

Assessing the Feasibility of Chemical Recycling for Plastics in Copenhagen

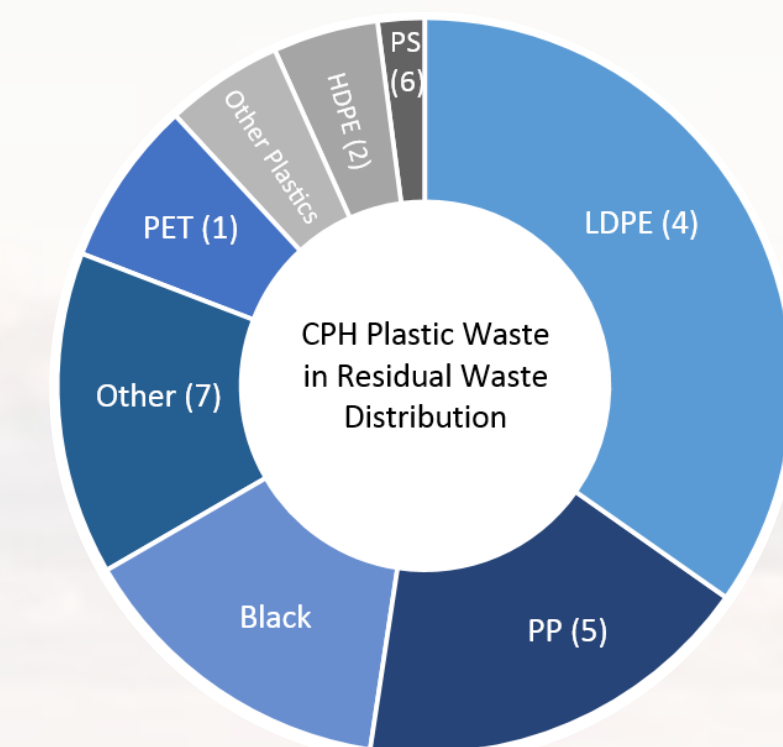
Robert Ciotti (CE/ME), Eric Himebaugh (ChE), Rebecca Serven (ME), Robert Starr (ECE)

Advisors: Professor Bruce Bursten and Professor Peter Hansen

Abstract

Our project team investigated and analyzed chemical recycling processes in order to develop more circular and sustainable practices for waste plastics in Copenhagen. The results show that pyrolysis is the most technically and operational feasible process considering the city's plastic waste streams, waste processing system, stakeholder perspectives, and consumer participation.

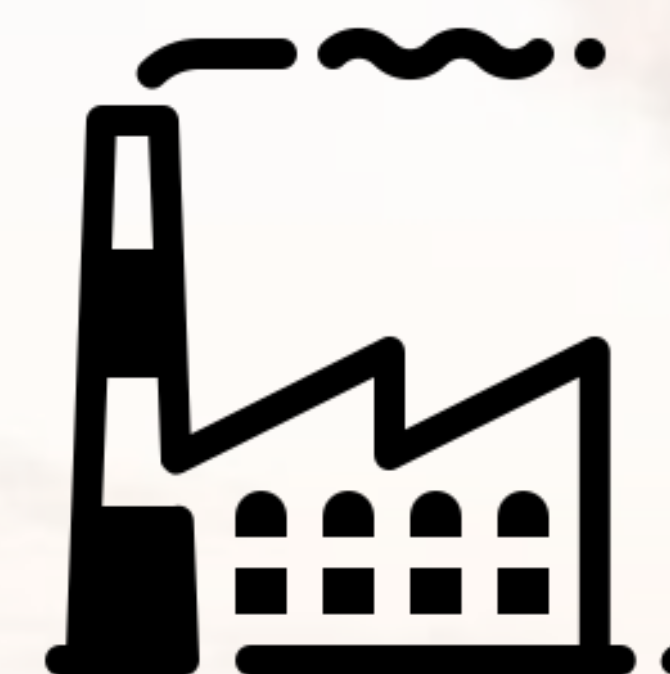
A process needs to meet these specifications



Takes in mixed plastic waste as an input



Produces feedstock to make new plastics



Reduces CO2 emissions

How do chemical recycling processes compare?

