2022 NORTH AMERICAN BIOCHAR & BIOENERGY CONFERENCE

BIOMASS CONTROLS PBC

Producing Biochar from Human Excreta and other High Moisture Feedstocks

Technical Session 3D #88
Carbon Markets & Circular Economies

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What is a circular economy?

In our current economy, we take materials from the Earth, make products from them, and eventually throw them away as waste - the process is linear. In a circular economy, by contrast, we stop waste being produced in the first place.

The circular economy is based on three principles, driven by design:

Eliminate waste and pollution

Circulate products and materials (at their highest value)

Regenerate nature

It is underprinned by a transition to renewable energy and materials. A circular economy decouples economic activity from the consumption of finite resources. It is a resilient system that is good for business, people and the environment.

https://ellenmacarthurfoundation.org/

1 Eliminate Waste & Pollution


THIS AREA IS
DOWNSTREAM OF A
COMBINED SEWER
OVERFLOW POINT
MORGANTOWN
UTILITY BOARD
NPDES PERMIT NO.
WV0023124
AVOID WATER
CONTACT DURING
DISCHARGE OR
WITHIN 72 HOURS
AFTER RAIN
TO REPORT UNUSUAL
DISCHARGE CALL 304-296-4322

2 Circulate Materials At Their Highest Value

Goal is to have **the highest Energy Balance** possible

Fresher the better = highest carbon content

Smellier the better = more volatiles (VOCs) for drying

Focus on feedstocks that need minimum pre-processing

Most feedstocks will have enough energy to dry themselves

3 Regenerate Nature

Waste feedstocks will usually be below 50% carbon content.

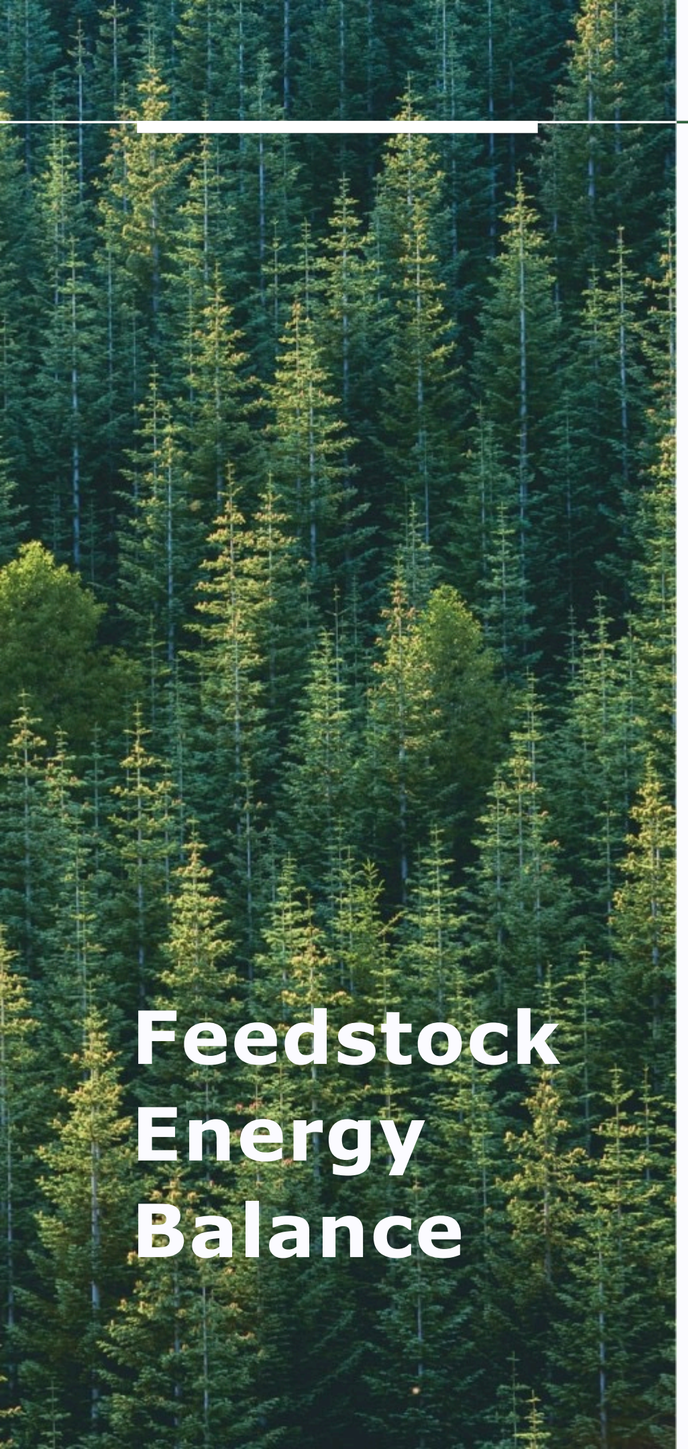
- Manures
- Human excreta
- Textiles
- Mixed Food Waste

