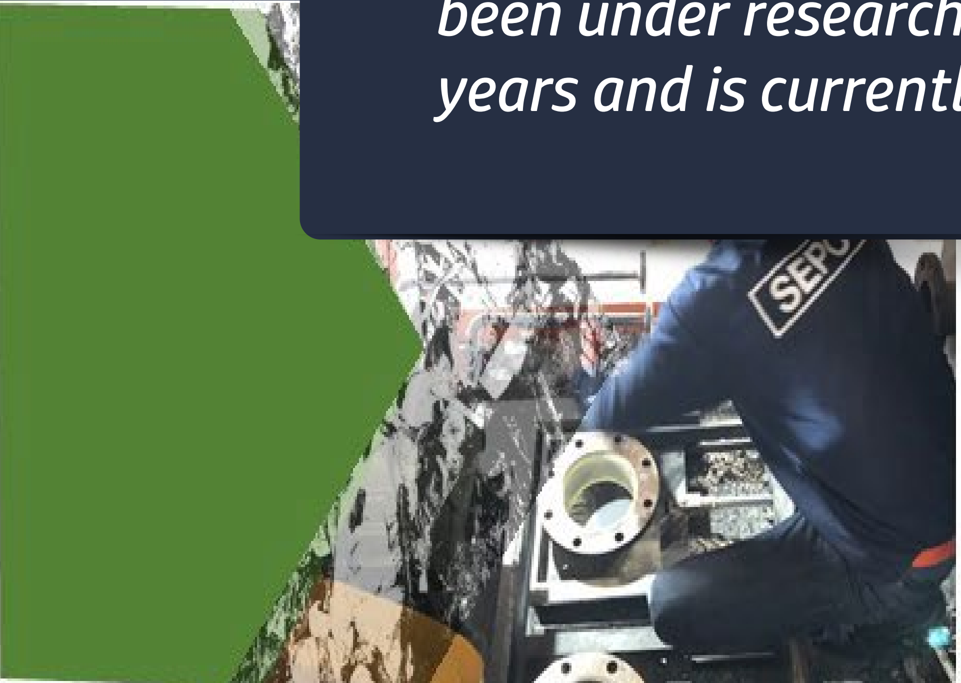
PLASTIC WASTE TO FUEL

Sepco Industries, has developed and perfected an efficient and ultra-clean process for converting waste plastics into high-quality, low-carbon fuel. This machine, known as the Polypetron™, has been under research and development for over 15 years and is currently in its 6th generation.

