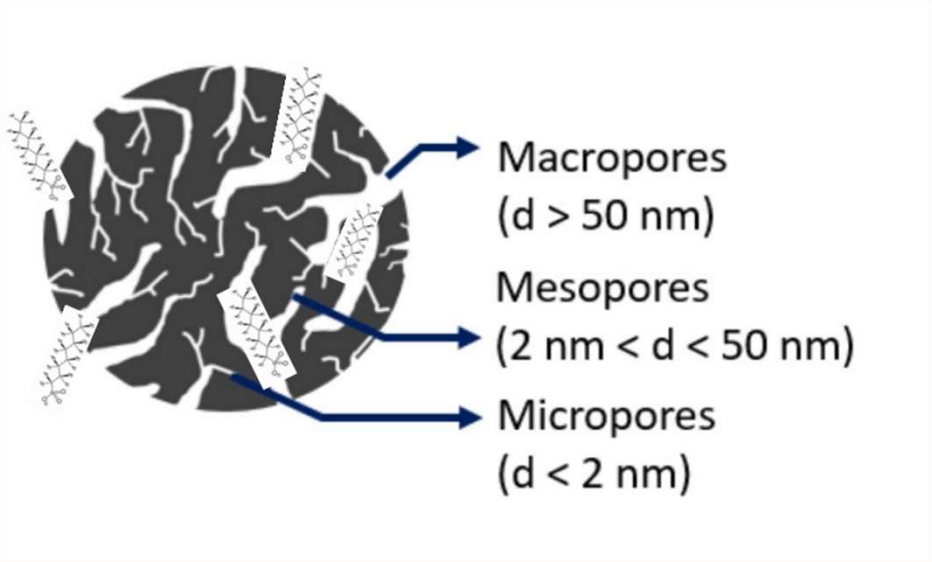


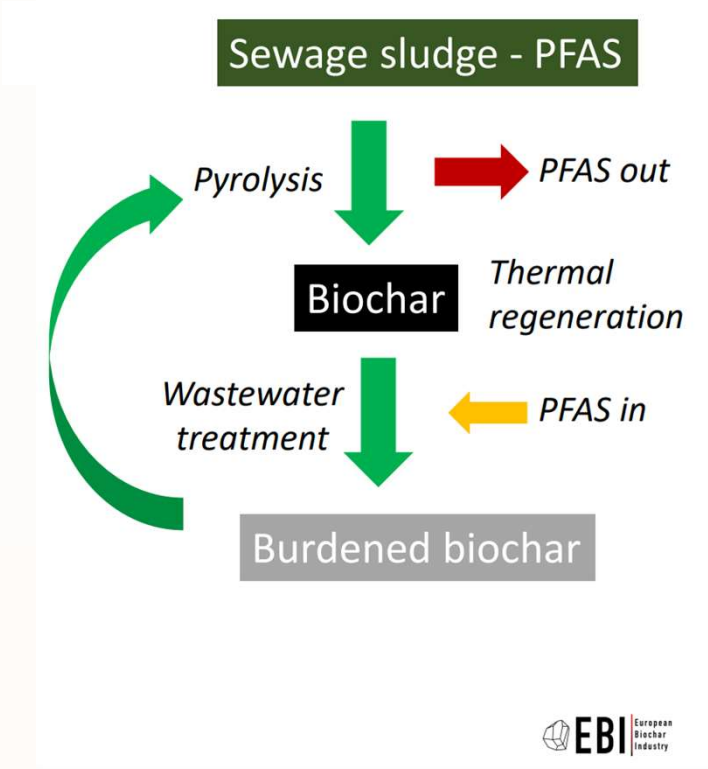


Source: NGI and Erlend Sormo et al, 2023

PFAS treatment and sorbent production

