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Path to Net Zero –

Plastics Circularity in Chemicals Manufacturing

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strong combination
of complementary
powerhouses.



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Downstream &
Refining



Chemicals



Upstream



Gas, Power
& Climate



Agribusiness

Chemicals

Every industry, from agriculture to energy to retail, relies on chemicals at some stage in the production process. To stay ahead, you need a deeper understanding of market volatility, regulatory pressures, supply-chain disruption and shifting end user demand.





Our chemicals consultants have experience advising chemical producers, governments, financial institutions and technology providers operating at any point along the value chain, from commodity to specialty chemicals.

We can help you with:

- ✓ Techno-economic and feasibility studies
- ✓ Plastics Circularity
- ✓ Market studies for commodity chemicals
- ✓ Transaction support
- ✓ Specialty chemicals studies
- ✓ Process technology



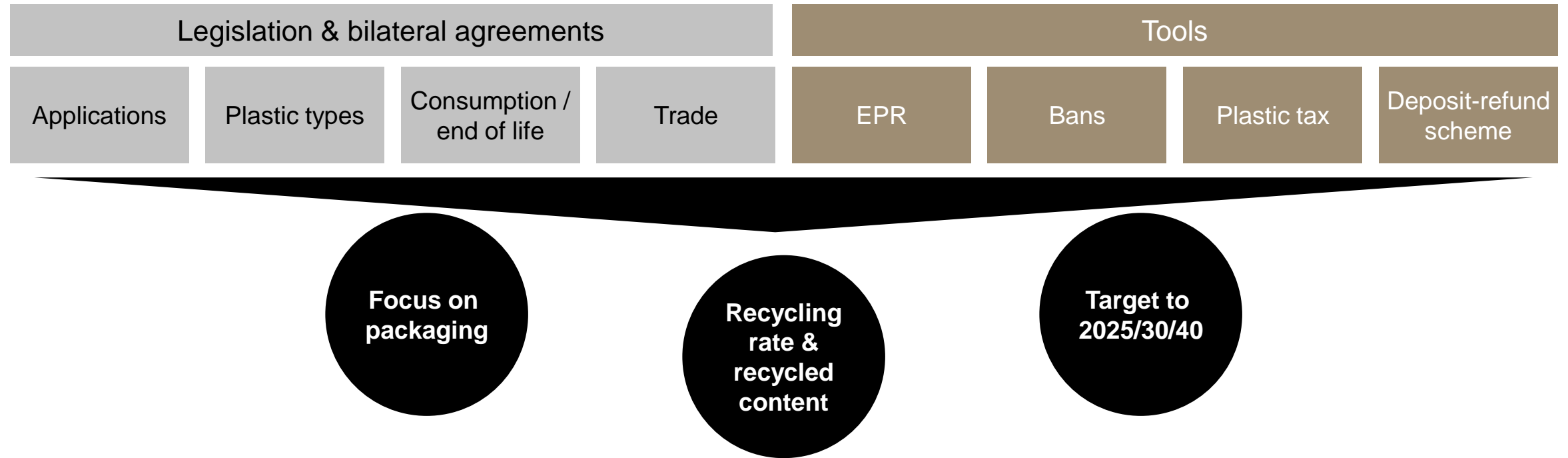
Why the interest in the Circular Economy?

<p>Climate change is leading industrials to decarbonize portfolios</p> 	<p>Energy players looking to diversify via chemicals.</p> 	<p>Increasing ESG influence from investors, brand owners</p> 	<p>As progress towards a circular economy accelerates, cost challenges emerge</p> 
<p>Plastics as visible component with increasing waste generation</p>	<p>Refining growth increasingly dependent on petrochemicals</p>	<p>Petrochemical industry to align on disclosure and metrics</p>	<p>Low margin environment, without carbon valuation; expect the change to be policy driven</p>

- Stakeholders along the value chain are driving a transformation of the plastic economy from linear to circular while commercially scaled technology, inadequate infrastructure and coordinated logistics all impede progress.
- Market volatility leads companies into reinvention
- Mismanaged plastics waste threatens the industry’s “social license to operate.”

