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CONCEPT NOTE

ENVIRONMENTAL IMPACT OF COFFEE AND COCOA INDUSTRIAL WASTE – AGRONOMIC PERSPECTIVES

The **H2Life Biomass E-Generator**, developed, produced, and distributed by **EWA Technologies Group**, offers a non-incinerating, sustainable, and high-efficiency solution for converting biomass and organic waste into steam or electricity. Designed for industrial applications, **including industrial coffee process**, this technology supports sustainable production, circular economy principles, and carbon neutrality, while reducing reliance on fossil fuels and lowering operational energy costs.

The **H2Life Biomass E-Generator** is a cutting-edge waste-to-energy technology, an advanced gasification system that transforms agricultural and organic waste into clean energy. The system employs a non-incinerating, low-carbon thermal process, capable of processing a wide range of carbon-based feedstocks. The resulting syngas is then used for high-efficiency green electricity generation via a sophisticated syngas e-generator.

Coffee Husk Composition and Energy Potential

Coffee husk is composed primarily of 73-85% carbohydrates, including 55% cellulose + hemicellulose and 24% lignin. These components make it highly suitable for gasification, producing hydrogen-rich syngas that can be used to generate steam or green electricity. The conversion of coffee pulp and husk into green electricity or steam is efficiently accomplished using the H2Life gasification system.

Advantages of Coffee Waste Valorization with H2Life Technology:

- Contributes to environmental protection and waste reduction
- Enables renewable energy production for self-use or sale to the grid
- Supports sustainable development in alignment with circular economy principles

Economic and Operational Benefits

Implementing the H2Life system for coffee waste valorization offers significant cost-benefit advantages. Each ton of coffee pulp (CP) or husks (CHs) can produce approximately:

- 600 kWh of green electricity, or
- 9.8 MJ of energy

This decentralized, circular model enhances energy resilience, reduces environmental impact, and lowers energy procurement costs for coffee processing operations.

What are the alternatives?

Fresh industrial coffee waste (e.g., grounds, pulp, husks) contains **caffeine** and **phenolic compounds** that exhibit allelopathic effects – **inhibiting seed germination, root development, and nutrient uptake** in



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crop plants. These compounds can also **disrupt beneficial soil microorganisms**, further impairing plant growth. As a result, dumping or composting coffee waste has negative impacts on agriculture and the natural environment.

Key Mechanisms of negative impact of Coffee biomass on plant:

1. Allelochemical Inhibition

- Caffeine and polyphenols released from decomposing coffee waste can:
 - Suppress germination (e.g., lettuce, clover) (*Souza et al., 2017*).
 - Stunt root elongation by disrupting cell division (*Batish et al., 2008*).
 - Interfere with photosynthesis and nutrient absorption.

2. Soil Microbial Disruption

- High caffeine concentrations may reduce populations of nitrogen-fixing bacteria (e.g., *Rhizobium*) while promoting harmful fungi.

3. Nutrient Imbalance

- Raw coffee waste can temporarily tie up nitrogen during decomposition, creating short-term deficits for plants (Chou, 1999).

Conclusion:

While composted coffee waste is generally safe, untreated or excessive application can harm crops and soil biology. Proper decomposition (3–6 months) and dilution ($\leq 20\%$ in soil) mitigate these risks.

Key Mechanisms of negative impact of coffee and Cocoa biomass on plant:

Like coffee waste, cocoa biomass (husks, shells, pulp, and pruning residues) can **harm** plant growth and crop.

Potential Negative Effects

1. Allelopathic Compounds

- Cocoa biomass contains **theobromine, caffeine, and tannins**, which can inhibit seed germination and root growth (*Alemanno et al., 2003*). Example: Fresh cocoa pod husks was found to reduced maize and bean growth (*Norgrove & Hauser, 2013*).

2. High Polyphenol Content

- Polyphenols can **bind soil nutrients**, making them temporarily unavailable to plants (*Ogunlade et al., 2021*).

3. Fungal & Pathogen Risks



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- Cocoa waste may harbor **Phytophthora spp.** (causes black pod disease) or promote harmful molds (*Akrofi et al., 2015*).

4. Temporary Nitrogen Immobilization

- Raw cocoa husks are high in lignin, leading to short-term nitrogen lockup as microbes break them down (*Tondoh et al., 2015*).

Concise comparison table summarizing the key differences between H2Life gasification, composting, incineration, and pyrolysis for treating coffee waste:

Factor	H2Life Gasification	Composting	Incineration	Pyrolysis
Process Type	Partial oxidation (syngas)	Biological decomposition	Combustion	Thermal decomposition
Primary Outputs	Syngas	Compost	Heat + ash	Synfuel + biochar + syngas
Energy Recovery	High (electricity, gas and heat)	None	Medium (heat only)	Medium (synfuel + syngas)
Waste Reduction	~90%	~50%	~95%	~70-80%
GHG Emissions	Low (controlled process)	High (CH ₄ /N ₂ O if anaerobic)	Very high (CO ₂ , NO _x , SO _x , smoke)	Medium (CO ₂ , NO _x , SO _x , VOCs)
Byproduct Value	Biochar	Low-value compost	Toxic ash (landfill)	Biochar, distillation residues)
Time Required	<30min	months	Minutes–hours	Hours
Pathogen/Toxin Removal	Yes	Partial (if properly managed)	creates toxic pollutants	Yes
Scalability	Yes (industrial use)	Yes	Yes (but regulated)	Limited – slow process



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Factor	H2Life Gasification	Composting	Incineration	Pyrolysis
Economic Viability	High (ROI of 8-9 months) + carbon benefits	Low	Medium (energy sales, high compliance costs)	Low-Medium

CONCLUSION

*For coffee and cocoa waste, H2Life gasification is optimal alternative - Balancing energy recovery, low emissions, minimal environmental impact, circular economy benefits (decarbonization) **better than all alternatives.***

If you want more information, please apply to us:

CONTACTS



Dr Eytan Bar
Founder and CEO of EWA Technologies
Bar.eytan1@gmail.com

+86 189 2274 1972

 www.linkedin.com/in/eytan-bar-7430b6243



Dr Jean Christophe Henry
Founder and CEO of 2LIFE
ic.henrypro@gmail.com

+33 6 1887 3007

 www.linkedin.com/in/jch2030/

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