Polyetha

POLYETHA

Transforming Polyethylene Waste into Valuable Hydrocarbons through Innovative Electrocatalytic Recycling Solutions

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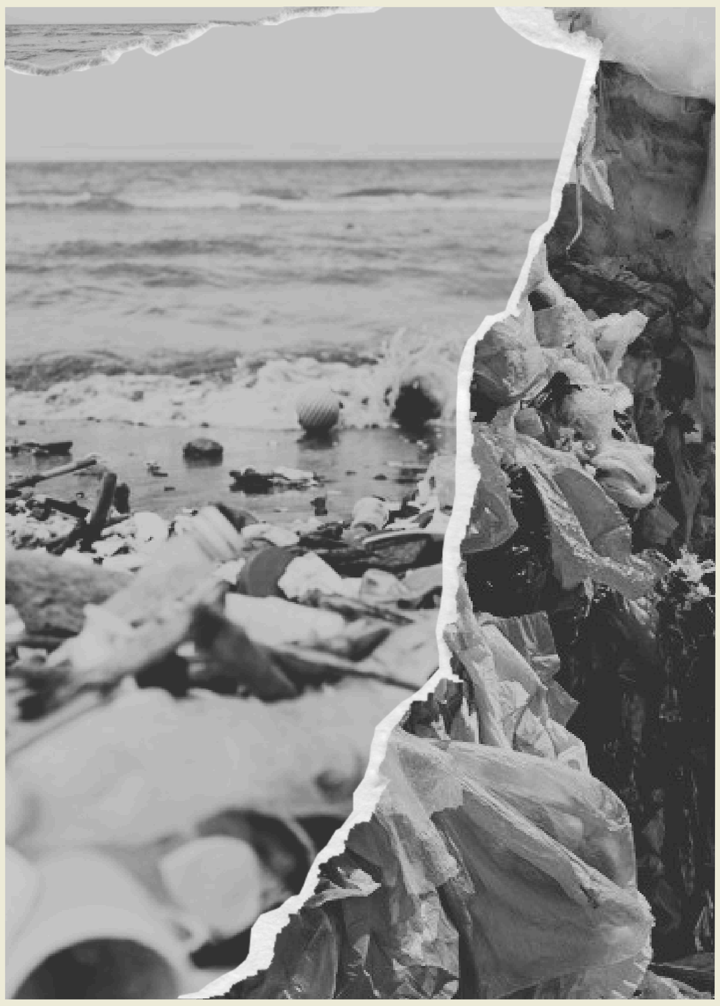
OUR FOUNDATION

What is the problem?