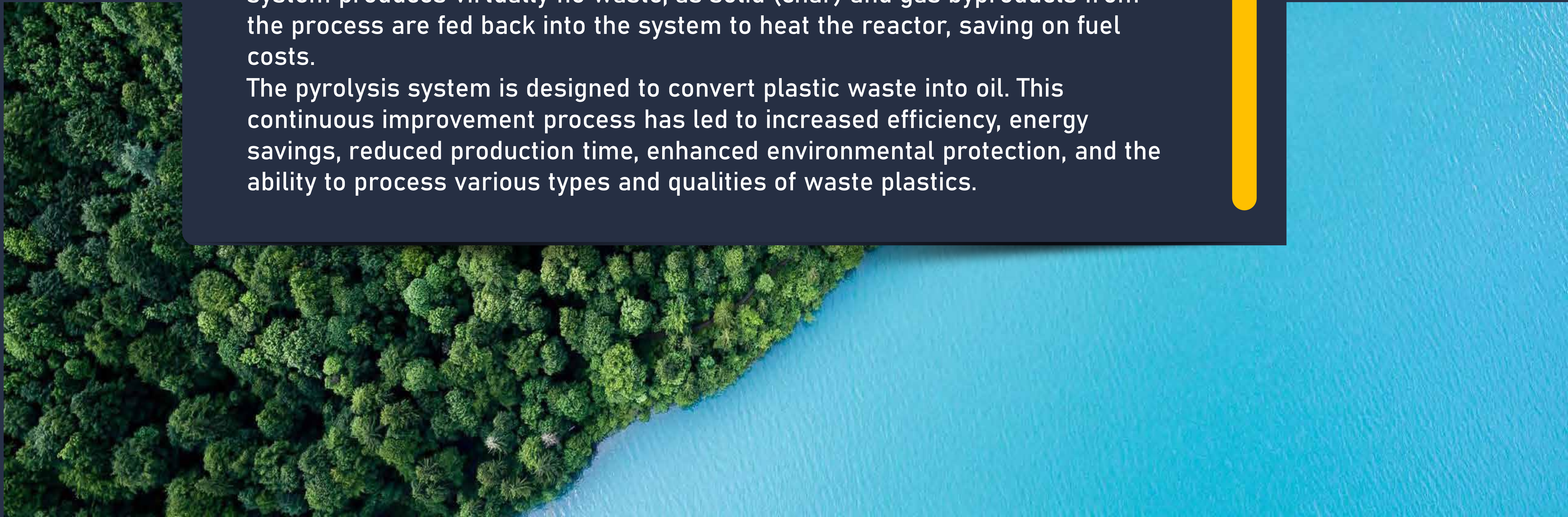




PLASTIC WASTE TO FUEL

The standard models, Polypetron™ Gen.5 and Gen.6, have a plastic waste management capacity of 20 metric tons per day and a production capacity of 12,000 liters of pyrolysis crude oil equivalent with 24-hour operation. The system produces virtually no waste, as solid (char) and gas byproducts from the process are fed back into the system to heat the reactor, saving on fuel costs.

The pyrolysis system is designed to convert plastic waste into oil. This continuous improvement process has led to increased efficiency, energy savings, reduced production time, enhanced environmental protection, and the ability to process various types and qualities of waste plastics.



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SOLUTION TO SOLVE PLASTIC WASTE PROBLEM

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PLASTIC WAS OUR HERO TO SOLVE ALL PROBLEMS IN THE PAST

"Throwaway Living," they called it, promising a world of disposable items that would cut down on household chores. Pictured, you see what appears to be a Life stock couple as well as their pretend child greeting this new dawn with open arms as disposable items fly through the air. You'll find paper plates and towels, popcorn that pops in its own packaging, as well as paper cups and frozen food containers, plastic cutlery, and trash bags. Every item in the picture, they claim, would take 40-hours to clean, "except that no housewife need bother." Just use once, and then throw it away.

BUT..!, Our culture depends on single-use plastics, and most of it ends up in the sea or in landfill.

SOLUTION TO SOLVE PLASTIC WASTE PROBLEM

The Mediterranean at risk of becoming 'a sea of plastic'

In a 2015 study, researchers trawled five coastal areas in the eastern Mediterranean and found that 60 percent of the marine litter detected was in the Saronic Gulf bordering greater Athens. And 95 percent of that trash was plastic, much of it single- use items like supermarket carrier bags or water and soft drink bottles.

The EU plans to make all plastic packaging on the market recyclable by 2030 and wants member states to crack down on single-use plastic, with consumers using no more than 40 lightweight plastic bags annually by 2025.

SOLUTION TO SOLVE PLASTIC WASTE PROBLEM

According to Eurostat, 31 kg of plastic waste is produced per person across the EU each year, adding up to 15.8 million tonnes in total. Even though Ireland made a statement by being the first EU country to impose a plastic bag fee in 2002, it remains Europe's worst offender when it comes to annual plastic packaging waste produced per head of the population.

In 2016, an average Irish citizen produced 58 kg of plastic packaging waste, ahead of second-placed Luxembourg's 53 kg. Even in Italy where cities like Naples have gained a poor reputation for waste management and pollution, the amount produced is less at 36.5 kg.

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In Greece, an ERDF-funded project is making EUR 20 million available for businesses which are aiming to create new value cycles by transforming, reusing and reducing waste.

The project will aim to promote the circular economy across Greece by providing financing to companies operating in the waste sector. Businesses in all 13 Greek regions are eligible, as long as their main focus revolves around boosting waste revalorisation and treatment. Investment available to eligible businesses will range from EUR 250 000 to EUR 2.5 million. If the available budget overall does not cover funding for all the projects, an additional EUR 15 million will be made available.