Globally, approx 9% of plastic waste is recycled while 22% is mismanaged

Pressure has picked up on the plastics industry to mitigate the negative impact of plastic consumption on the environment

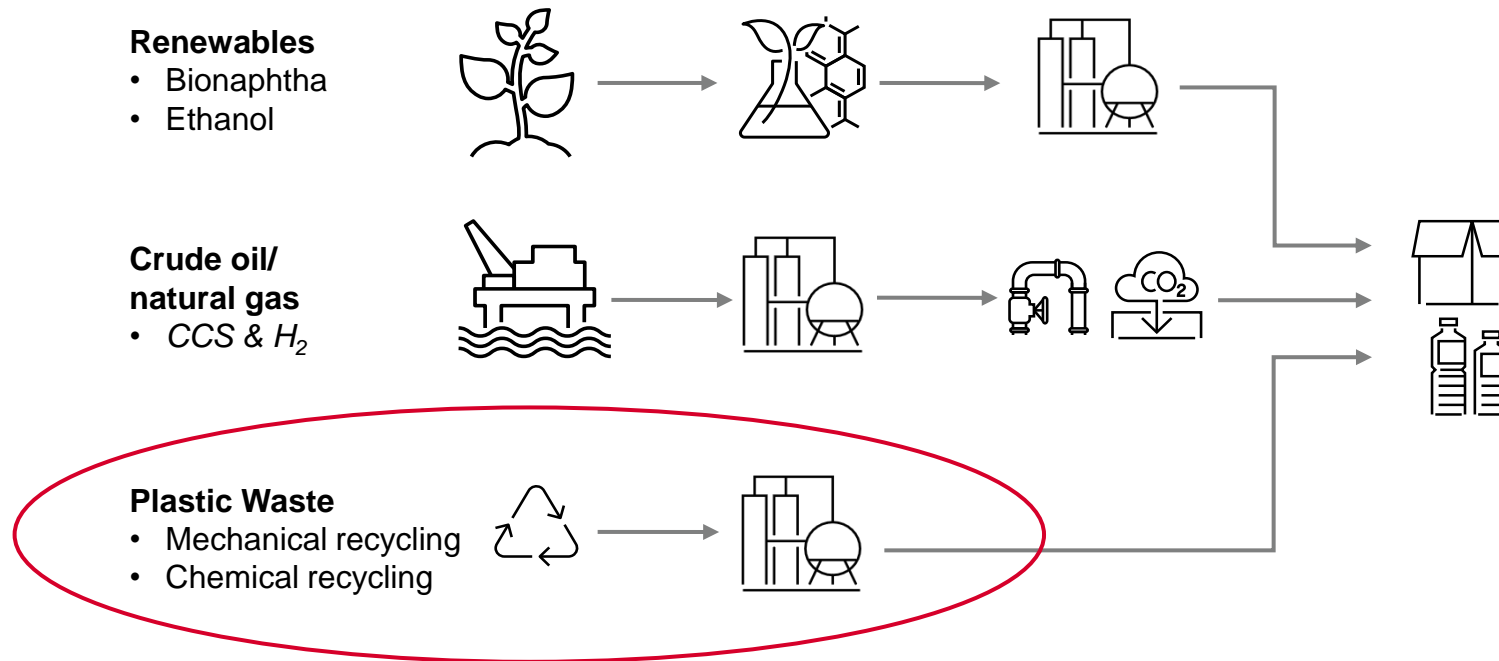


- Legislation focused primarily on applications rather than type of plastics with aim to reduce either consumption into these applications or promote end of life and plastics circularity.
- Regulation centered around trade and plastics' waste trade that can be beneficial but also counterproductive to promote recycling.
- Tools have been set in place to support legislation such as bans on certain applications, deposit schemes (that improve collection/sorting and mechanical recycling), and EPR and plastic tax schemes that drive financing

Source: S&P Global Commodity Insights

Most of the sustainability pathways require substantial capital investment, time and collaborative efforts

Plastic waste is an almost like free feedstock and is everywhere and requires relatively minor effort and expenditure. Basic infrastructure for recycling, such as collection and sorting facilities, is already in place in many regions.



