



# FUTURE-PROOF CARBON

Evaluating Technologies, Feedstocks, and  
Market Timing



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Director

# A STORY OF EVOLUTION



5 <b>B</b> Boron 10.81	6 <b>C</b> Carbon 12.01	7 <b>N</b> Nitrogen 14.01
13 <b>Al</b> Aluminum 26.98	14 <b>Si</b> Silicon 28.08	15 <b>P</b> Phosphorous 30.97



# NESTLÉ

Porvoo Refinery, Finland

“ ”

**We invested in our first NEXBTL plant with the export market in mind, but now legislation requiring the use of biofuels on the road will also be introduced in Finland, and we need a second plant to meet domestic demand as well as growing demand elsewhere.**

– Kimmo Rahkamo, executive vice president of Neste Oil's Components Division



# NESTE'S RENEWABLE DIESEL SITES

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3.3 Mtonne of renewable products

# NESTE'S GLOBAL PARTNERSHIPS



PE & PP plastics



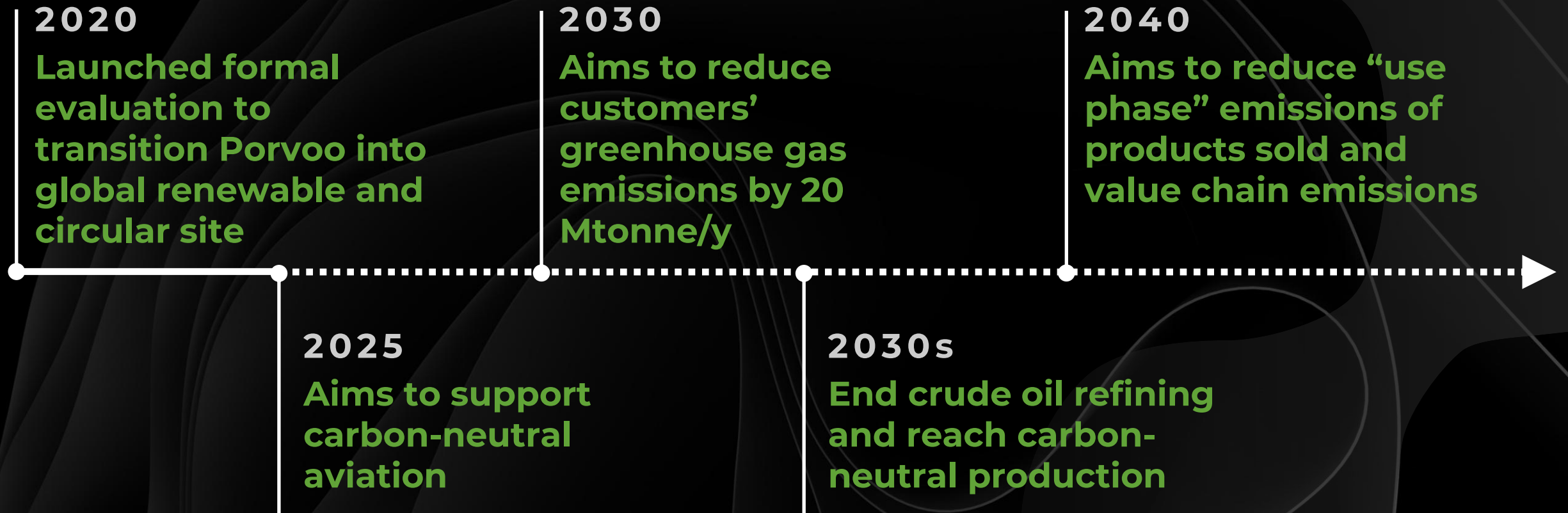
Polyurethanes



Terephthalic acid



# NESTE'S TIMELINE FOR THE FUTURE



## Finland's Neste shares plummet on downbeat biofuel sales margin outlook

By Reuters

February 8, 2024 2:12 AM PST · Updated 9 months ago



REUTERS



## Neste to deprioritize sustainable chemicals, polymers amid refocus on fuels

6:06 PM | February 14, 2025

Chemical Week

by S&P Global

## Oil refiner Neste says CEO Matti Lehtinen will be stepping down

By Reuters

April 29, 2024 12:33 PM PDT · Updated 6 months ago



REUTERS



## Refiner Neste warns of weaker biofuel outlook, shares drop

By Elviira Luoma and Essi Lehto

September 11, 2024 4:46 AM PDT · Updated 2 months ago



REUTERS



# A STORY OF EVOLUTION

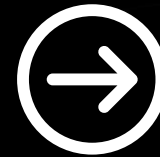
Renewable hydrocarbons for fuels



2000s



2025



The Future

# SUPPLY CHAIN RESILIENCE

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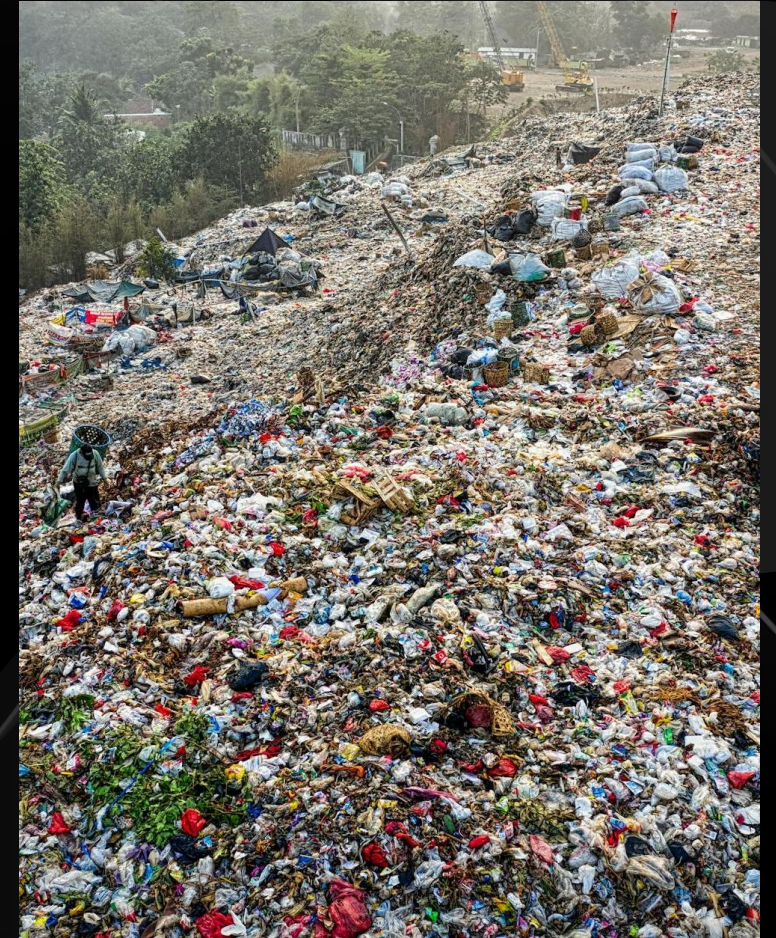
# DECARBONIZING MATERIAL INPUTS

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# WASTE VALORIZATION

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**The evolution of carbon has begun  
— your job is to identify the future-  
proof opportunities**

# AGENDA

**01** | Understanding the pathways to defossilize

**02** | Evaluating defossilization opportunities

**03** | Finding the right time to engage

# IMPACT OF INDUSTRIAL DEFOSSILIZATION

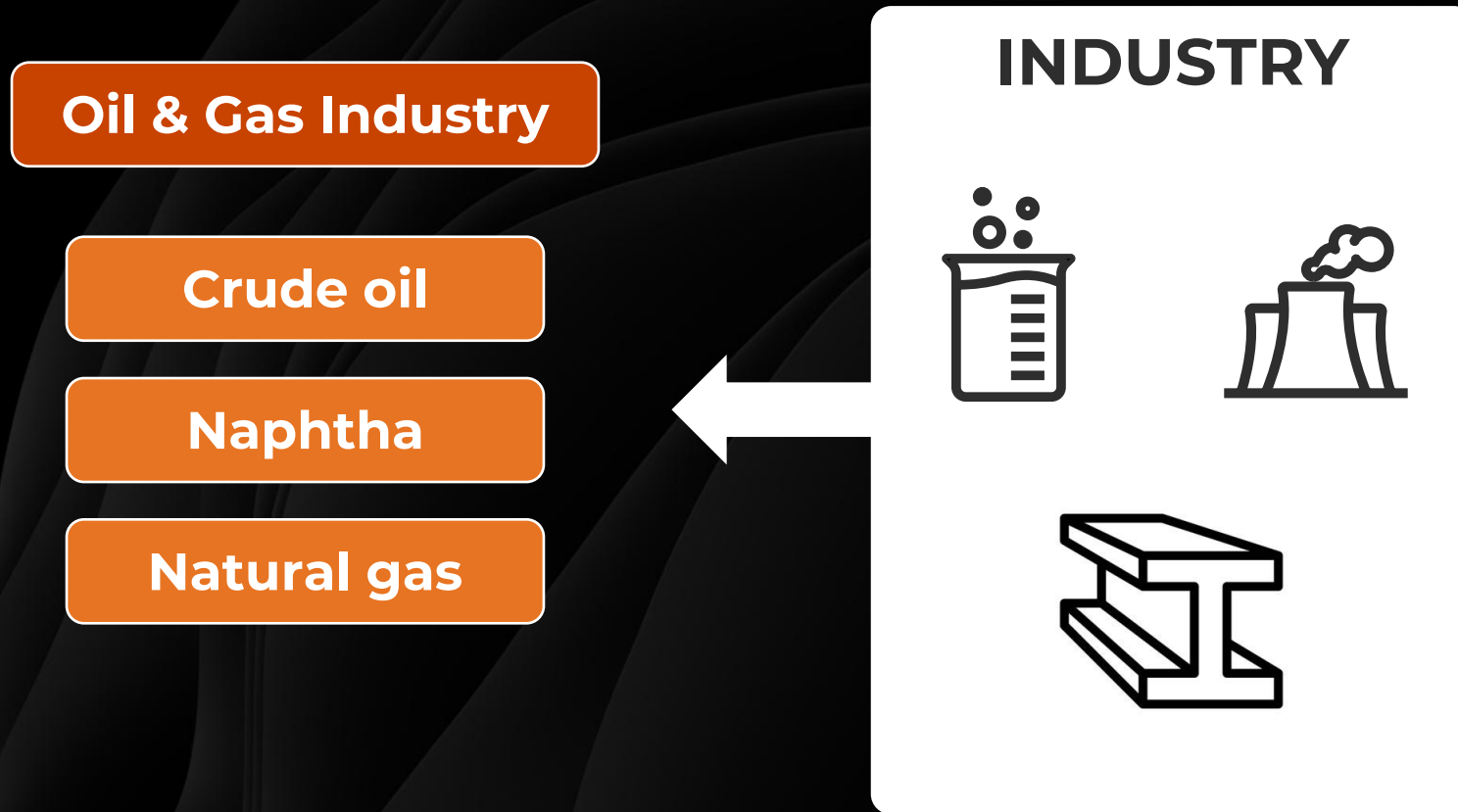
Upstream and downstream impacts

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# IMPACT OF INDUSTRIAL DEFOSSILILIZATION