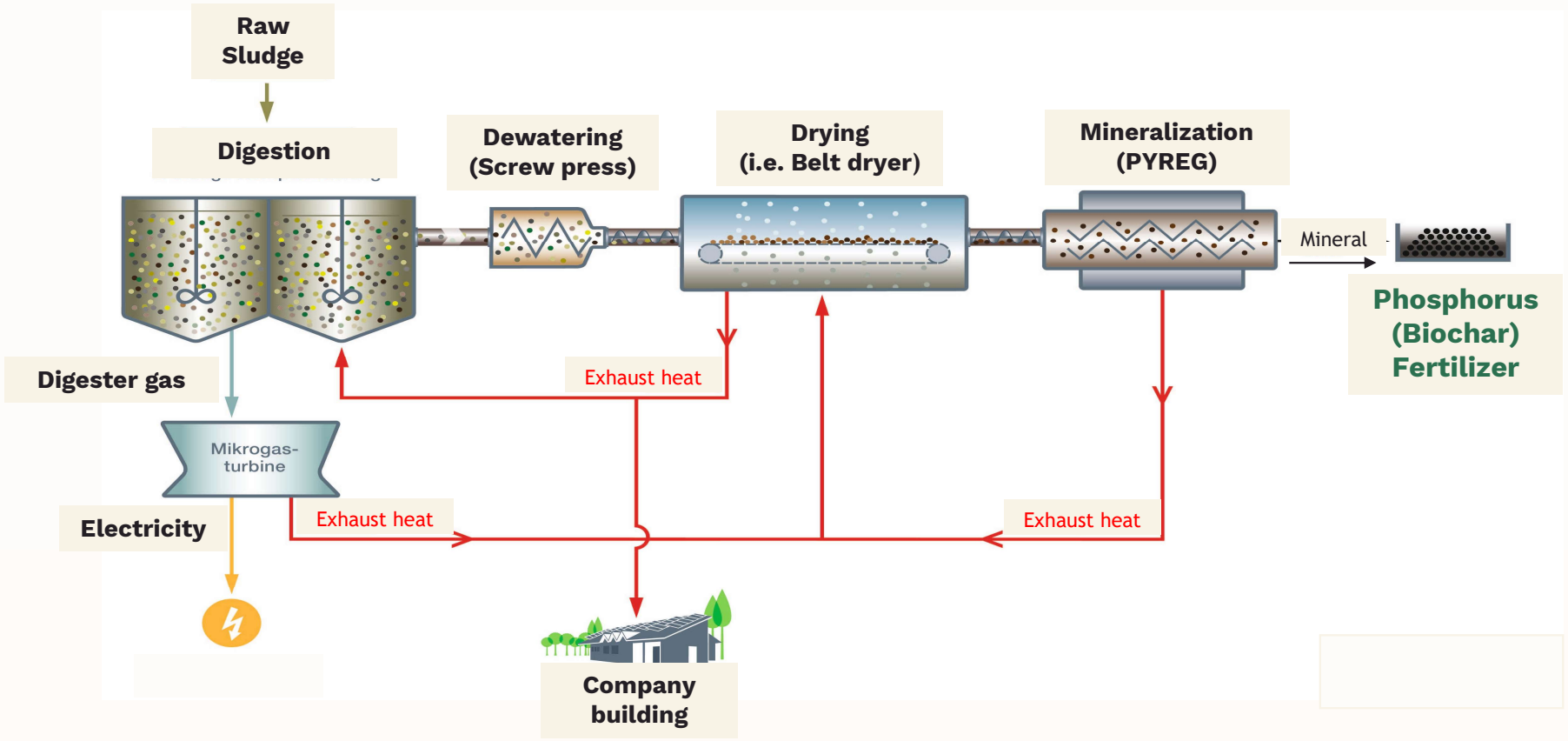
In addition to PFAS destruction Biochar made from sludges, used as a sorbent, binds already existent contaminants due to his high surface and properties.