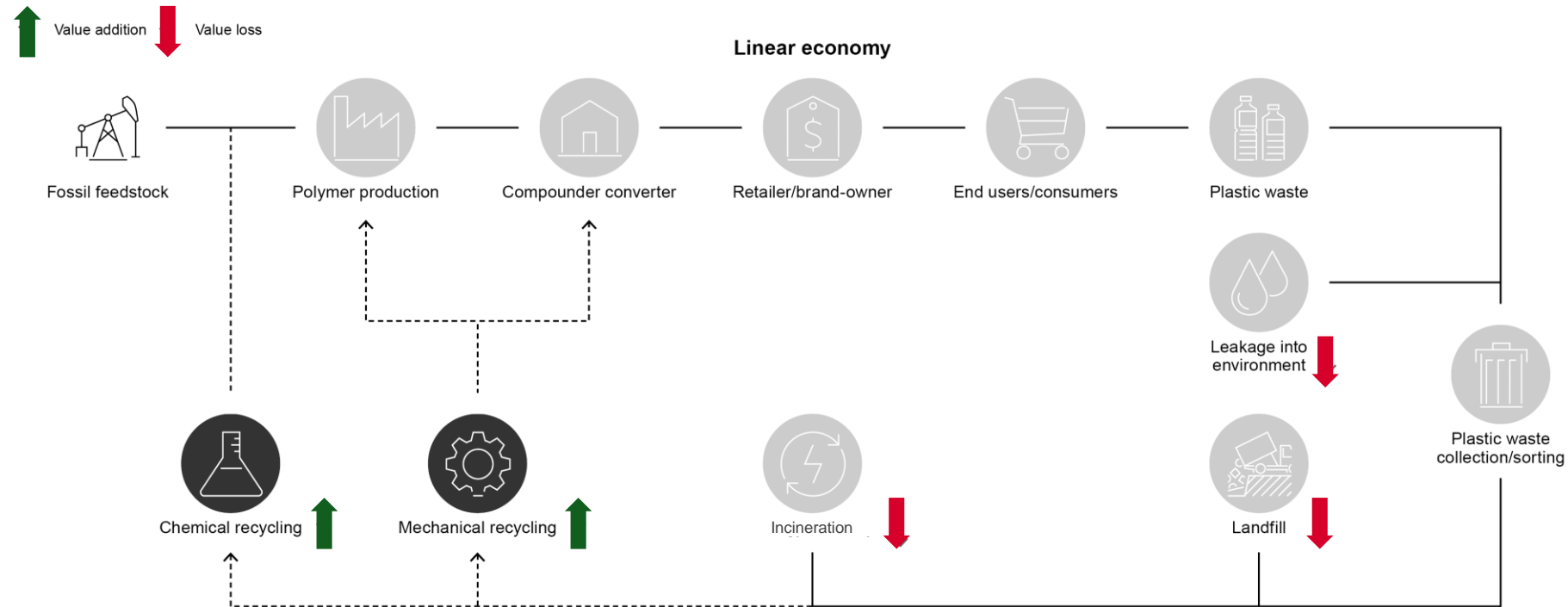
Pathway to sustainability
Less capital intensive, with feedstock availability

Source: S&P Global Commodity Insights.

Playing a crucial role within the recycling ecosystem, mechanical and chemical recycling are complementary enablers in the transition towards circularity

Chemical recycling such as pyrolysis, gasification, chemical depolymerization, catalytic cracking, reforming and hydrogenation can convert plastic waste into chemicals. These technologies can produce feedstocks that can in turn be used to make virgin polymers.

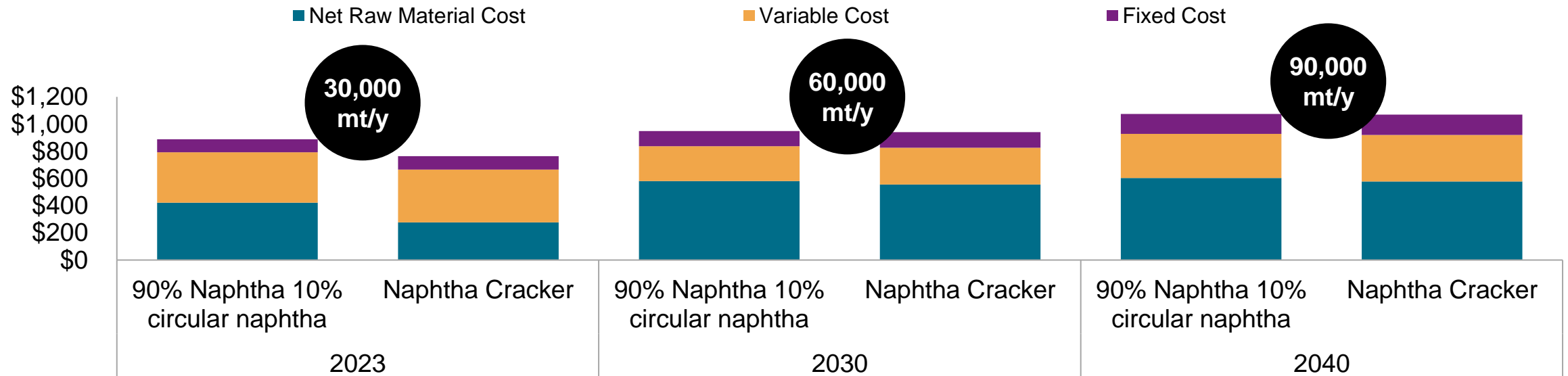
Linear economy versus circular economy



As of Sept. 22, 2023.
Sources: S&P Global Commodity Insights, PEP Solvent Based Recycling of Waste Plastics.
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Economies of scale benefits direct and indirect costs