Chemolysis

Mixed Plastic Waste Input

Produces Plastic Feedstock

Reduces CO2 Emissions

Gasification

Mixed Plastic Waste Input

Produces Plastic Feedstock

Reduces CO2 Emissions

Pyrolysis

Mixed Plastic Waste Input

Produces Plastic Feedstock

Reduces CO2 Emissions

Plastic incineration is counter to Copenhagen's goals

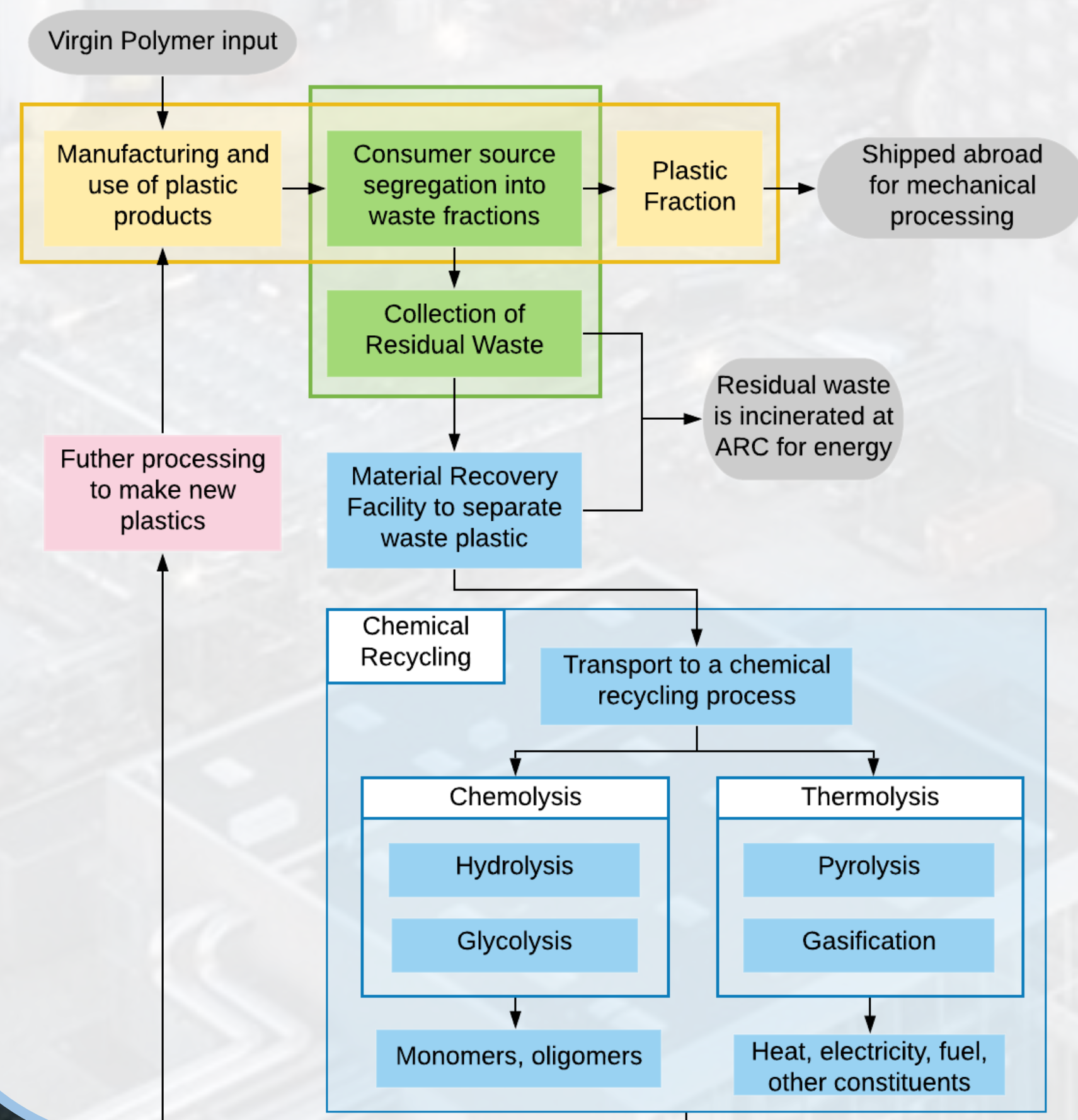


Copenhagen aims to implement a circular economy and be the world's first carbon neutral city by 2025