Upstream energy providers risk losing customers

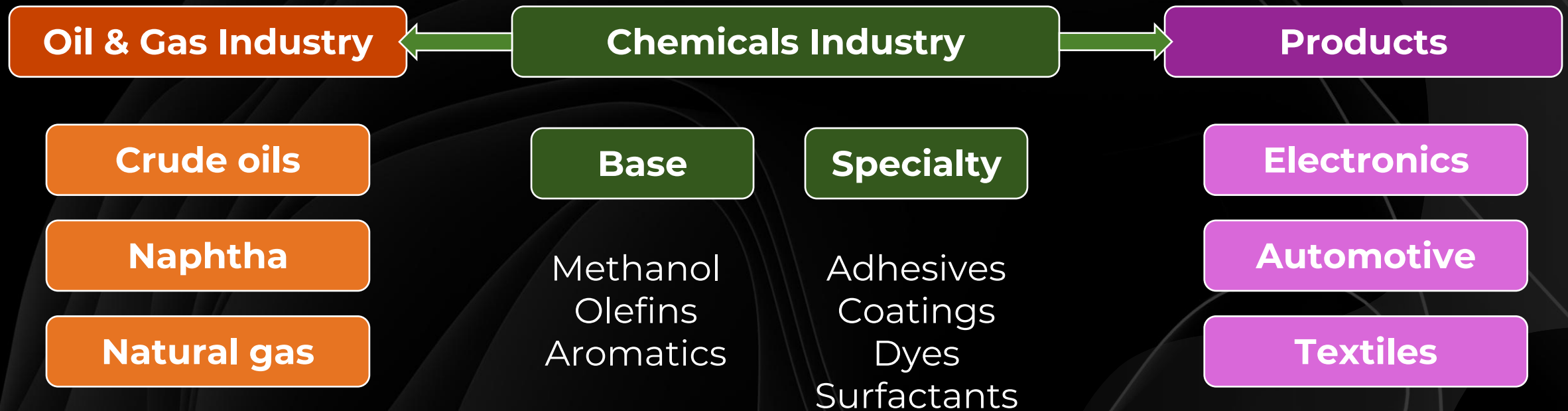


# IMPACT OF INDUSTRIAL DEFOSSILIZATION

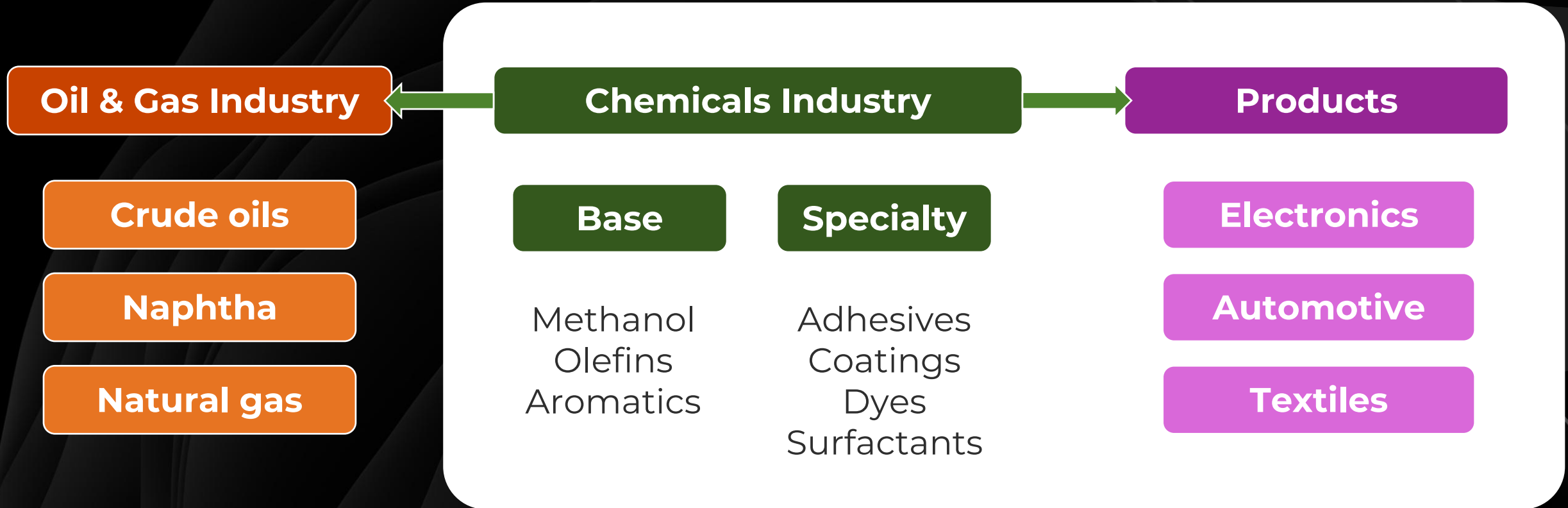
Downstream customers risk higher raw materials cost