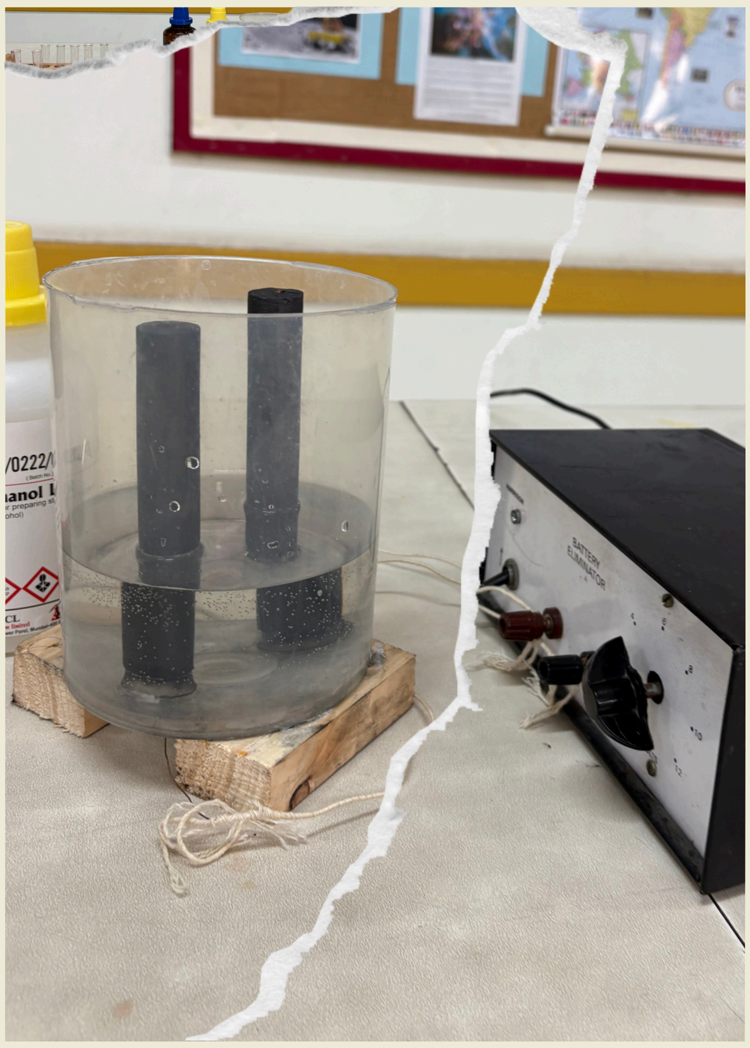
plastic apocalypse

Polythene, the most commonly used plastic classified under plastic grades 2 and 4, PE's chemical structure makes it highly durable, non-reactive, and resistant to streamlined recycling methods.Traditional recycling methods often produce a mishmash of compounds that are challenging to separate. This limitation stems from treating symptoms rather than addressing root causes. To uncover why recycling systems are failing, let's employ the "5 Whys" approach:

- *Why is PE hard to recycle? Its chemical inertness.*
- *Why does this matter? It makes depolymerization inefficient.*
- *Why hasn't this been resolved? Current technologies focus on mechanical recycling.*
- *Why isn't mechanical recycling enough? It degrades the material.*
- *Why do we rely on such methods? Lack of innovation in chemical recycling processes.*

The root cause is glassy transparent: we need a sustainable and transformative proposition.

Our Solution



polyetha's solution

Our solution is the depolymerization of PE into organic acids, followed by electrocatalytic decarboxylation to produce hydrocarbons like ethene. These compounds, far from being waste, can serve as valuable fuels used in power generation, industrial heating, and even as building blocks for the chemical industry. Ethane could replace fossil-derived alternatives in producing polymers, chemicals, or energy, offering a trajectory to limit pollution. Let's face it: it'll be a long, long time before we ever run out of plastic. The truth is that while plastic waste isn't disappearing anytime soon, fossil fuels are running out. And you know what's coming next: factories dependent on those fuels will hike prices to levels so high, that you'll think you're buying platinum. Our solution flips the narrative—it's about creating a 21st-century economy where plastic waste becomes the backbone of sustainability. The future doesn't belong to fossil fuels—it belongs to bold ideas, fueled by high schoolers who refuse to accept plastic as the problem when it can be the solution.

Practical Procedure

- We take Polythene wastes collected from garbage dumps, and neighbourhoods and shred them.

- We heat the resulting pieces to around 180 degrees Celsius before reacting them with a 6% W/W solution of HNO_3 which is oxidative depolymerisation.

- This gives us a solution of succinic acid (44%), glutaric acid (22%), adipic acid (21%), acetic acid (9%) and propanoic acid (4%).

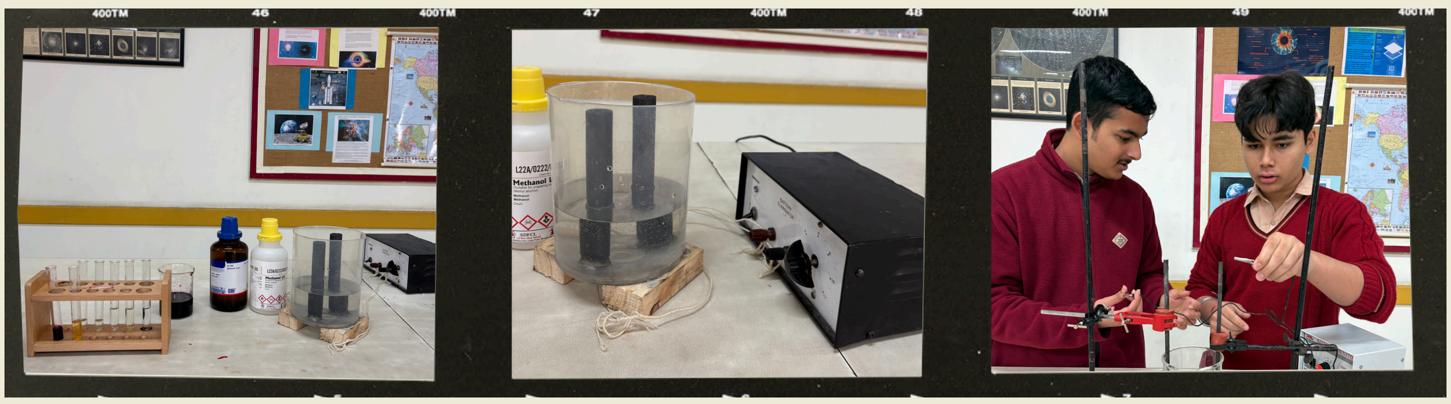
- We then move this solution to another chamber where it undergoes electrolysis with graphite electrodes.