But, the incineration of plastics ends their material lifespan and releases over **40,000 metric tons of CO2** each year in Copenhagen

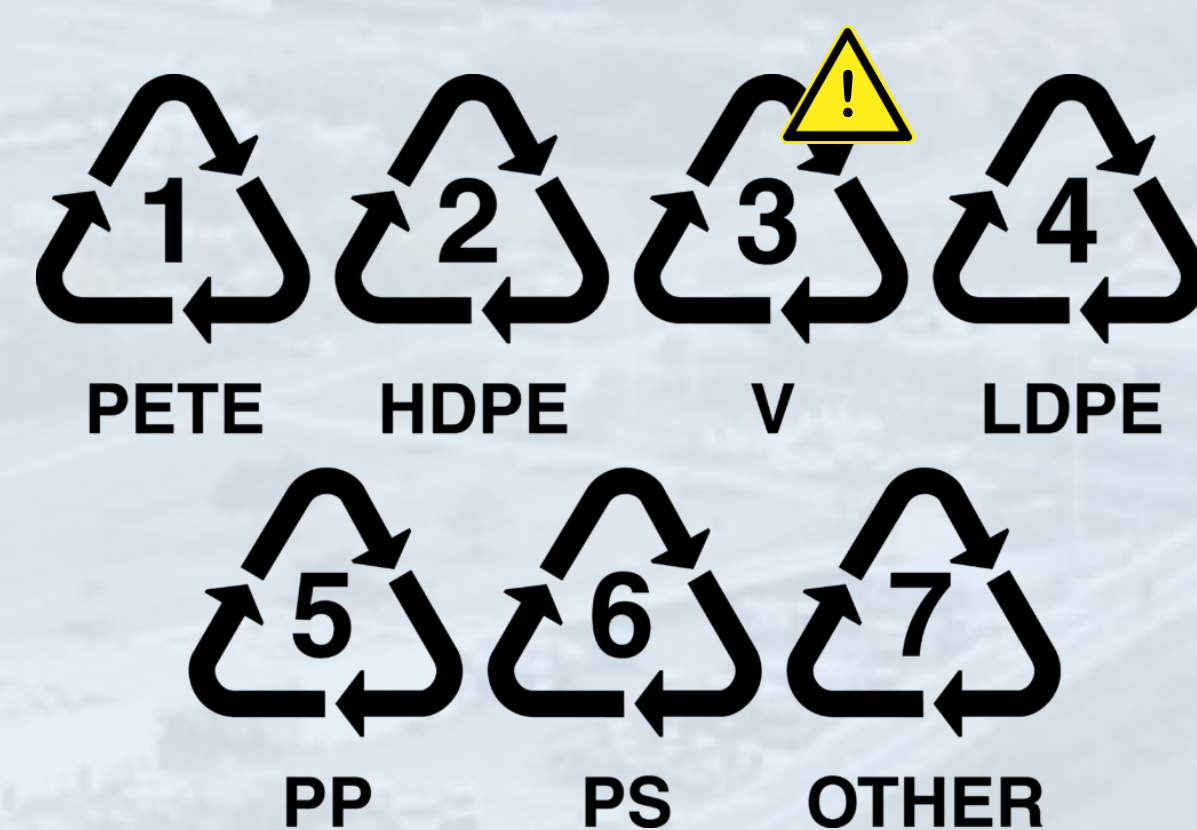
Chemical recycling offers a potential solution

Chemical recycling is the recovery of a plastic's chemical constituents through a depolymerization process.



How does pyrolysis fit into Copenhagen's plastic challenge?

Takes mixed plastic as an input



Pyrolysis is able to process plastic types 4-7 in large quantities and types 1-2 in smaller quantities.

Type 3, PVC, is not included because it releases hazardous gases when incinerated or pyrolyzed.