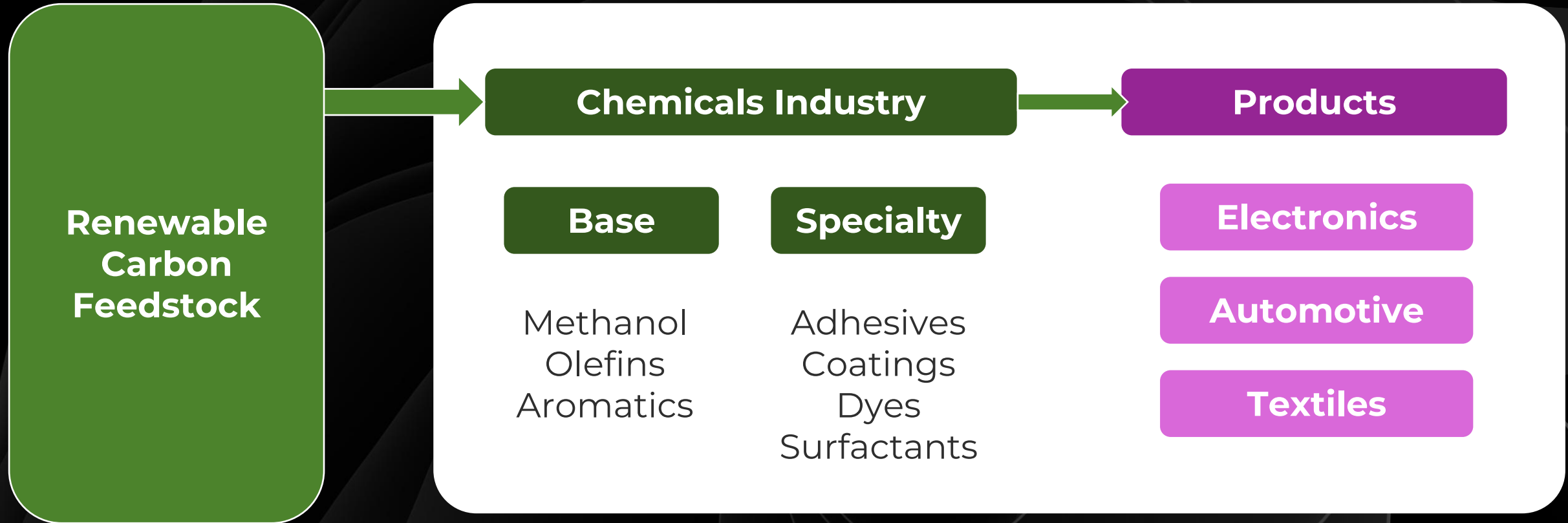
# IMPACT OF DEFOSSILIZATION



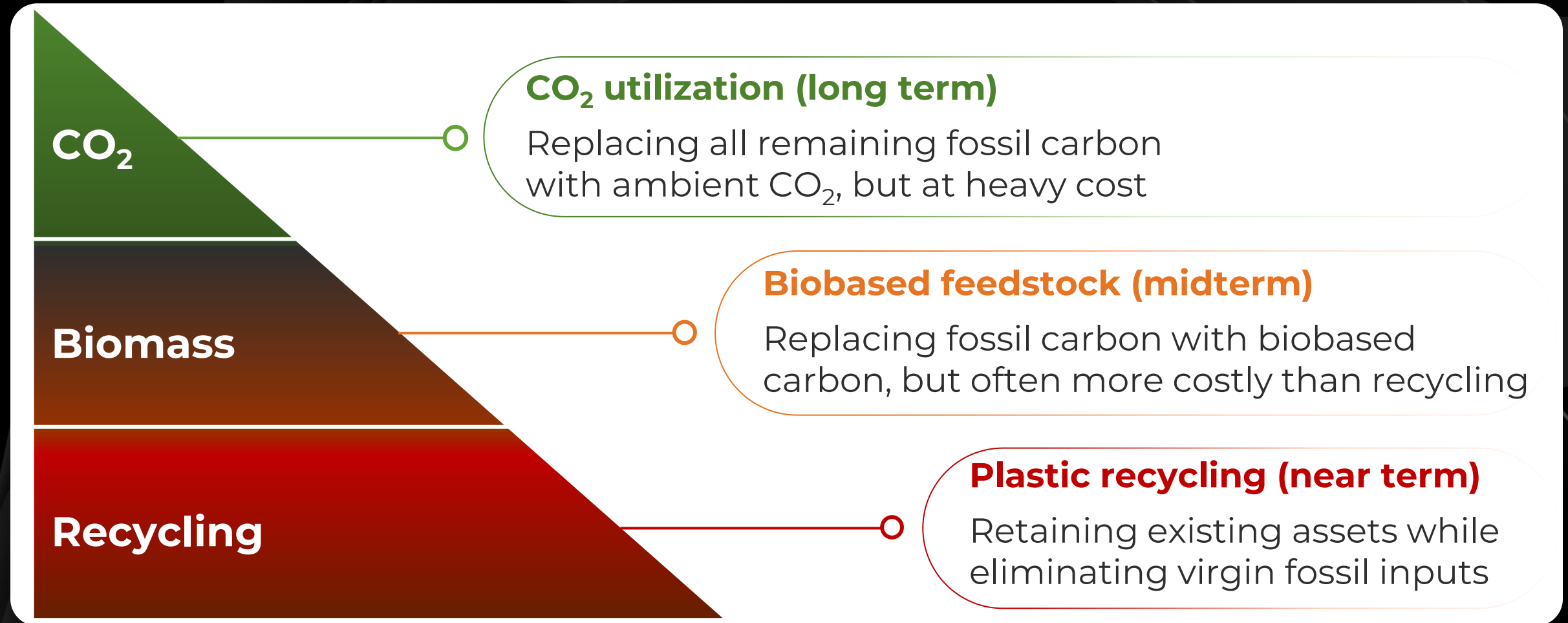
# ASSUMING PRODUCTS DON'T CHANGE



# THE FEEDSTOCK LEVER MUST EVOLVE



# SIMPLIFIED FEEDSTOCK HIERARCHY



# BUT REALITY IS LESS LINEAR

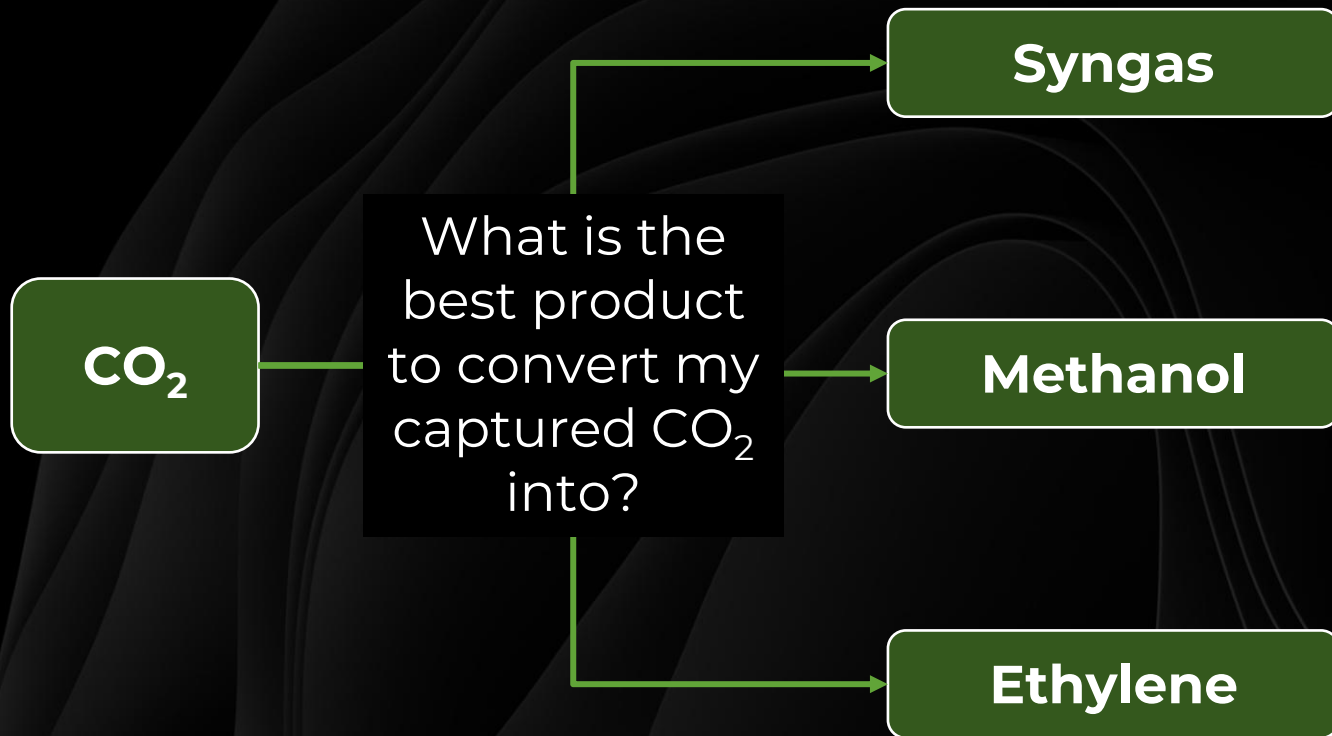
Feedstock-process-product alignment is critical to evolve carbon sources



# 2 WAYS OF VIEWING THE PROBLEM

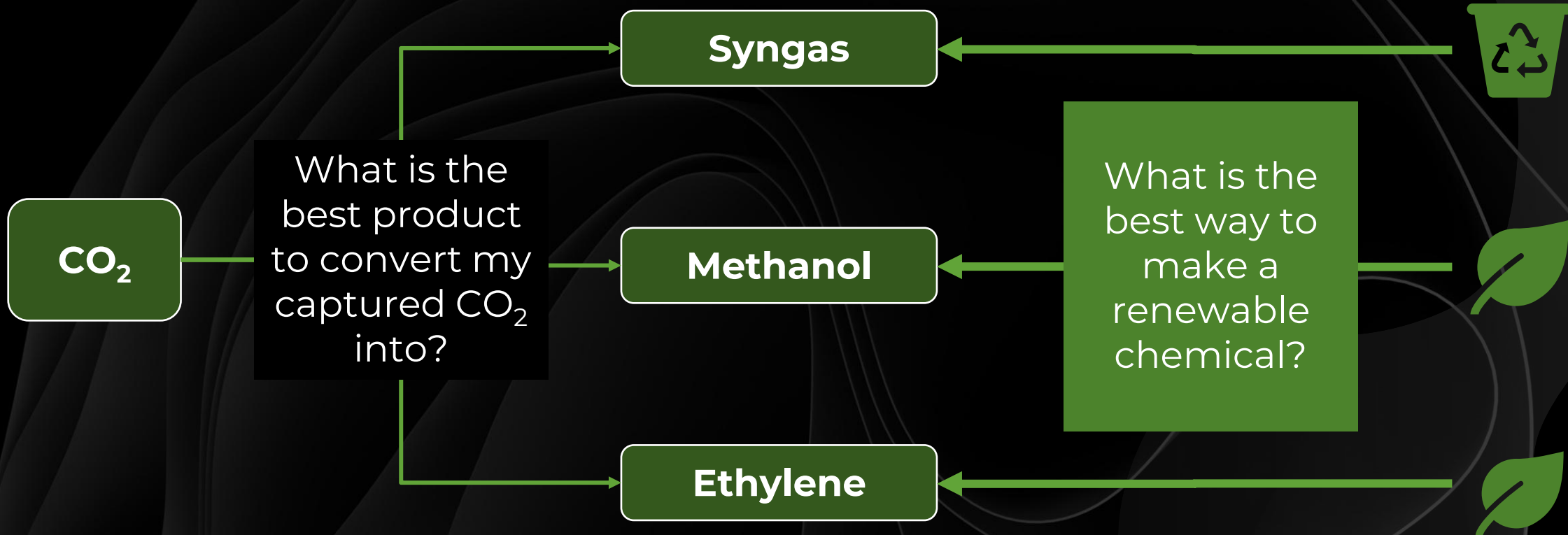
## The feedstock lens

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# 2 WAYS OF VIEWING THE PROBLEM