Nature has a lot of inorganic materials

- Some feedstocks are high in silica
- Human waste and manures contain calcium, magnesium and manganese

Be sure of the biochar application

- Biochar pH will be high but tea and coffee like acidic soil
- Work with an expert in your industry such as a Soil Scientist



Feedstock Energy Balance

What is the dry weight energy available?

9 - 23 MJ/kg

or

3,869 - 9,888 BTUs/lb

(1 MJ/kg = 430 Btu/lb)

What is the % Carbon Content?

What is the moisture %?

900 -1400 btus/lb.

or

2-3.2 MJ/kg needed for drying

What is the % inorganics?

Will the inorganics sinter?

What is the feedstock geometry?

Will any preprocessing be necessary?

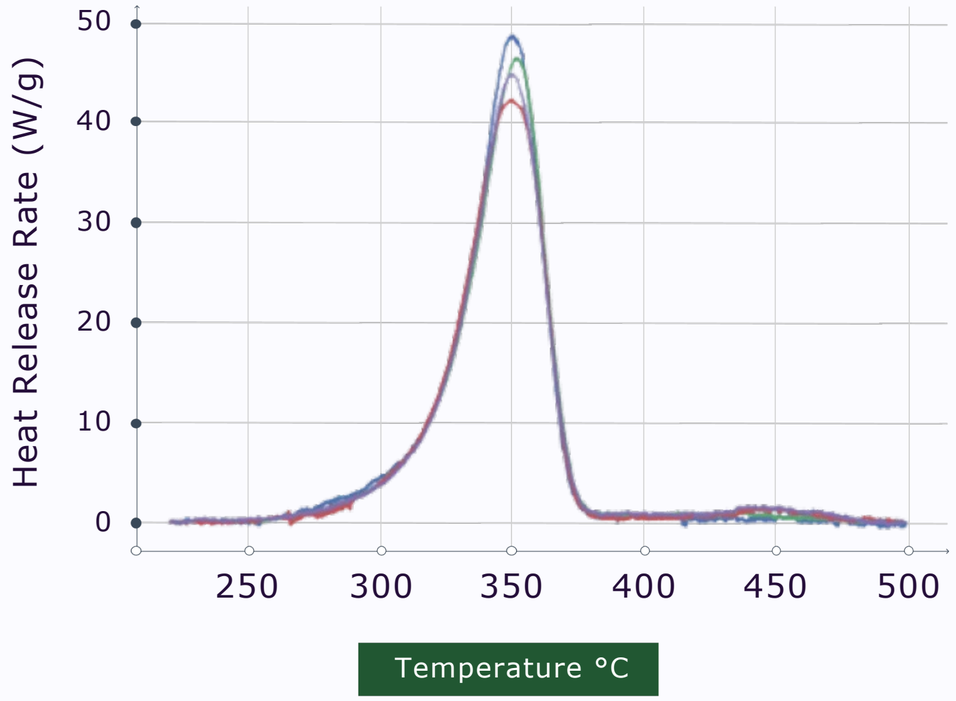
Batch or continuous pyrolysis?

23/07/2022.