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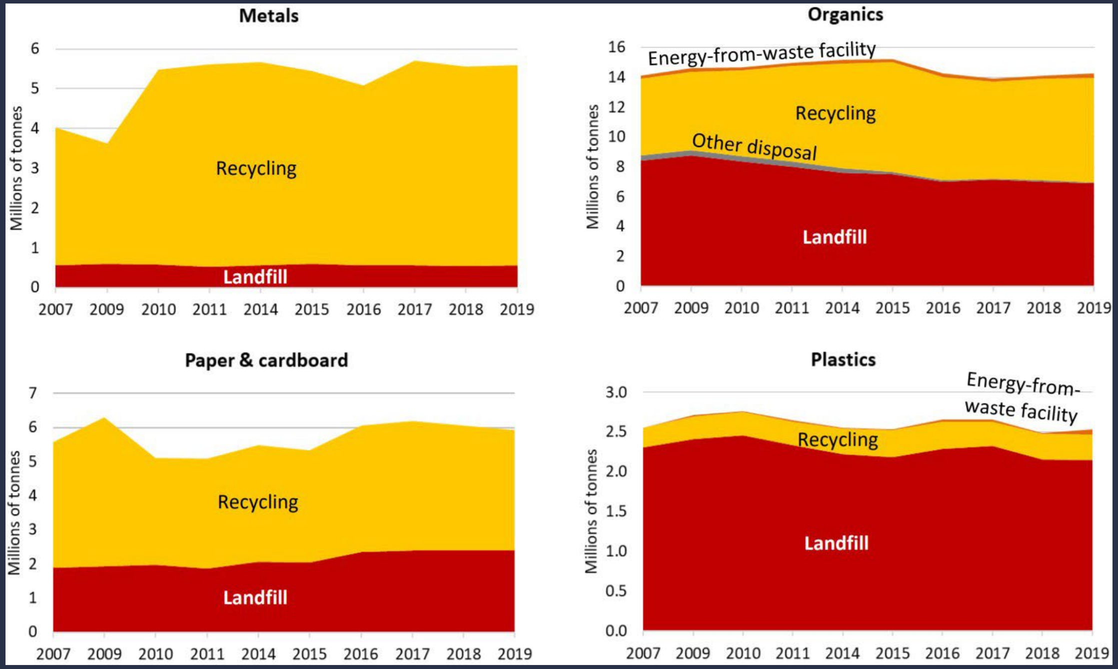
Metals

In 2018-19 about 5.60 Mt, or 223 kg per capita, of metal waste was generated (down from 5.71 Mt in 2016-17). The recycling rate of 90% was higher than any other material category. Metal recycling is well-established in every state and territory but the industry has suffered from falling global prices in recent years. .



Plastics

About 2.54 Mt or 101 kg per capita of plastic waste was generated in 2018-19, down from 2.66 Mt in 2016-17. A little less than 13% (in 2016-17 it was 12%) was recycled and a little less than 3% used for its energy value, mostly in solid recovered fuels for energy recovery. The remainder was deposited in landfill.

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Covid comes with more Waste Plastic

Approximately 129 billion disposable masks, mostly made from plastic micro-fibres, and 65 billion disposable gloves have been used every month during the pandemic, according to a study in the journal Environmental Science and Technology.

The United Nations estimates about 75% of plastic generated by the pandemic including medical waste and packaging from home deliveries during lockdowns will likely end up in landfills or the sea.

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NORMAL WAY TO SOLVE WASTES PLASTIC PROBLEM WHICH NEVER WORK

While the increased use of plastic is necessary to fight the pandemic, particularly for PPE, countries need to ensure these emergency changes do not derail long-term progress on the passage of laws aimed at reducing plastic pollution. If countries want to build back better after COVID-19, legislative reform on curbing plastic waste is an essential part of the agenda.

Policy shifts can reduce plastic pollution by incentivizing changes in both business and consumer behavior, as well as in plastic design, alternatives and recycling. Here are four policy and legal approaches from UNEP and WRI's guide that countries can use to reduce their plastic waste permanently:

1. Single-use Plastic Bans
2. Taxes and Economic Incentives
3. Product Standards
4. Extended Producer Responsibility

TO END OF LIFE PLASTIC POLLUTION OUR WAY IS TRANSFROM PLASTIC WASTE INTO INDUSTRIAL RAW MATERIALS

- Recycle - Today not more than 10% of waste!
- To Electricity - Grid connection is the main problem! Generate more CO2
- To Fuel – THE BEST SOLUTION REDUCE CO2