## The product lens

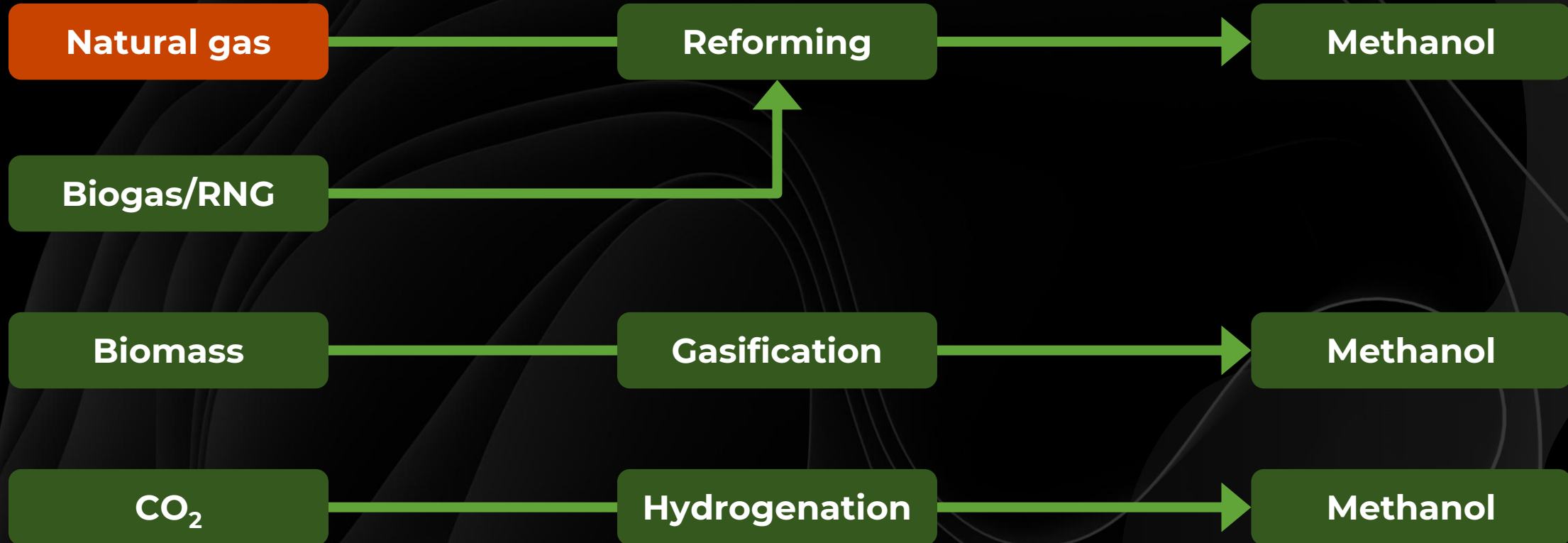


# FEEDSTOCK-PROCESS ALIGNMENT

Different feedstocks will require different processing

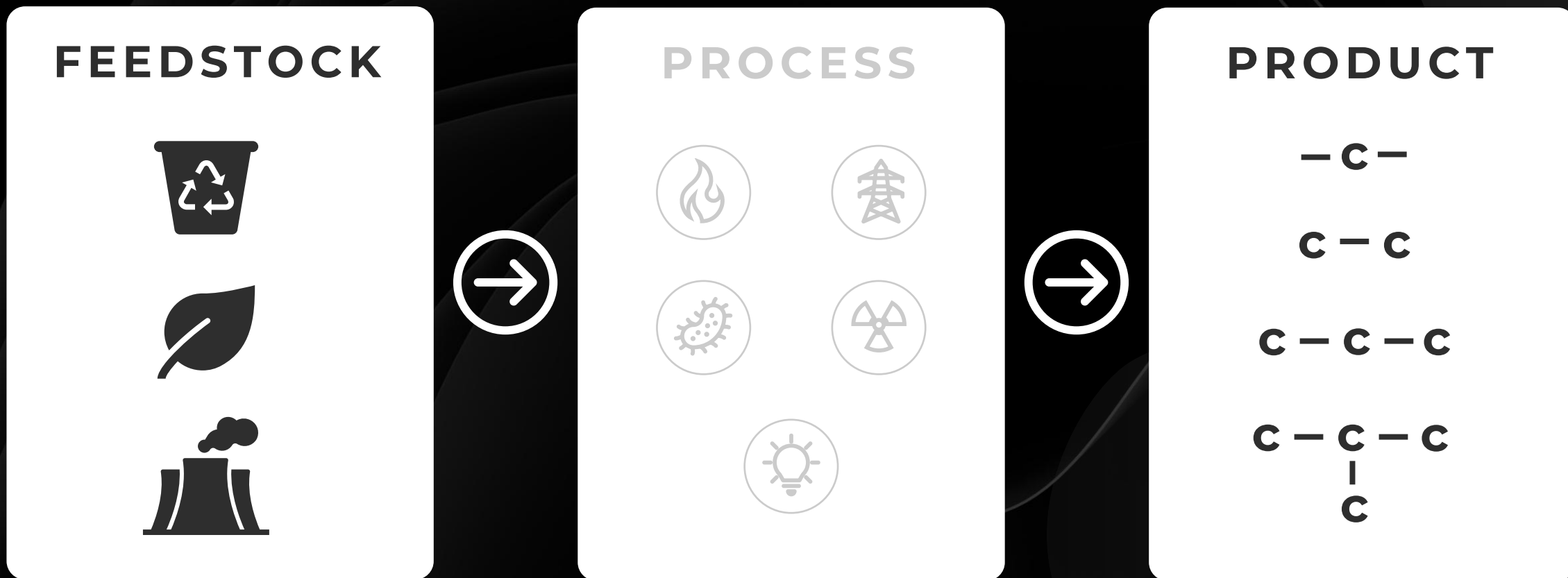


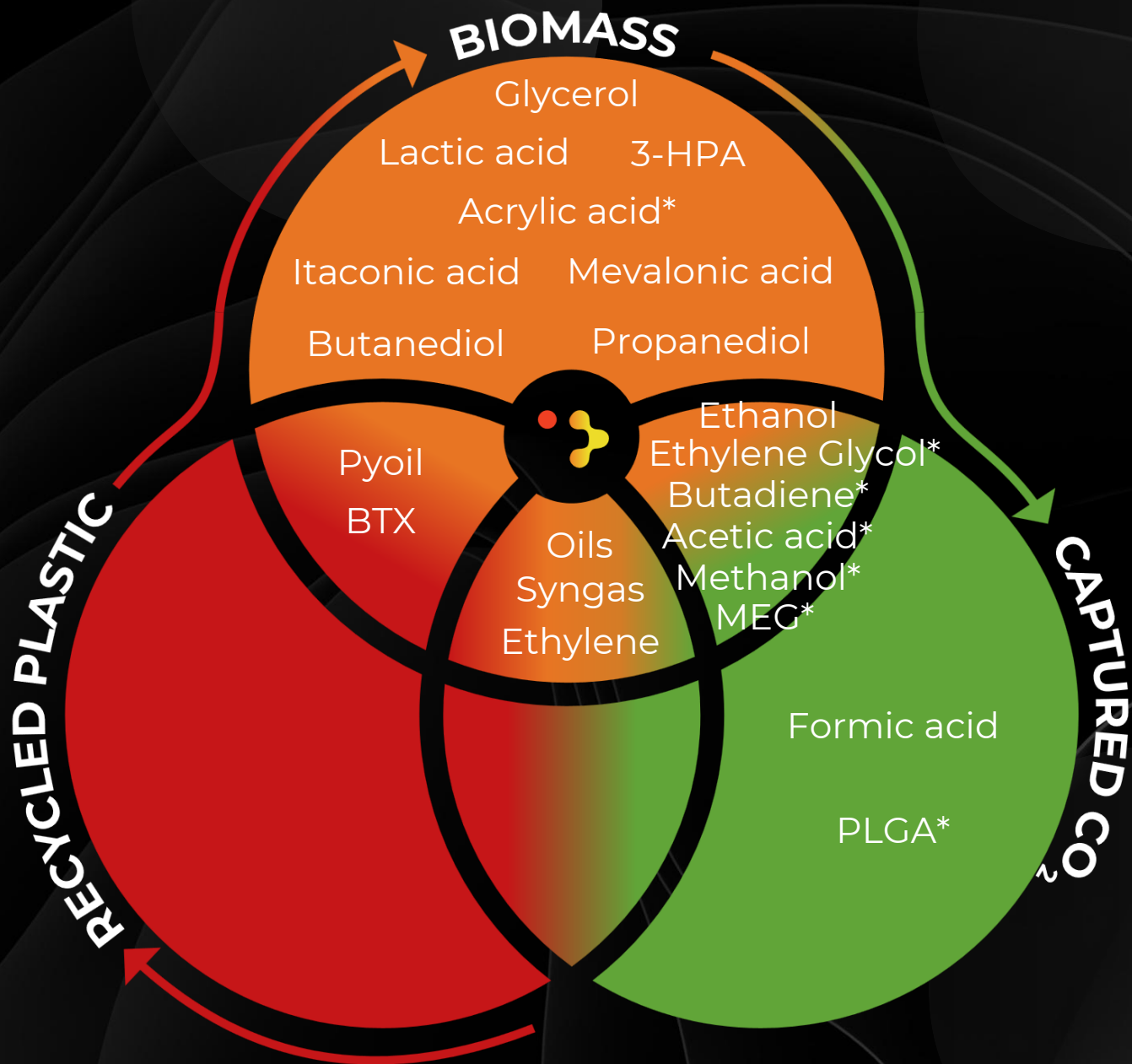