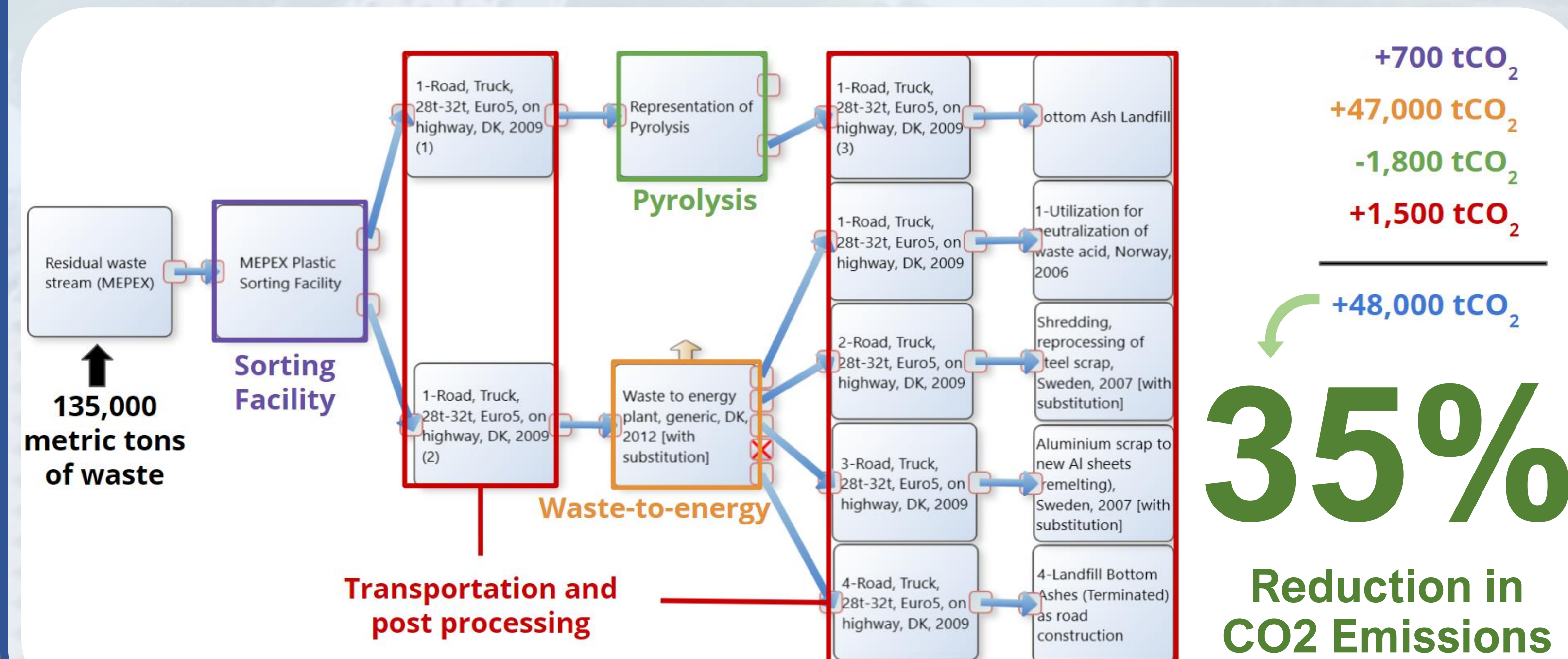
Produces plastic feedstock

Through pyrolysis, plastic waste becomes...