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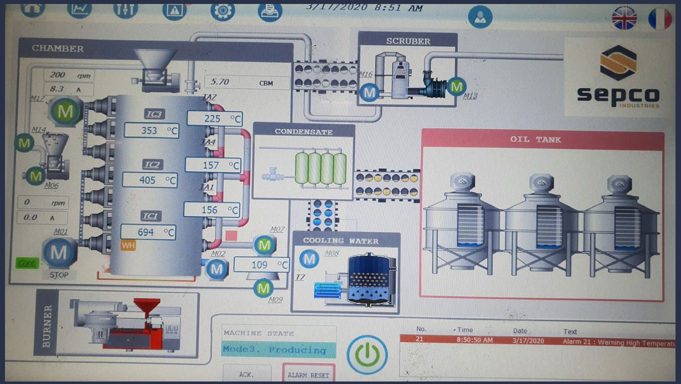
Pyrolysis technology of plastic is the inverse process of manufacturing plastic products by crude oil material



Our pyrolysis system adds difference catalysts using different temperatures for different type of plastic materials. Compared with the other pyrolysis technologies we improve oil yield and quality. Since mixed plastic is made of different raw material the staged pyrolysis process is also different.

PE, PP and PS decomposed at 300-400 Deg. C. PVC is decomposed at two stages which 200-300 Deg. C and 300-400 Deg. C. The PVC may release HCL and hydrocarbon and then break down step by step. Due to the corrosively of HCL it will affect the pyrolysis catalyst life span and the oil quality, so PVC content should be limited within the plastic feedstock.

SOLUTION TO SOLVE PLASTIC WASTE PROBLEM

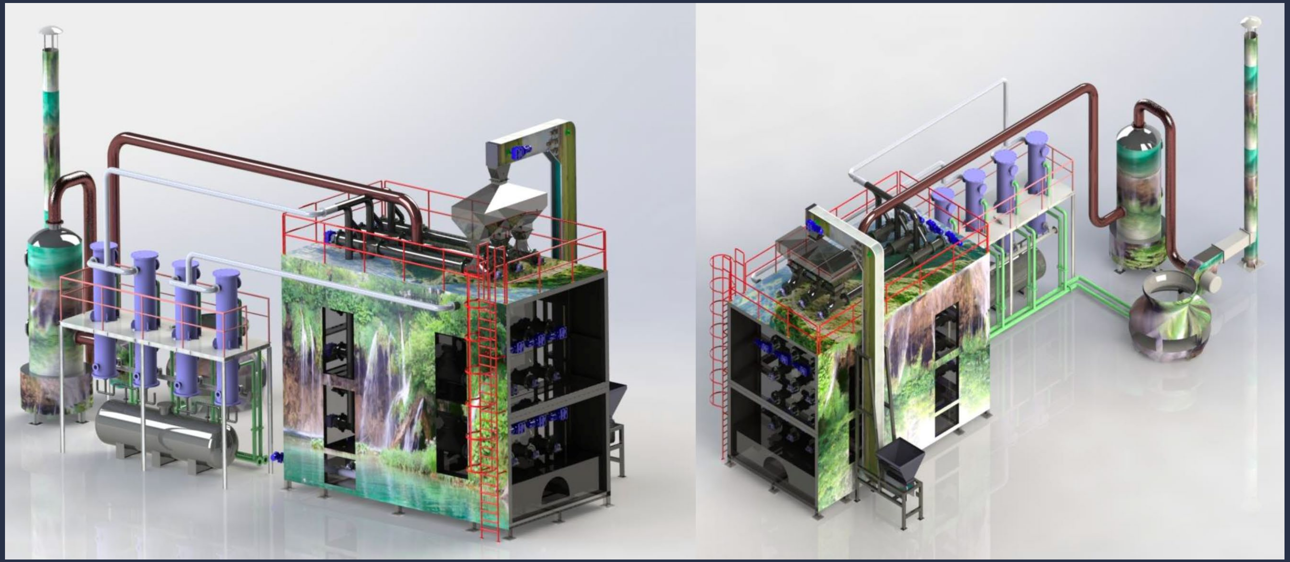
Sepco Continuous Pyrolysis Process

Plastic waste is heated to 450–650°C in a Screw Type Reactors, breaking down its long polymer chains into shorter hydrocarbons.