# BUT NEW FEEDSTOCK NEEDS NEW TECH

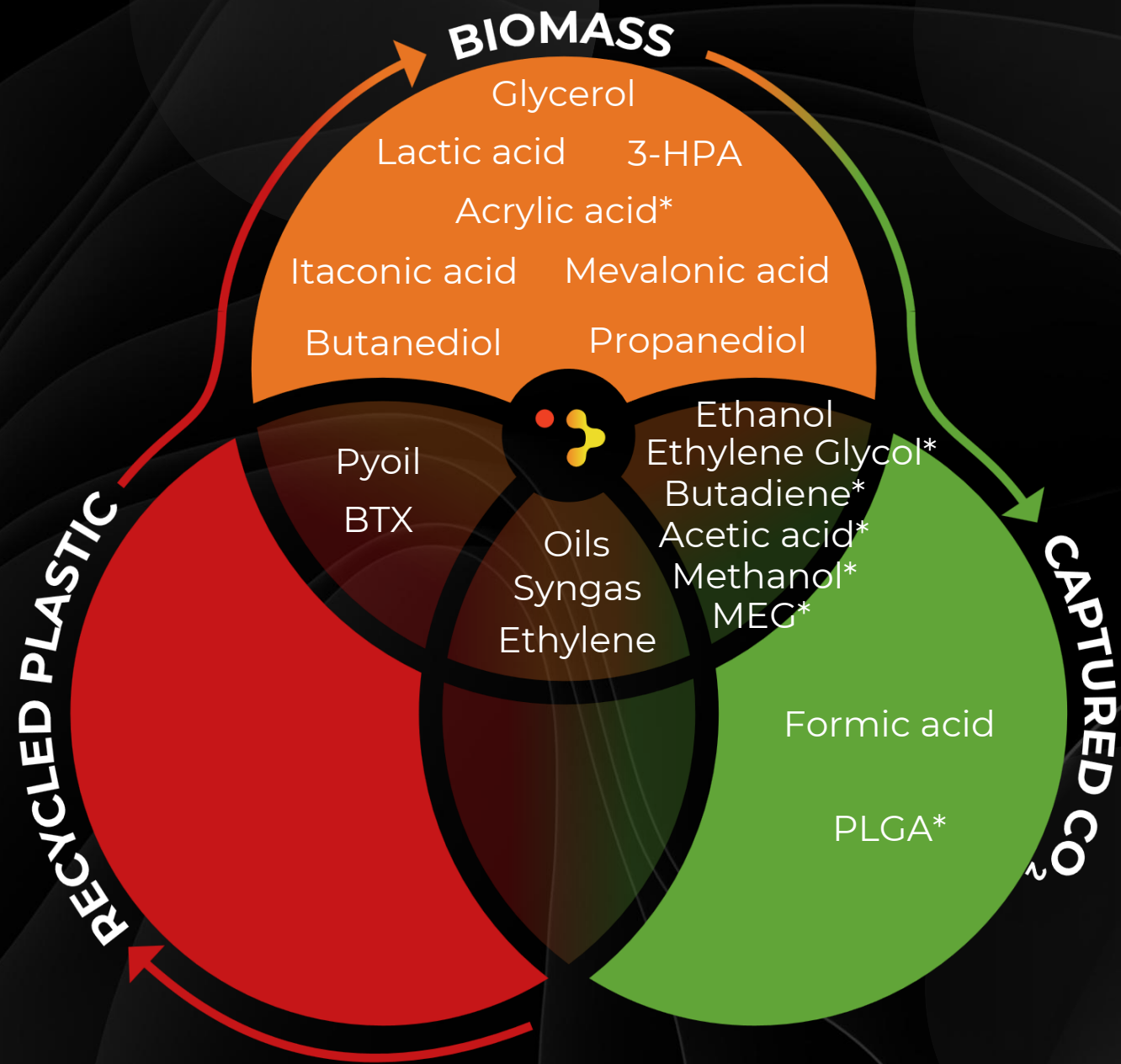


# FEEDSTOCK-PRODUCT ALIGNMENT

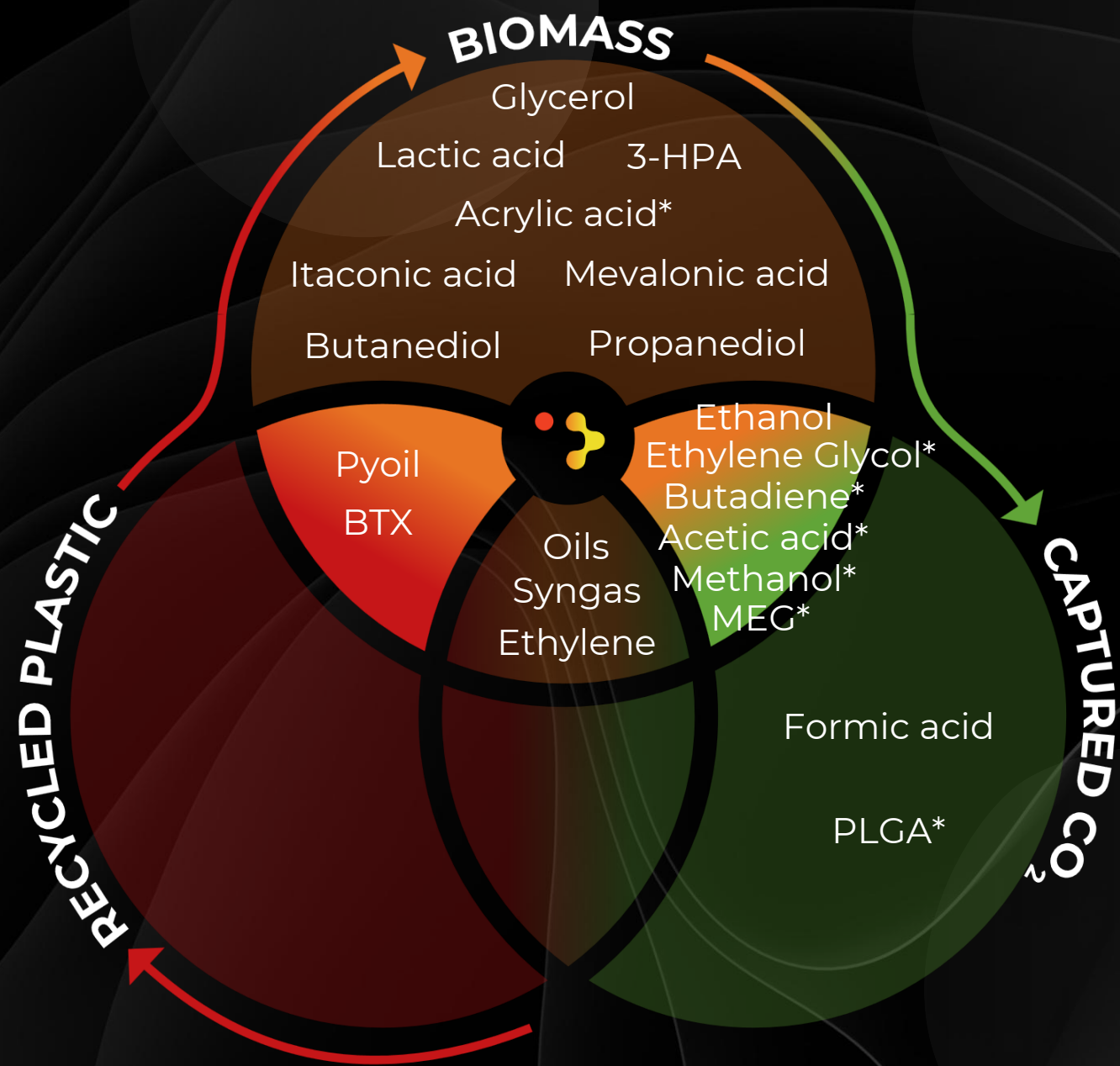
Not all feedstocks are suitable for all products