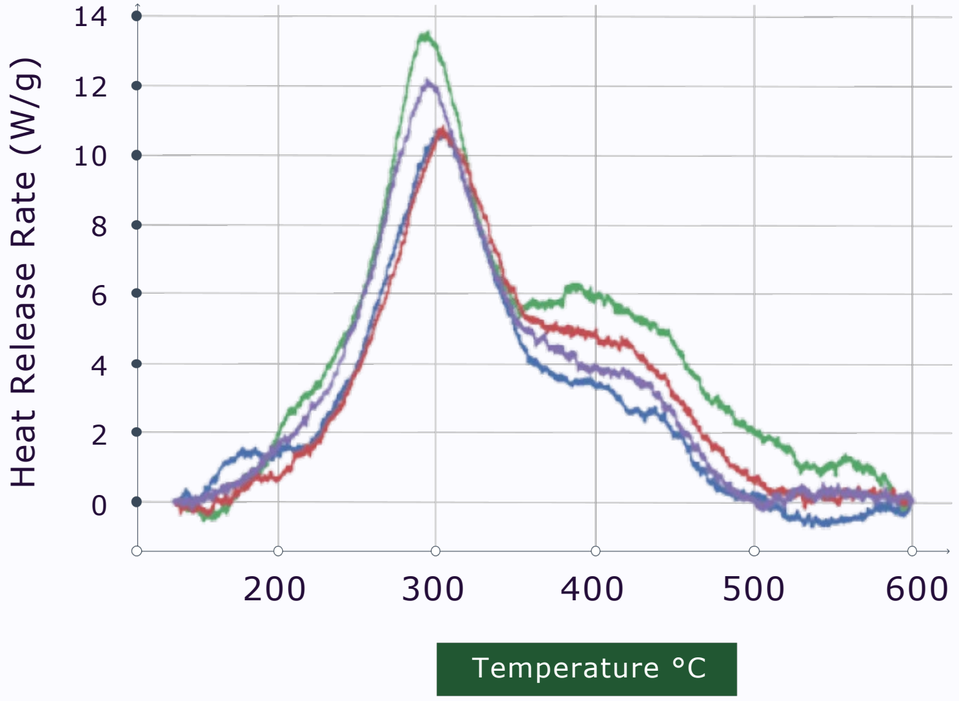
S.No.	Parameters	Unit	Result	Test Method
1.	Total Moisture	%	84.62	IS:9235
2.	Volatile Matter	%	2.68	IS:10158
3.	Ash Content	%	8.45	IS:1350(P-1)
4.	Fixed Carbon	%	5.1	IS-228(P-1)
5.	Gross Calorific Value	cal/gm	173	By Bomb Calorimeter
6.	Carbon	%	4.9	ASTMD 3178-89
7.	Oxygen	%	19.4	ASTMD 3178-89
8.	Nitrogen	%	1.2	ASTMD 3178-89
9.	Sulphur	%	1.9	IS:228(P-9)

Energy Balance - MCC Examples

Mean Temperature of Volatilization Onset	**290.0 °C**
Mean Temperature of Complete Volatilization	**374.0 °C**
Volatile Fraction	**0.86 +/- 0.01**
Char and Ash Fraction	**0.14 +/- 0.01**
Heat of Combustion of Volatilies	**11.86 +/- 0.08 MJ/kg**



Mean Temperature of Volatilization Onset	**176.0 °C**
Mean Temperature of Complete Volatilization	**505.0 °C**
Volatile Fraction	**0.64 +/- 0.04**
Char and Ash Fraction	**0.36 +/- 0.04**
Heat of Combustion of Volatilies	**15.85 +/- 1.46 MJ/kg**



Industry Standard Examples

Non-Sewered Sanitation

ISO 31800

This specifies performance and safety requirements of **community-scaled resource-oriented fecal sludge treatment units** serving approximately 1,000 to 100,000 people, ensuring technical robustness and safety in terms of human health and the environment.

ISO 30500

This standard provides general safety and performance requirements for the product design & performance testing of **prefabricated integrated treatment units that are not attached to a network sewer or drainage system.**

Emissions - RCRA

Resource Conservation and Recovery Act

RCRA was an amendment to the Solid Waste Disposal Act of 1965, which was the first statute that specifically focused on improving solid waste disposal methods.

RCRA was signed into law on October 21, 1976 to address the **increasing problems the nation** faced from our growing volume of municipal and industrial waste.