- Products

  Plastic crude pyrolysis oil (PPO) is a liquid fuel produced by the pyrolysis of plastic waste, a process that involves heating plastic to high temperatures in an oxygen-free environment: The result is PPO, along with by-products like char and gases. The composition of the PPO depends on the type of plastic and the pyrolysis conditions.
- Properties

  PPO is a dense, dark brown liquid with a high calorific value, similar to fossil fuels. It has lower greenhouse gas emissions than fossil fuels and is easier to store and transfer than char and gas.



SOLUTION TO SOLVE PLASTIC WASTE PROBLEM

a) Origins

- Crude Plastic Pyrolysis Oil (PPO). PPO is produced through a process called pyrolysis, which involves heating plastic waste to high temperatures in an oxygen-free environment. The result is PPO, along with by-products like char and gases. The composition of the PPO depends on the type of plastic and the conditions under which pyrolysis occurs.
- Crude Petroleum Oil. Crude petroleum oil, commonly known as crude oil, is a natural fossil fuel formed from the remains of ancient marine organisms. Over millions of years, heat and pressure converted these remains into a mixture of hydrocarbons that we extract today from underground reservoirs.

b) Properties

- Crude Plastic Pyrolysis Oil (PPO). PPO is a dense, dark brown liquid with a high calorific value, similar to fossil fuels. It has lower greenhouse gas emissions compared to traditional fossil fuels. Additionally, it is easier to store and transfer than the by-products of pyrolysis, such as char and gas. However, PPO contains impurities like heteroatomic and metallic compounds, and the release of chlorine from certain plastics (e.g., PVC) can pose challenges.
- Crude Petroleum Oil. Crude petroleum oil is also a dense, dark liquid but can vary in color depending on its specific composition. It has a high energy content and serves as a primary source of fuel worldwide. Crude oil contains various impurities and requires extensive refining to produce usable fuels and other products. Its extraction and use are significant contributors to greenhouse gas emissions and environmental pollution.

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a) Potential Uses

- Crude Plastic Pyrolysis Oil (PPO)

  PPO can be utilized as an alternative fuel in vehicles or as an energy source for industrial machines. Its application can contribute to reducing plastic waste and enhancing energy sustainability.

- Crude Petroleum Oil

  Crude petroleum oil is refined into various products, including gasoline, diesel, jet fuel, heating oil, and lubricants. It also serves as a feedstock for petrochemical industries, producing plastics, chemicals, and other materials.

a) Environmental Benefits and Challenges

- Crude Plastic Pyrolysis Oil (PPO)

  PPO offers several environmental benefits, such as reducing plastic waste and contributing to the Sustainable Development Goals of affordable and clean energy, climate action, and environmentally sustainable economies. However, the presence of impurities and the challenges associated with chlorine release during pyrolysis present obstacles that need to be addressed.

- Crude Petroleum Oil

  The extraction, refining, and combustion of crude petroleum oil have significant environmental impacts, including greenhouse gas emissions, oil spills, and pollution. While crude oil is a vital energy source, its use is increasingly scrutinized due to its contribution to climate change and environmental degradation.

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Chemical Analysis Components Comparison

Crude Plastic Pyrolysis Oil (PPO) - Crude plastic pyrolysis oil typically comprises a complex mixture of hydrocarbons, including alkanes, alkenes, and aromatic compounds, similar to those found in crude petroleum oil. However, the specific composition can vary widely based on the type of plastic waste used and the pyrolysis process conditions. Key components often include:

- **Hydrocarbons**: A mixture of C5-C20 alkanes and alkenes.
- **Aromatic Compounds**: Benzene, toluene, ethylbenzene, and xylenes (BTEX).
- **Oxygenates**: Compounds like phenols, carboxylic acids, and alcohols.
- **Impurities**: Presence of chlorine and other halogens due to additives in plastic materials, requiring further refinement.