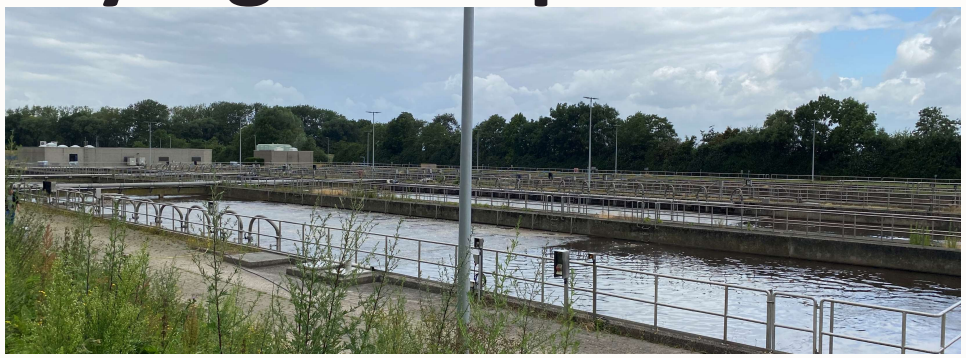


Installation Examples

Integration examples - PYREG in WWTP



Pyreg Example: WWTP Kleve, Germany



Pyreg Example: WWTP Kleve, Germany

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Next Installation:
WWTP Ephrata, Pennsylvania (BioForceTech)

Figure 1 Ephrata Borough Authority WWTP #1

Source:

Residuals and Biosolids Conference 2022

AUTOGENOUS BIOCHAR PRODUCTION FROM MUNICIPAL WASTEWATER BIOSOLIDS FEEDSTOCK

Charles Winslow[1], Stanley Chilson[1], John Harris[1], Aimee Teplitskiy[2], Jeremy Kraemer[3]
[1]GHD, 1140 Welsh Road, Suite 120, North Wales PA 19454 USA
Email: Charles.Winslow@ghd.com, John.Harris2@ghd.com
[2] GHD, White Plains, NY
[3] GHD, Whitby, ON

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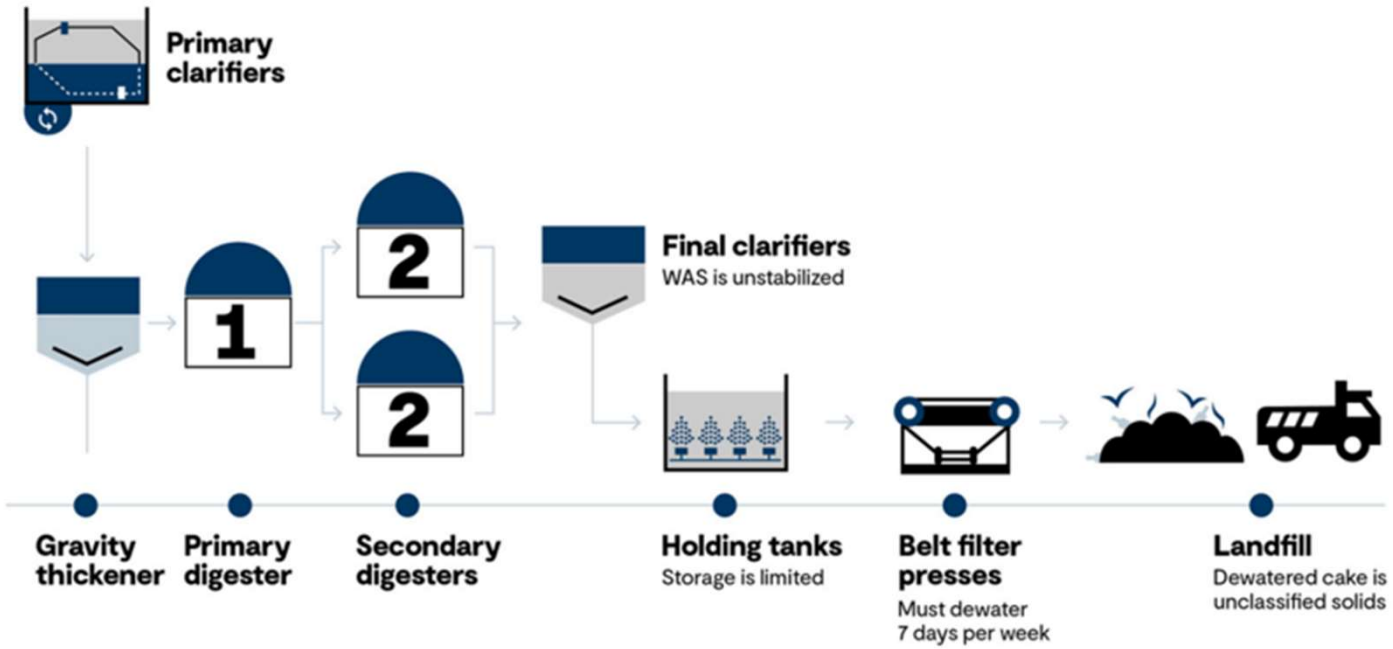