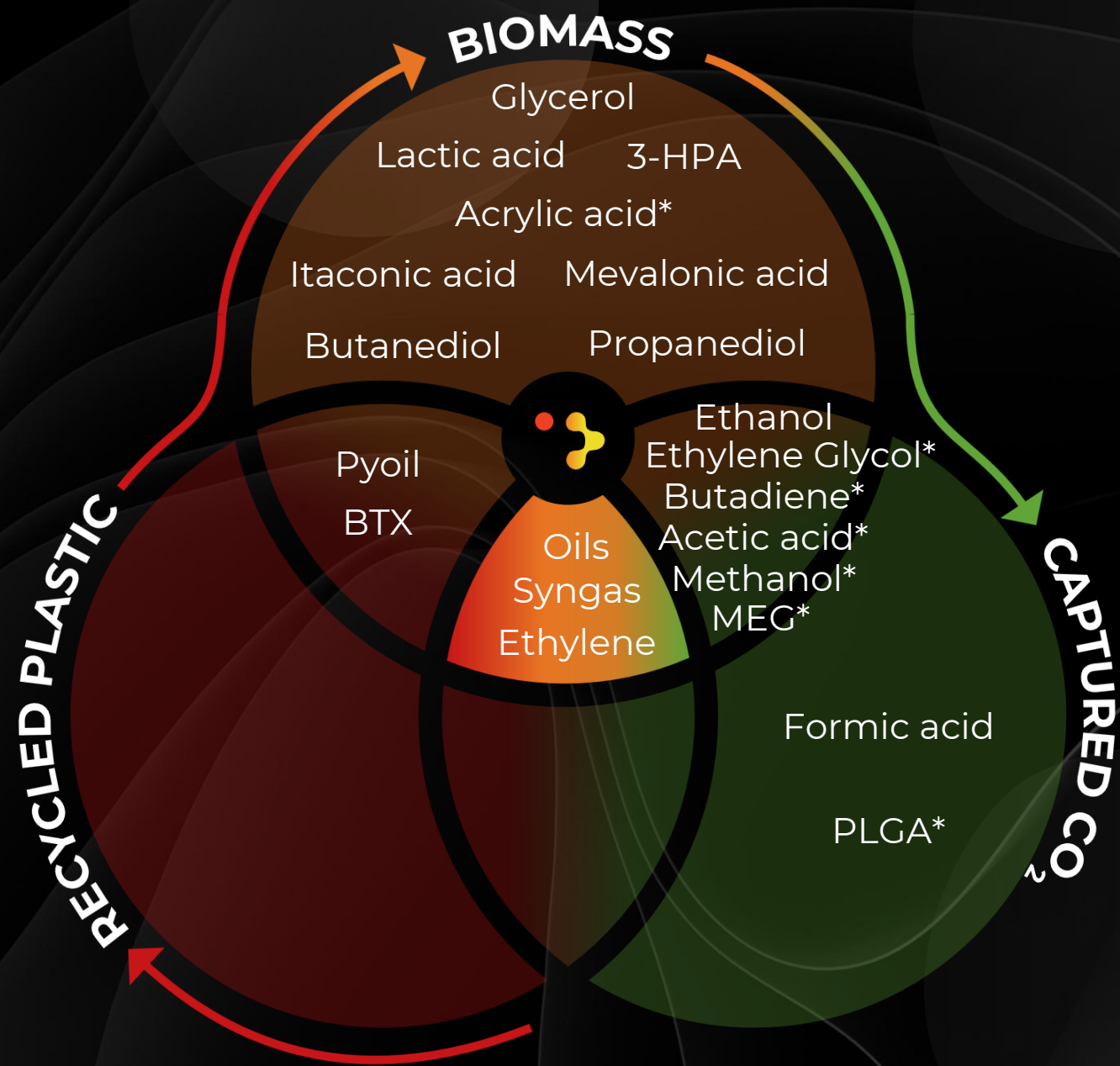




\*Indirectly produced from the feedstock via an intermediate



\*Indirectly produced from the feedstock via an intermediate



\*Indirectly produced from the feedstock via an intermediate

# AGENDA

**01** | Understanding the pathways to defossilize

**02** | **Evaluating defossilization opportunities**

**03** | Finding the right time to engage

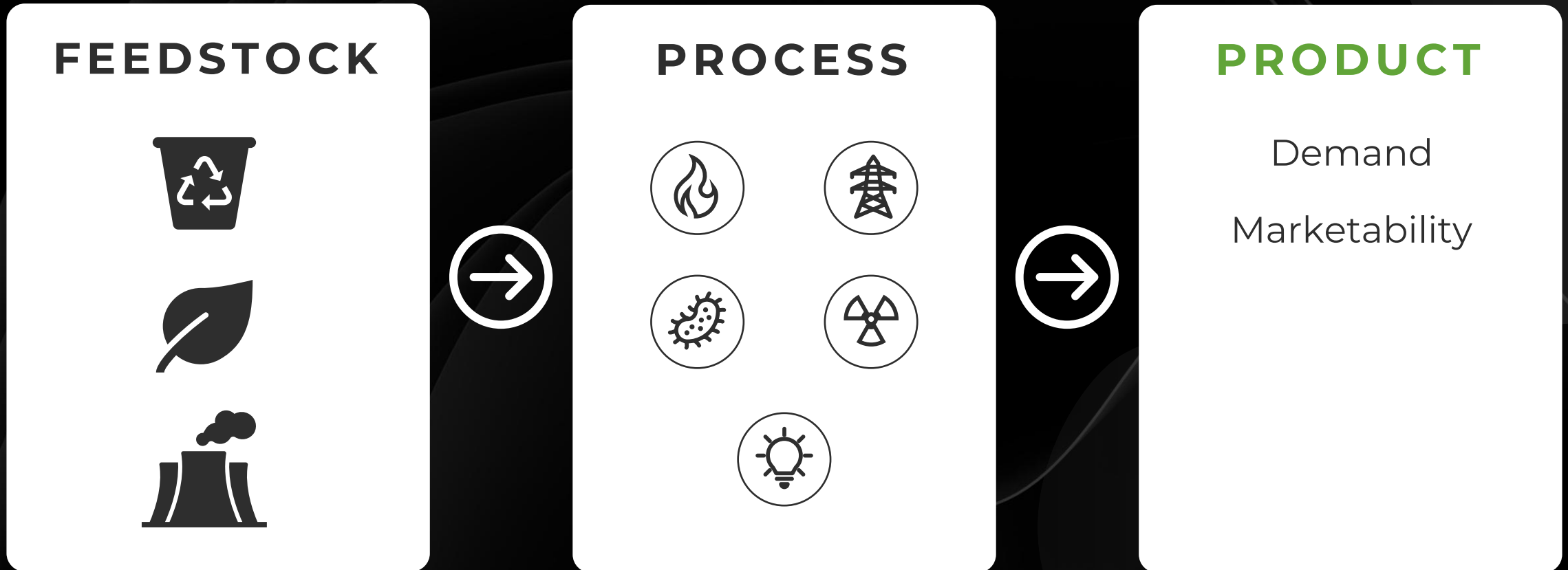
# ASSESSING DEFOSSILIZATION OPTIONS

Feedstock-process-product alignment is critical to evolve carbon sources



# ASSESSING DEFOSSILIZATION OPTIONS

A methodology to evaluate defossilization opportunities



# ASSESSING DEFOSSILIZATION OPTIONS

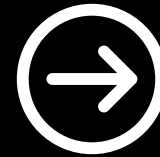
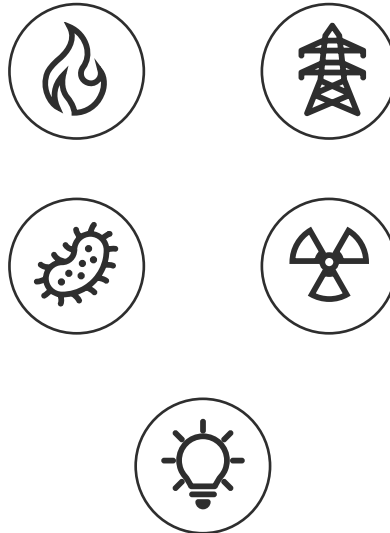
A methodology to evaluate defossilization opportunities

## FEEDSTOCK

Availability



## PROCESS



## PRODUCT

Demand  
Marketability

# ASSESSING DEFOSSILIZATION OPTIONS

A methodology to evaluate defossilization opportunities

## FEEDSTOCK

Availability

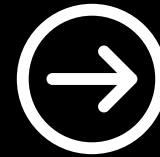


## PROCESS

Resource intensity

Tech maturity

Production cost



## PRODUCT

Demand

Marketability

# ASSESSING DEFOSSILIZATION OPTIONS

A methodology to evaluate defossilization opportunities

## FEEDSTOCK

Availability

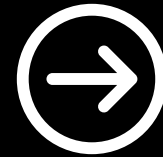


## PROCESS

Resource intensity

Tech maturity

Production cost

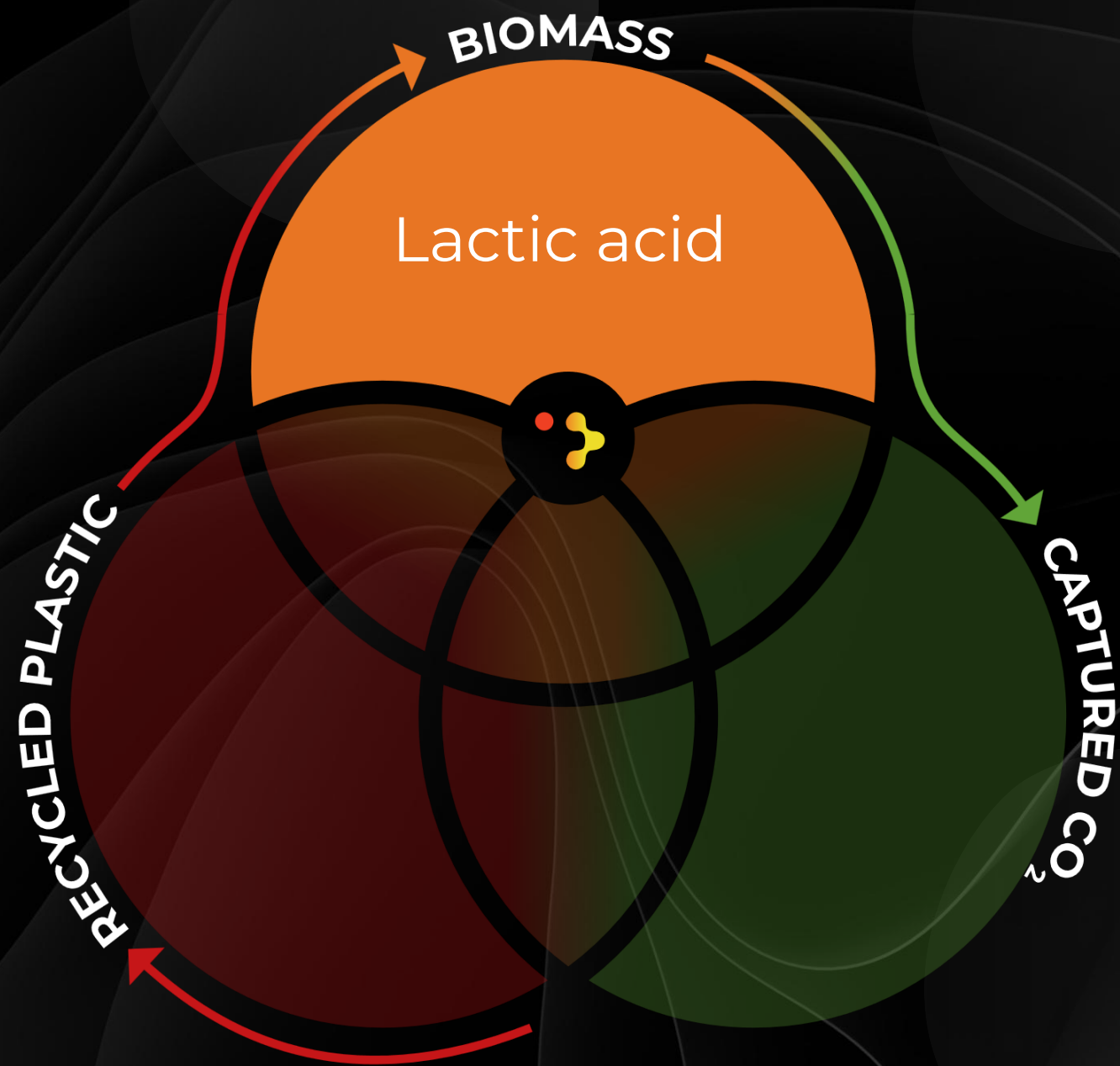


## PRODUCT

Demand

Marketability

Applying this methodology to the chemicals industry



# LACTIC ACID FROM BIOMASS

Interest in moving away from first-generation sugars to using waste feedstock to lower cost