Crude Petroleum Oil - Crude petroleum oil is a naturally occurring fossil fuel composed predominantly of hydrocarbons. Its chemical composition is influenced by its geologic formation and extraction location, but generally includes:

- **Hydrocarbons**: A broad range of alkanes, cycloalkanes, and aromatic hydrocarbons.
- **Sulfur Compounds**: Hydrogen sulfide, thiols, and other organosulfur compounds.
- **Nitrogen Compounds**: Pyridines, quinolines, and amines.
- **Metals**: Trace amounts of vanadium, nickel, iron, and other metals.
- **Resins and Asphaltenes**: Heavy molecular weight compounds contributing to the oil's viscosity.

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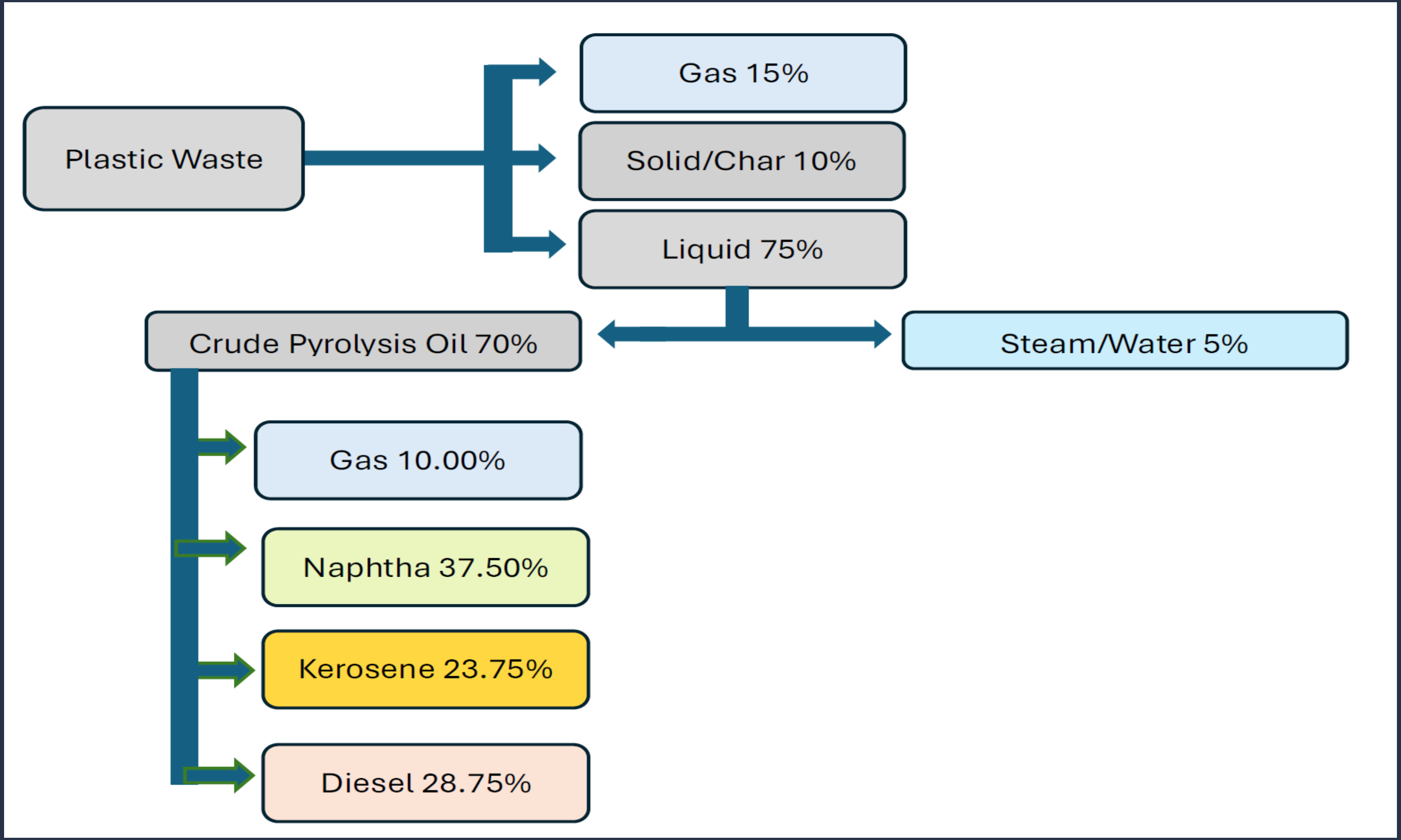