Figure 2 Existing solids handling process configuration at WWTP #1

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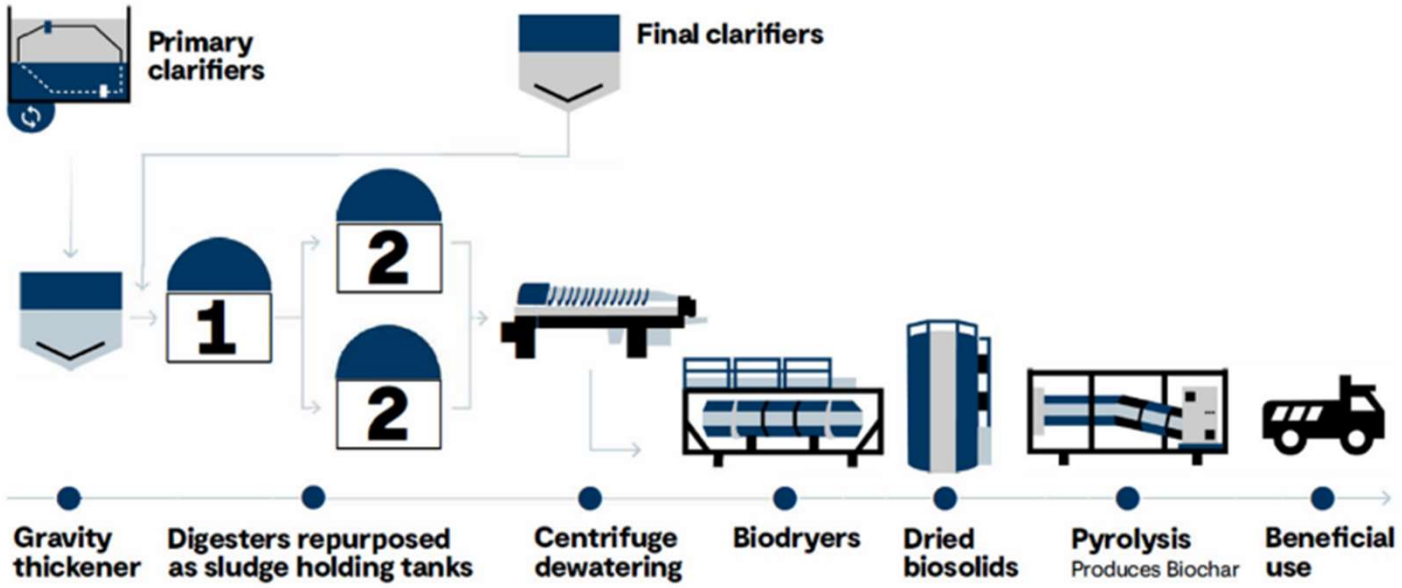

Figure 3 Proposed solids handling process configuration at WWTP #1

Source:

Residuals and Biosolids Conference 2022

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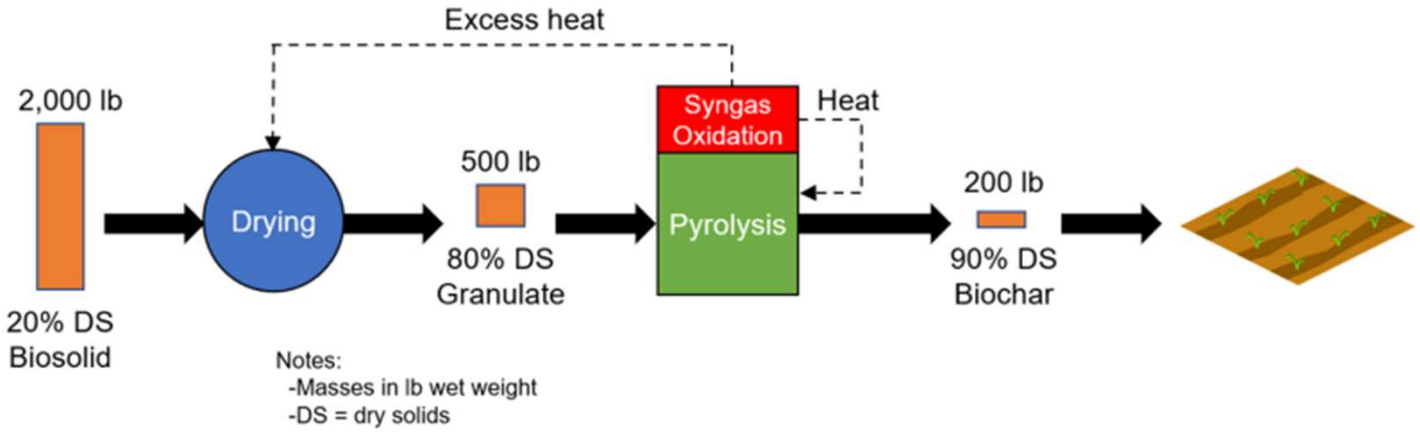

Figure 4 Process mass balance for a biodrying and pyrolysis system

Source:

Residuals and Biosolids Conference 2022

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CONCLUSION

At the completion of the plant's upgrade, the EBA's WWTP #1 will be the second municipal wastewater treatment facility in the U.S. to process biosolids using biodrying and pyrolysis. With biosolids standards rising and available landfill space dwindling, more facilities will soon find themselves choosing between adopting new technology or paying exceedingly high solids transport and management costs. New alternatives for solids processing, like biodrying or thermal drying coupled with pyrolysis, can not only reduce a treatment plants' energy usage and biosolids management costs through syngas recycling and significant biosolid mass and volume reduction, but also help municipalities meet their environmental goals. Treatment facilities can lower their GHG emissions, (including GHG emissions from landfill) significantly mitigate the risks of biosolids disposal and produce an end product that is beneficial and safe for both the environment

Source:

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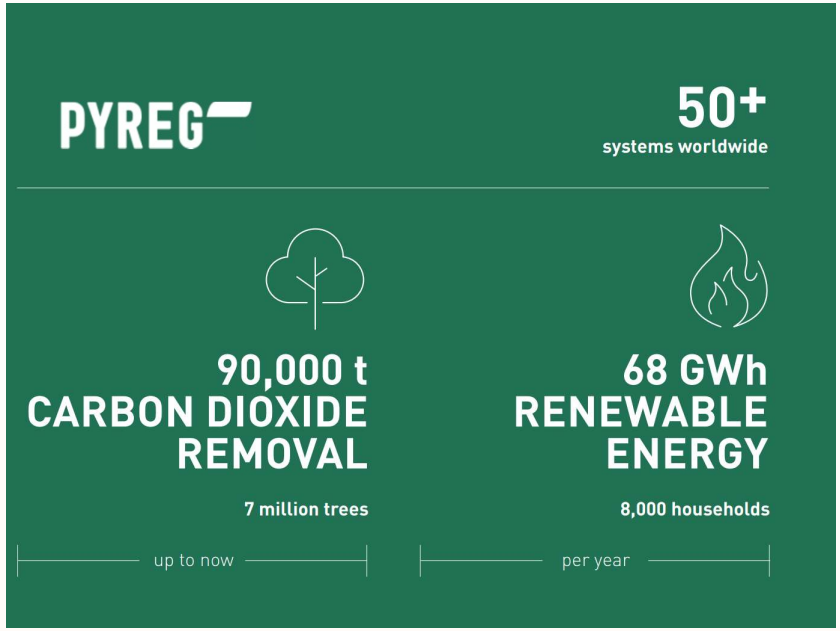
PYREG

NET ZERO TECHNOLOGY

THANK YOU!



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