The market is still being developed; much future demand dependent on its use for PLA to replace incumbent plastics and single-use plastics policy

	Biomass
Feedstock availability	Low challenge
Resource intensity	Moderate challenge
Tech maturity	Low challenge
Production cost	Moderate challenge
Demand	Moderate challenge
Marketability	Low challenge

Major challenge

Moderate challenge

Low challenge

# LACTIC ACID FROM BIOMASS IN APAC

India implemented a single-use plastics ban in 2022

	Biomass
Feedstock availability	Low challenge
Resource intensity	Moderate challenge
Tech maturity	Low challenge
Production cost	Moderate challenge
Demand	Low challenge
Marketability	Low challenge

Major challenge

Moderate challenge

Low challenge

# POLICY DRIVING ADOPTION

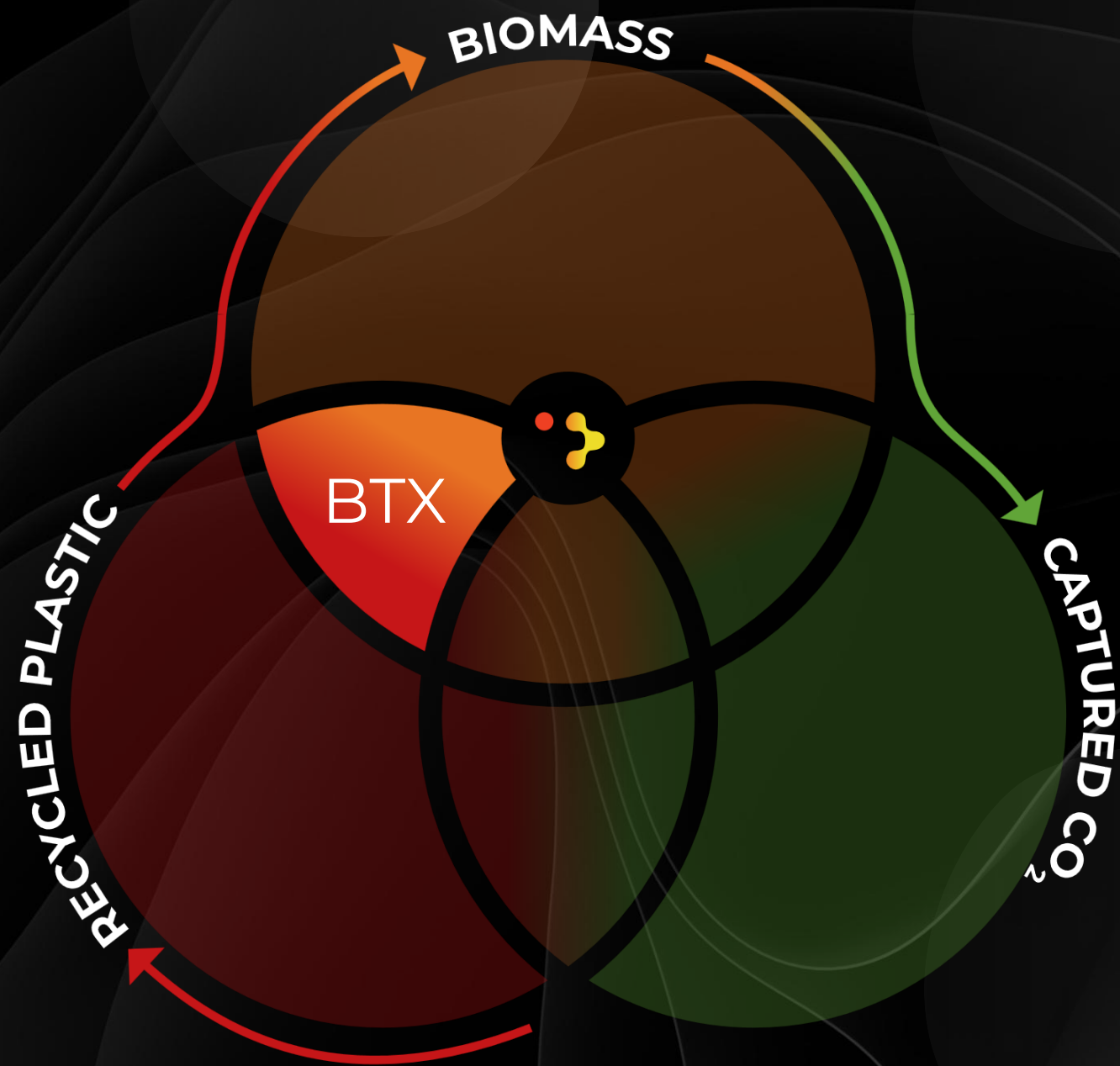
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Balrampur Chini Mills is one of the largest sugar producers in India

INR 20 billion (JPY 35 billion) to construct 75,000-tonne/y PLA facility in Uttar Pradesh

Set to take advantage of the single-use-plastics ban that India implemented in July 2022





# CATALYTIC PYROLYSIS TO BTX

Catalytic pyrolysis to BTX technologies were initially developed for biomass, but developers have pivoted focus to plastic waste, given the strength of circularity as a defossilization driver

	Biomass	Plastic waste
Feedstock availability	Low challenge	Major challenge
Resource intensity	Moderate challenge	Moderate challenge
Tech maturity	Moderate challenge	Moderate challenge
Production cost	Moderate challenge	Moderate challenge
Demand	Moderate challenge	Low challenge
Marketability	Low challenge	Low challenge

Major challenge

Moderate challenge

Low challenge

# CATALYTIC PYROLYSIS TO BTX

Countries investing in waste collection infrastructure and other efforts to establish feedstock supplies will benefit scale-up success

	Biomass	Plastic waste
Feedstock availability	Low challenge	Low challenge
Resource intensity	Moderate challenge	Moderate challenge
Tech maturity	Moderate challenge	Moderate challenge
Production cost	Moderate challenge	Moderate challenge
Demand	Moderate challenge	Low challenge
Marketability	Low challenge	Low challenge