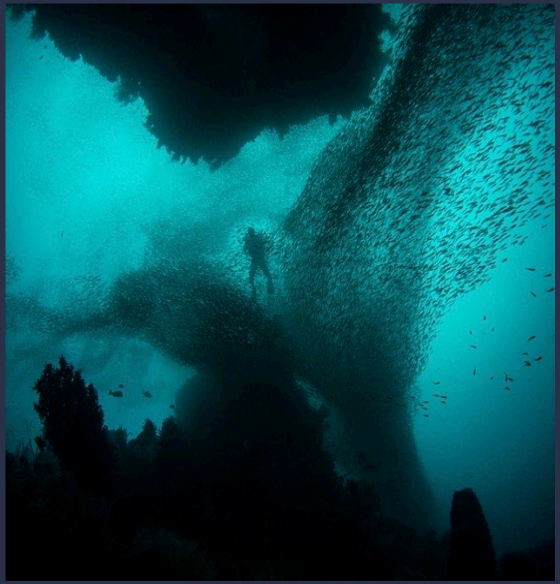

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Conclusion

Both crude plastic pyrolysis oil (PPO) and crude petroleum oil are integral components of the energy sector, each presenting unique advantages and challenges. PPO offers a promising solution for managing plastic waste and providing a cleaner fuel alternative, though it necessitates further refinement to eliminate impurities.

Conversely, crude petroleum oil, while deeply embedded in the global energy infrastructure, demands a shift toward more sustainable energy sources to mitigate its environmental impact. The future of energy sustainability will depend on balancing the use of existing resources with the development of innovative solutions.

Despite similarities in hydrocarbon content, PPO typically contains higher levels of oxygenates and impurities such as chlorine. Crude petroleum oil, however, is characterized by a greater presence of sulfur, nitrogen compounds, and trace metals, reflecting its natural geological origins. Both types of oil require specialized refining processes to produce clean, usable fuels.

SOLUTION TO SOLVE PLASTIC WASTE PROBLEM

The pyrolysis process and function of the equipment.

3.1 Plastic Feeding System: Plastic feedstock is automatically fed through pre-processing stages and then into the system reaction hopper. This initial stage may include mechanical separation from other wastes, washing, drying, and shredding.

3.2 Pyrolysis Chamber: The pyrolysis chamber consists of racks of screw conveyors that transfer materials linearly through the system. These screws operate continuously and are first heated to the point at which feedstock is admitted to the process. The chamber temperature is raised by heat from the furnace to 500-600 degrees Celsius. The plastic begins to melt, and agitation is employed to even out the process temperature. The feedstock breaks down into vapours at controlled temperature steps and is progressively extracted from the reaction tubes. Pyrolysis is a process of degradation in the absence of oxygen, resulting in the production of clean hydrocarbon gases and a solid char residue, which flows through to the extraction point.

3.3 Gas Extraction and Condensation: These gases are extracted and condensed in condensate process columns, and the fuel is separated. The product is pumped to storage tanks where it is available for sale as pyrolysis fuel oil or sent to the distillation process. Reactor pipes are closed-loop air-control systems.

3.4 Condenser: The condenser acts to condense the vapors from the reaction tube into liquid. Other fractions remain as non-condensed vapor, which may be sold as a by-product or used as furnace fuel.

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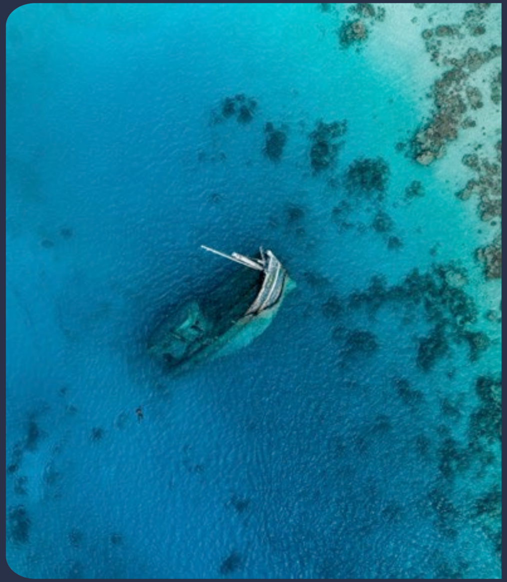
The pyrolysis process and function of the equipment.