- After electrolysis, ethene gas is produced at the cathode along with H_2 and CO_2. trace amounts of C_2H_2 are also present, but it shows hydrogenation to give ethane so it doesn't affect the overall process.

- The mixture of these three gases is passed through a tube with a coolant surrounding it. This liquifies the CO_2 which is then separated into other containers.

- The mixture of H_2 and Ethene is then brought to another chamber with a nickel plate at high temperatures (150-200 Celsius). Hydrogenation occurs in this chamber leading to ethane gas.

- The ethane gas is then extracted after turning off the electrodes and ensuring a complete reaction of ethene.



Science Behind Our Idea

Team Polyetha has been working towards generation of cleaner fuel using electrocatalytic depolymerisation of polyethene. We use melted polyethylene and make it react with a 6% w/w HNO_3 solution. The resulting solution is then put into an electrolysis setup. The products of electrolysis are ethene (C_2H_4) and dihydrogen (H_2). These are then taken into a chamber with a Nickel catalyst which causes Hydrogenation, converting ethene to ethane.

1) Depolymerisation
Polyethylene is a polymer of ethene gas. What this means is that polyethylene is made of thousands of ethene molecules which are connected by many types of bonds. We melt the polyethylene at approximately 180° C (453 K) and then make it react with nitric acid. This causes depolymerisation and a subsequent conversion to organic acids like succinic and glutaric acids. The composition of the solution is:

Succinic acid 44%
Glutaric acid 22%
Adipic acid 9%
Acetic acid 21%
Propanoic acid 4%

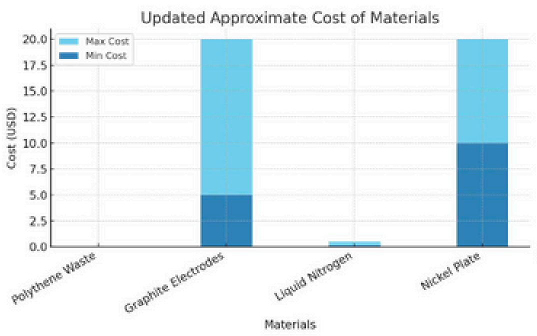
2) Electrolysis
The solution is then funneled into a chamber containing two graphite electrodes which form a basic two electrode electrolysis setup. Once the circuit is activated, electrolysis (splitting of an aqueous solution into multiple products) occurs, with the resulting products being ethene gas (C_2H_4), Dihydrogen (H_2), Carbon dioxide (CO_2) and minor quantities of ethyne (C_2H_2). We then pass this mixture through tubes maintained at -78° C (195 K), which liquifies the CO_2 produced, thus separating it from the gaseous mixture.

3) Hydrogenation
The mixture produced is then brought to another chamber with a Ni catalyst at a very high temperature of approximately 200 C (473 K) (achieved through a Nichrome wire). Here, Hydrogen is added to ethene, breaking the double bond and thus forming ethane (C_2H_6).