Naphtha to make new plastic
Fuels for transportation
Waxes for food packaging

Reduction of CO₂ from EASETECH Life Cycle Assessment



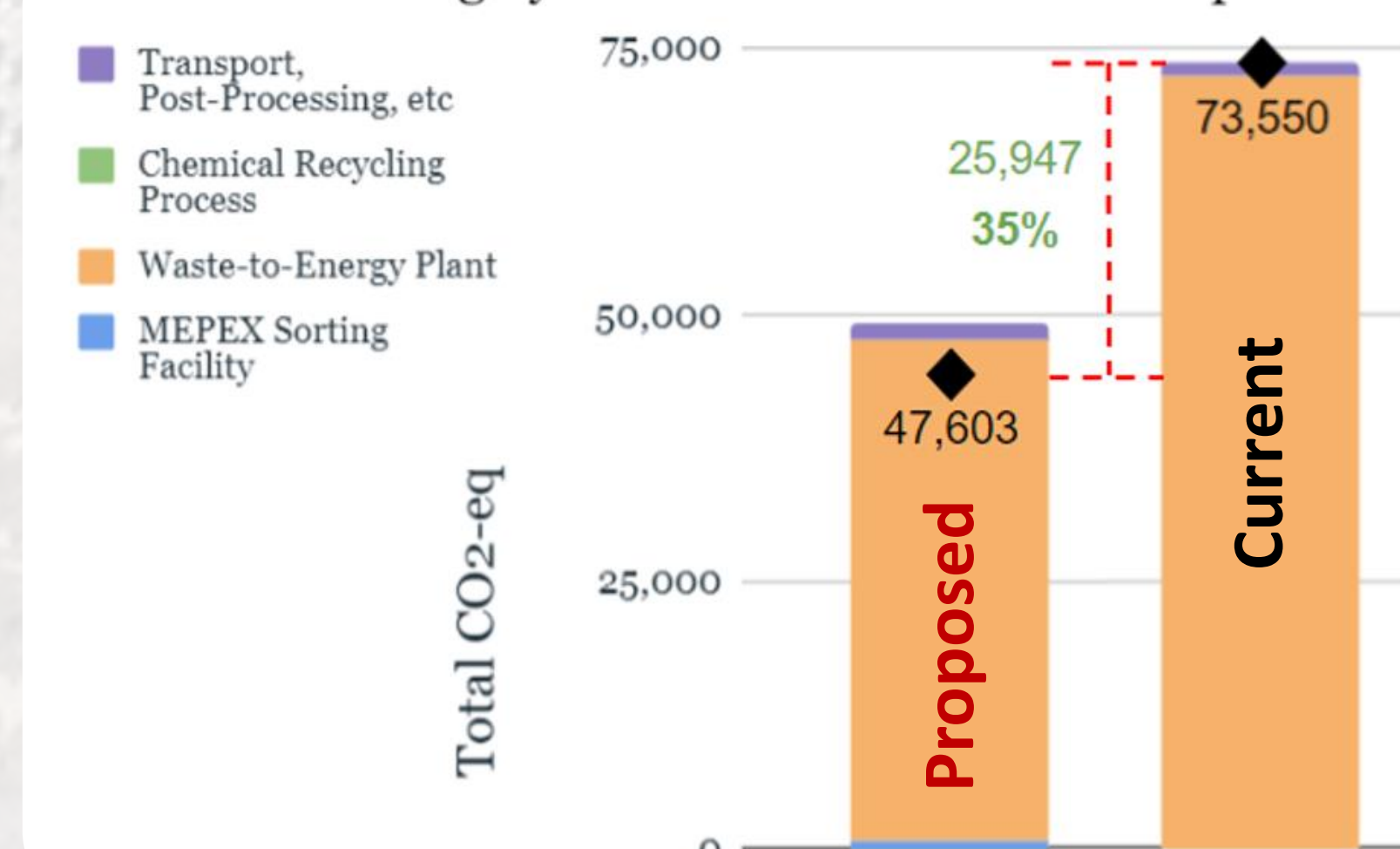
Poses a limited societal impact

- There was a societal consensus that incineration was not sustainable and not an ideal way to manage plastic waste
- Minimal impact on consumer behavior because of the material recovery facility planned for 2021 which will segregate plastic waste

Pyrolysis best addresses the incineration of plastics

- The **most environmentally friendly** process
- Addresses Copenhagen's environmental goals** outlined in the CPH 2025 climate plan
- Allows for a **circular and ethical** use of materials
- Would **not change** the recycling habits of consumers

Waste Processing System - CO₂ Emissions Comparison



Next Steps



- Investigate the economic and organizational feasibility of pyrolysis
- Conduct more field studies to understand why and how plastic waste is recycled
- Investigate alternative paths to chemical recycling
- Explore near-future technologies, such as carbon capture