3.5 Emissions Scrubber: Where required, an emissions scrubber treats pollution from the exhaust gases of the combustion chamber, in accordance with applicable regulations.

3.6 Cooling Tower: The cooling tower controls the temperature of recycled cooling water in the condenser.

3.7 Waste Heat Utilization: Where specified, surplus waste heat from the combustion chamber is used as a hot air source to dry plastic prior to processing. Dryer emissions may then pass through a scrubber for pollution control and treatment before being released into the atmosphere.

3.8 Distillation facilities: The process can be used 2 types of crude of pyrolysis oil, one in the form of vapor (Temperature around 375°C) another liquid (Temperature around 35°C). Due to both of crudes must be fed into the fractionating column at temperature around 400°C, so feed have to adjust at that temperature by heating furnace. In case of vapor crude oil will be used fuel in furnace for adjusting the temperature less than in case of liquid feed. This distillation column is designed for 12,000 liters/day and the total yield of product is 10,000 liters/day and the remains will be uncondensable gas and residues. The column is composed of 12 tries including reflux and re-boiler and whole process will be controlled by PLC system. When pyrolysis oil is injected in the column, each component fraction will be separated by boiling point difference. The products are designed as 3 fractions: gasoline BP < 200°C, kerosene BP 200-250°C, diesel 250-350°C and fuel oil at 370°C. The expected fraction after distilling will be 30% wt, gasoline, 15%wt, kerosene and 55%wt, diesel and then three products will be stored in independent storage tank.



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- Panagiotis Tsakaldinis, COO
- Anastasios Skontas, Civil Engineer
- Ilias Chantzos, ESG
- Theodore Vougioukas. Civil Engineer
- George Tsarmanidis, PM North America
- Lazaros Alexiou, Agriculture
- George Tsarmanidis, PM North America
- Zoran Andjelkovic, PM Serbia
- Rehan Siddiqui, PM Middle East
- Khaled Al Bahu, PM Middle East

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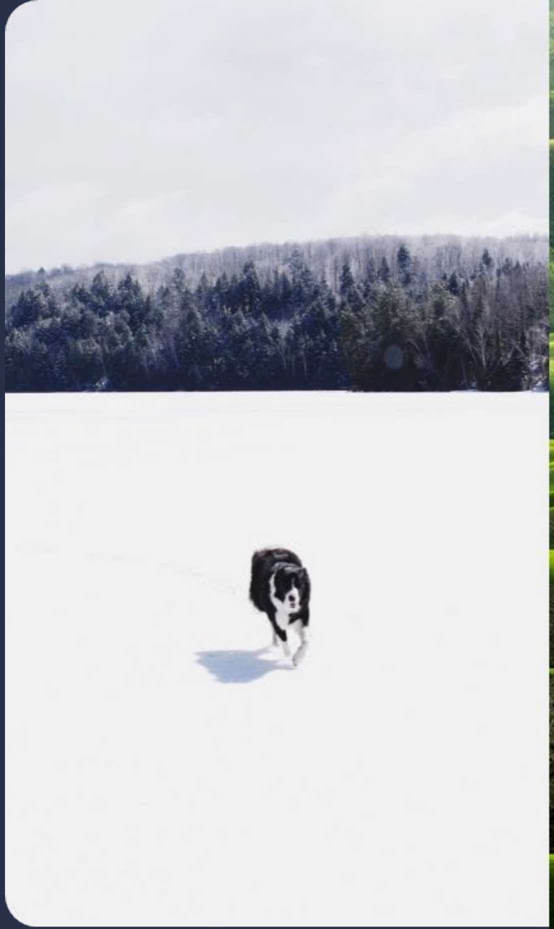
- Tasos Gkiokas
- Stamatis Tournis
- Spyros Papadopoulos
- George Frangkou
- George Karavias
- Karen McLeLlan

PROJECTS DEVELOPED

- Greece & Cyprus, GCC (UAE, KSA, Oman, Qatar, Bahrain), Italy, Spain, United Kingdom, USA, Canada, Germany, Switzerland, Turkey, Bulgaria, Serbia, Africa (Sudan, Egypt)



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