Subtitle D – Non-hazardous Waste

Non-hazardous solid waste is regulated under Subtitle D of RCRA.

Regulations established under Subtitle D ban open dumping of waste and set minimum federal criteria for the operation of municipal waste and industrial waste landfills, including design criteria, location restrictions, financial assurance, corrective action (cleanup), and closure requirement.

States play a lead role in implementing these regulations and may set more stringent requirements. In absence of an approved state program, the federal requirements must be met by waste facilities.

Pollution Prevention Act (P2 Act)

P2 Law

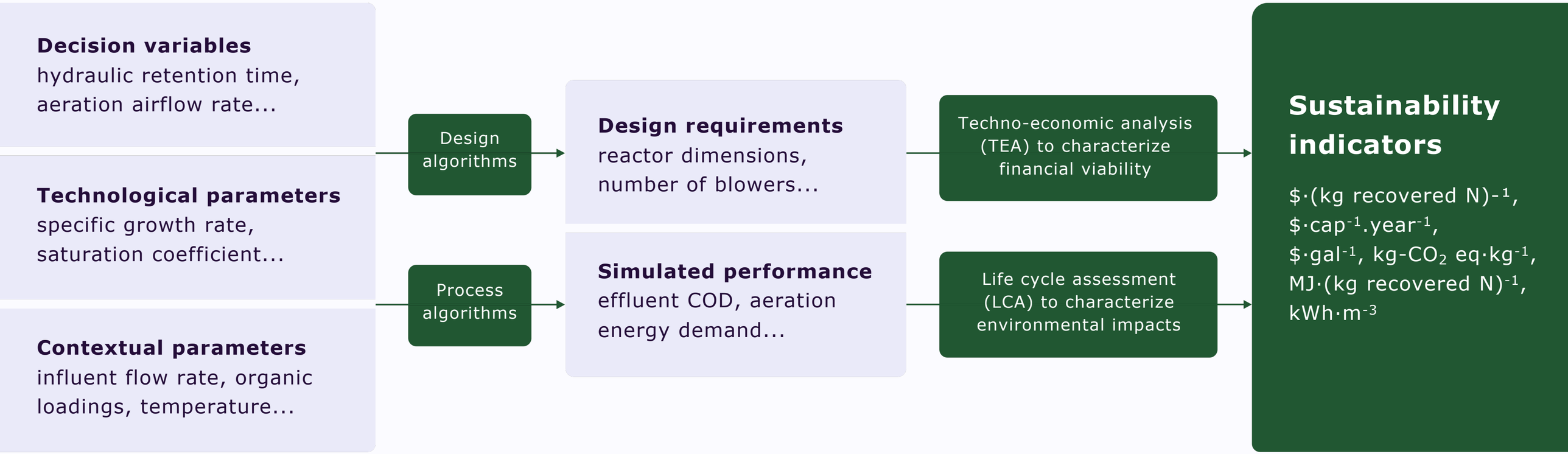
In 1990, Congress passed the Pollution Prevention Act (P2 Act) which states **"The Environmental Protection Agency must establish a source reduction program which collects and disseminates information, provides financial assistance to States, and implements the other activities...."**

Pollution prevention (P2), also known as source reduction, **is any practice that reduces, eliminates, or prevents pollution at its source** prior to recycling, treatment or disposal.

The "Findings" section of the Pollution Prevention Act of 1990 explains why Congress passed the Act. Some of the reasons include:

- The United States of America annually **produces millions of tons of pollution and spends tens of billions of dollars per year controlling this pollution.**
- There are significant opportunities for industry to reduce or prevent pollution at the source through cost-effective changes in production, operation, and raw materials use.
- The opportunities for source reduction are often not realized because existing regulations, and the industrial resources they require for compliance, focus upon treatment and disposal, rather than source reduction.
- **Source reduction is fundamentally different and more desirable than waste management and pollution control.**

Life Cycle Analysis & Techno-Economic Analysis



Uncertainty analysis (UA) to quantify the uncertainty of model outputs based on variability and epistemic uncertainty of inputs

Sensitivity analysis (SA) to attribute output uncertainty to individual model inputs or the interactions between model inputs

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THANK YOU

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