Cash cost production of ethylene in Europe (USD/ton)



- Economies of scale improves with technology learning rate, thus benefits direct and indirect costs.
- Scalability of pyrolysis plants and waste availability are key factors to maintain a healthy circular naphtha/naphtha ratio.
- Combination of these factors in the long run gives a better cost level of circular naphtha, closing the cost gap with conventional naphtha.

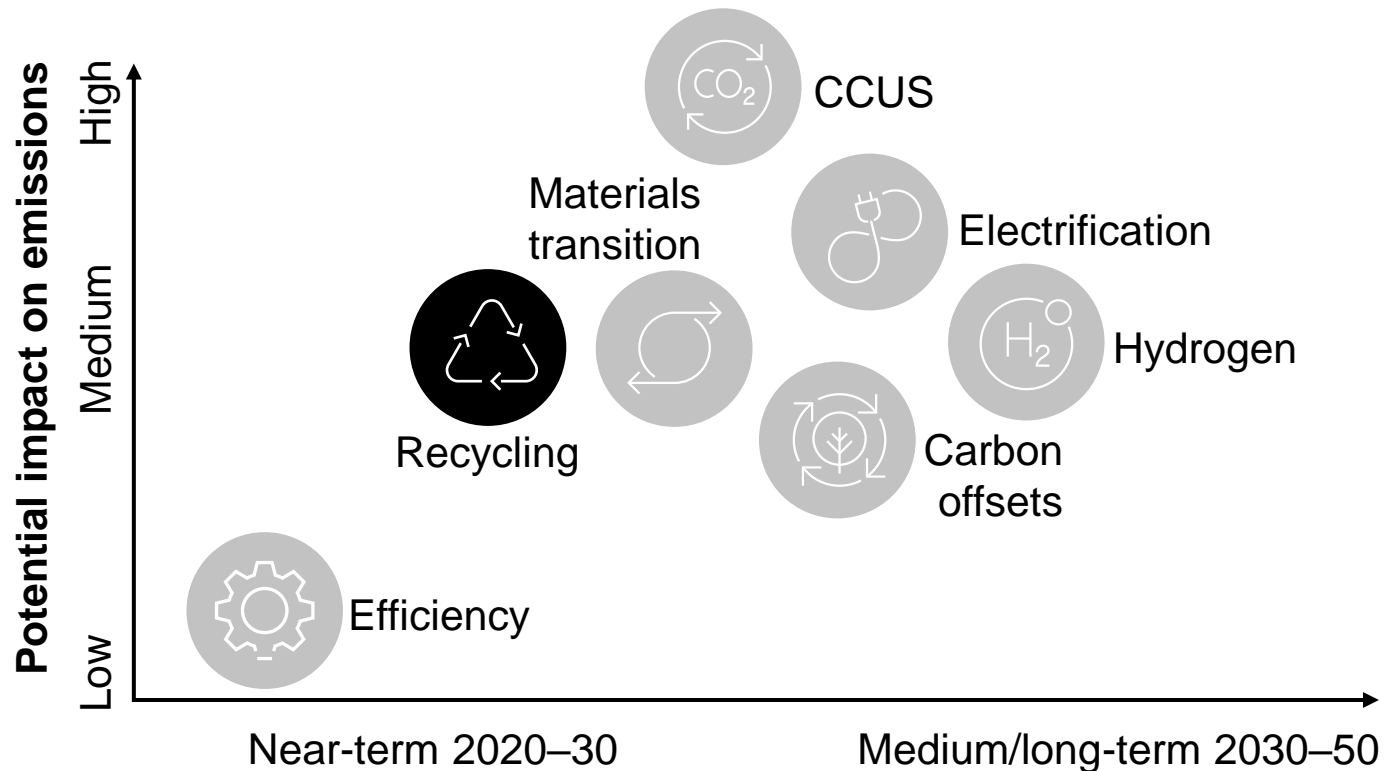
Data compiled: Oct 2023
Source: S&P Global Commodity Insights