Major challenge

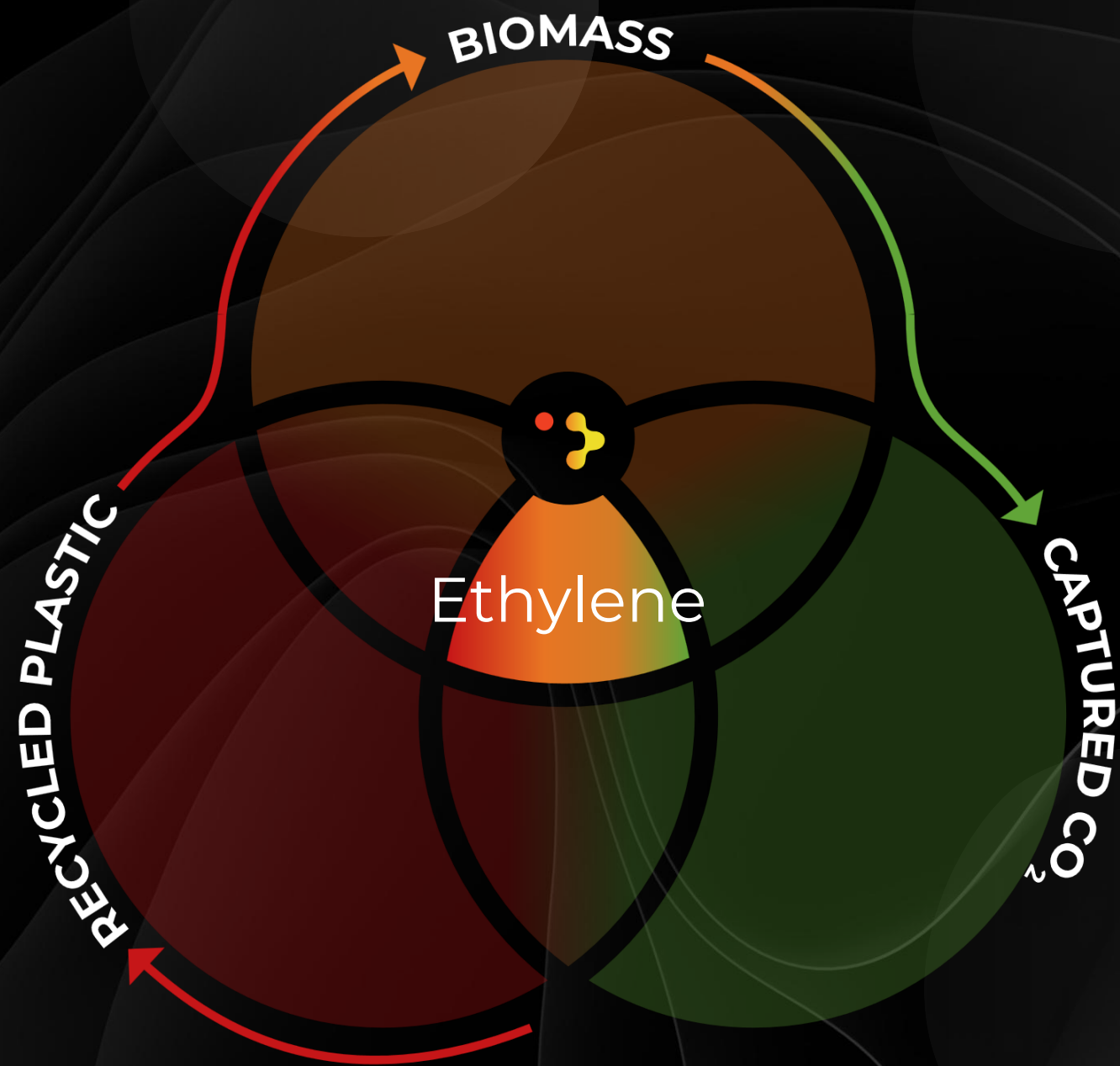
Moderate challenge

Low challenge

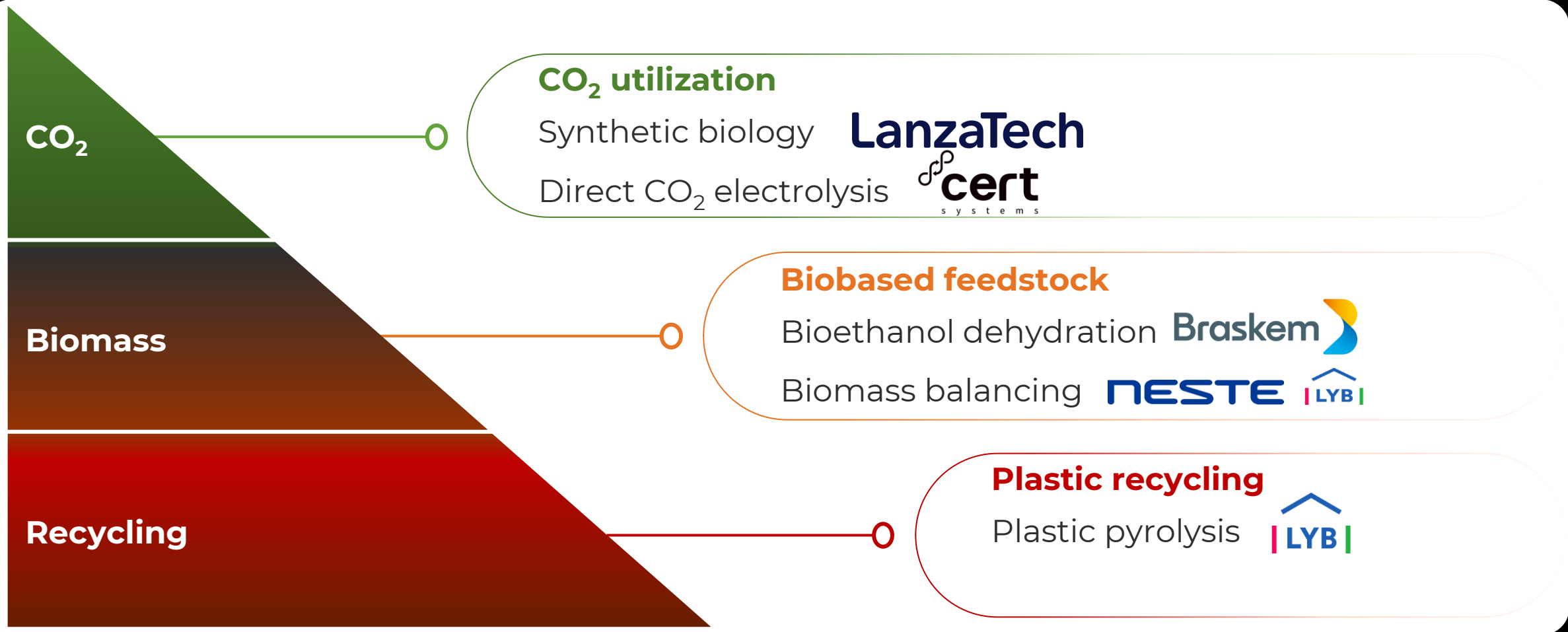
# SECURING PLASTIC WASTE SUPPLIES

In 2022, BioBTX partnered with Clariter, Bollegraaf, and N+P to develop Europe's largest plastic waste-sorting plant to supply feedstock for chemical recycling. Processing capacity will be 350,000 tonne/y and will target low-grade plastic that would otherwise be sent to landfills.





# DEFOSSILIZING ETHYLENE



# ETHYLENE DEFOSSILIZATION OPTIONS

	Feedstock Availability	Resource Intensity	Tech Maturity	Production Cost	Demand	Marketability
Pyrolysis	Major challenge	Major challenge	Low challenge	Moderate challenge	Low challenge	Major challenge
Biomass balancing	Moderate challenge	Low challenge	Low challenge	Low challenge	Low challenge	Major challenge
De-hydration	Low challenge	Moderate challenge	Low challenge	Moderate challenge	Low challenge	Low challenge
Synbio	Low challenge	Moderate challenge	Major challenge	Major challenge	Low challenge	Moderate challenge
Electrolysis	Low challenge	Major challenge	Major challenge	Major challenge	Low challenge	Moderate challenge

# DEFOSSILIZATION STRATEGY – STEP 1

	Feedstock Availability	Resource Intensity	Tech Maturity	Production Cost	Demand	Marketability
Pyrolysis	Major challenge	Low challenge	Low challenge	Low challenge	Low challenge	Low challenge
Biomass balancing	Moderate challenge	Low challenge	Low challenge	Low challenge	Low challenge	Low challenge
De-hydration	Low challenge	Low challenge	Low challenge	Low challenge	Low challenge	Low challenge
Synbio	Low challenge	Low challenge	Major challenge	Low challenge	Low challenge	Low challenge
Electrolysis	Low challenge	Low challenge	Major challenge	Low challenge	Low challenge	Low challenge

**Assess the link between feedstock availability and technology maturity for the long term**

# DEFOSSILIZATION STRATEGY – STEP 2

	Feedstock Availability	Resource Intensity	Tech Maturity	Production Cost	Demand	Marketability
Pyrolysis	Major challenge	Major challenge	Low challenge	Moderate challenge	Low challenge	Major challenge
Biomass balancing						
De-hydration						
Synbio						
Electrolysis						

**Create near-term opportunities through infrastructure investment**

# DEFOSSILIZATION STRATEGY – STEP 3

	Feedstock Availability	Resource Intensity	Tech Maturity	Production Cost	Demand	Marketability
Pyrolysis				Major challenge		Major challenge
Biomass balancing				Low challenge		Major challenge
De-hydration				Moderate challenge		Low challenge
Synbio				Major challenge		Moderate challenge
Electrolysis				Major challenge		Moderate challenge

**Explore the link between cost and marketability**

# DEFOSSILIZATION STRATEGY – STEP 4

	Feedstock Availability	Resource Intensity	Tech Maturity	Production Cost	Demand	Marketability
Pyrolysis					Major challenge	
Biomass balancing					Moderate challenge	
De-hydration					Moderate challenge	
Synbio					Moderate challenge	
Electrolysis					Moderate challenge	

**Stay aware of external defossilization drivers that impact demand**

# DEFOSSILIZATION STRATEGY – STEP 4

	Feedstock Availability	Resource Intensity	Tech Maturity	Production Cost	Demand	Marketability
Pathway 1					Moderate challenge	
Pathway 2					Moderate challenge	
Pathway 3					Major challenge	
Pathway 4					Major challenge	
Pathway 5					Major challenge	
					Major challenge	

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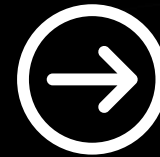
Renewable hydrocarbons for fuels



2000s



2025



The Future

# SUPPLY CHAIN RESILIENCE

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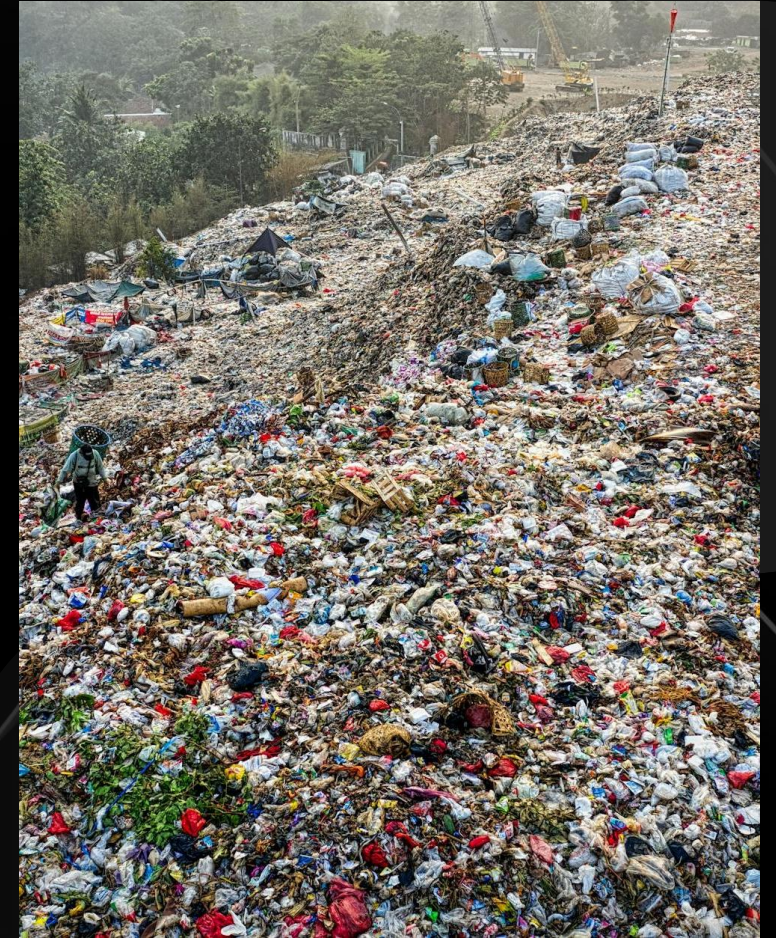
# DECARBONIZING MATERIAL INPUTS

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# WASTE VALORIZATION

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# KEY TAKEAWAYS

1

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**Feedstock-process-product alignment is critical to understanding opportunities for unlocking future carbon sources.**

2

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**There will be near-term opportunities exploiting the marketability of products — but pay attention to the overall strength of defossilization drivers impacting demand.**

3

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**Value chain developments could also unlock pathways to defossilize, especially when they can stand in the way of mature technologies.**



# THANK YOU

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