FINANCIAL ANALYSIS

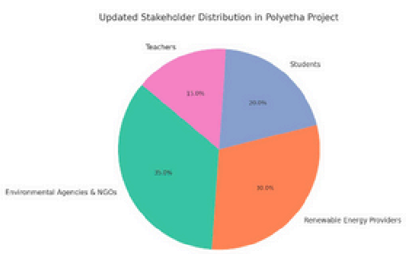
We focus on evaluating the financial aspects of Polyetha's initiative for a futuristic ethane-based fuel at a student level, with a primary emphasis on profit, loss, and expenses. We aim to provide a detailed breakdown of both direct and indirect costs involved, assessing their impact on our project's financial performance as well as quantify and evaluate expenditures, identify potential revenue streams, and calculate profit margins to determine overall feasibility. By highlighting critical cost drivers, financial risks, and opportunities, we seek to pinpoint areas for cost optimization and efficiency improvements. Additionally, we do account for potential financial challenges via this analysis, ensuring a clear understanding of the project's economic viability. This analysis will serve as a foundational tool for stakeholders to make informed decisions, allocate resources effectively, and align financial planning with budgetary constraints while pursuing long-term sustainability and profitability.

Material Expenses (USD)



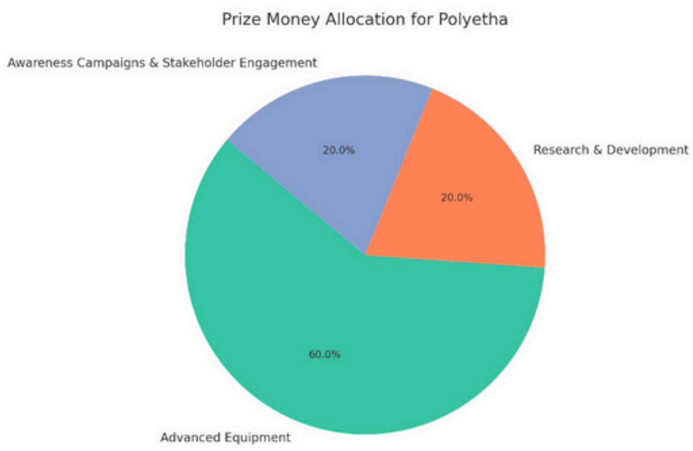
Material	Approximate Cost (USD)
Polythene Waste	Free or minimal cost
Graphite Electrodes	\$5–\$20 per electrode
Liquid Nitrogen	\$0.10–\$0.50 per liter
Nickel Plate	\$10–\$20 per kg

Graphical Representation of Stakeholder Distribution



- **Environmental Agencies & NGOs:** 35%
- **Renewable Energy Providers:** 30%
- **Students:** 20%
- **Teachers:** 15%

Distribution of $12,500 budget



We would allocate the $12,500 Prize money in a 60:20:20 ratio for Advanced Equipment ($7,500) including lab materials such as electrolysis cells & optimized catalysts that we'd require to enhance this process we are using of electrocatalytic depolymerisation; Research & Development ($2,500) to facilitate better working conditions & get access to more advanced research tools to aid our cause, & finally Awareness Campaigns & Stakeholder Engagement ($2,500) to advertise & promote our mission of creating a clean ethane-based fuel. We believe this division of the prize money would aid us in this, our initial year of setting up Polyetha, to increase the efficiency of our establishment & move forth closer towards the green energy goal we're working for.

COMPETITOR COMPARISON

THEME	Polyetha (Ethane)	CNG Based Companies	Petroleum based Companies
Environmental Impact	Low CO_2 emissions (up to 24% reduction with CCS), sustainable	Lower CO_2 emissions than petrol, but still a produces nitrous oxides when extracted	High CO_2 emissions, major contributor to pollution
Production Temperature	Low (≤180°C, energy-efficient)	Requires energy-intensive extraction and processing	Requires high-temperature refining and distillation
Feedstock Source	Recycled polyethylene waste (plastic waste)	Fossil fuel-based (methane from natural gas)	Crude oil (non-renewable resource)
Cost and Availability	Potentially lower production cost with scalability, emerging technology	Widely available but requires expensive infrastructure	High and fluctuating prices due to crude oil dependence
Sustainability and Future Scope	Aligns with the Paris Agreement, scalable with green energy integration	Transitional fuel, but still dependent on non-renewable resources	Unsustainable, contributes to fossil fuel depletion