Carbon intensity overview

An overview of GHG pledges and how transiting to a circular economy contributes to a lower GHG emissions overall

Recycling will be one of several routes to reduce emissions

Enablers of the Energy Transition

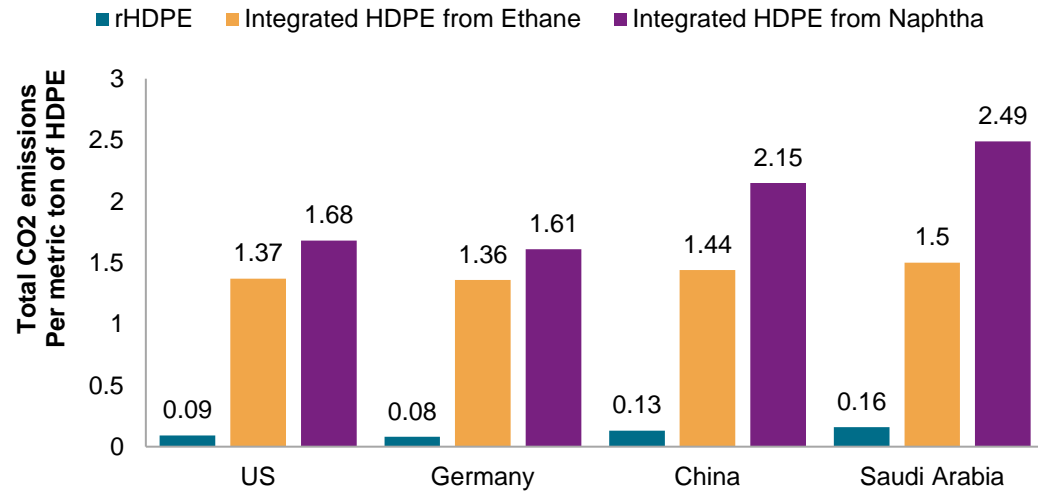


How can achieving circularity support carbon intensity reduction?

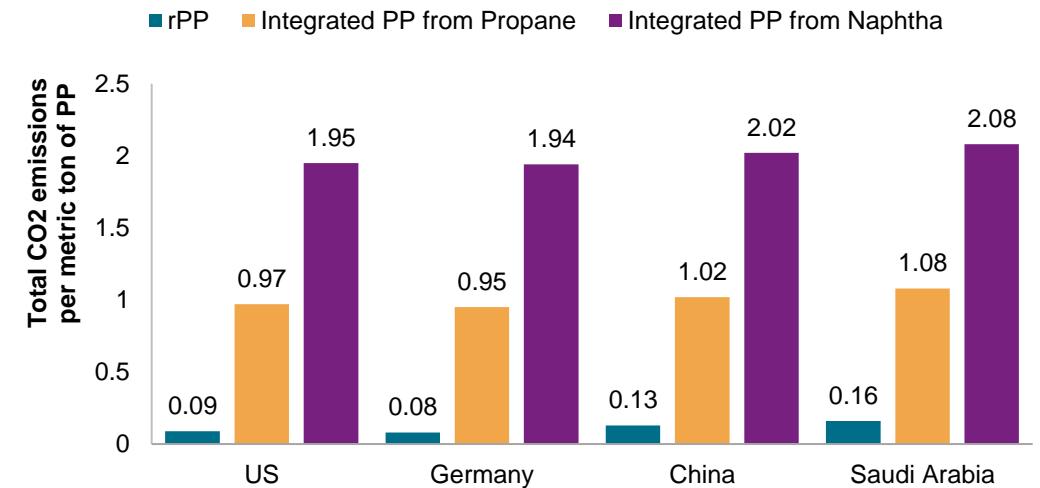
- Divert waste away from landfill
- Streamline material selection
- Enhanced carbon circularity
- Demand creation for new materials

Carbon intensity of mechanically recycled polymers can further promote additional sustainability commitments of companies looking to reduce overall scope emissions

Carbon footprint of mechanically recycled rHDPE vs prime HDPE



Carbon footprint of mechanically recycled rPP vs prime PP

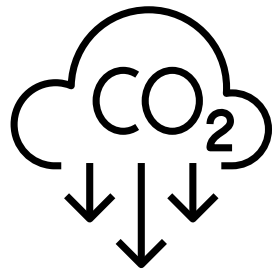
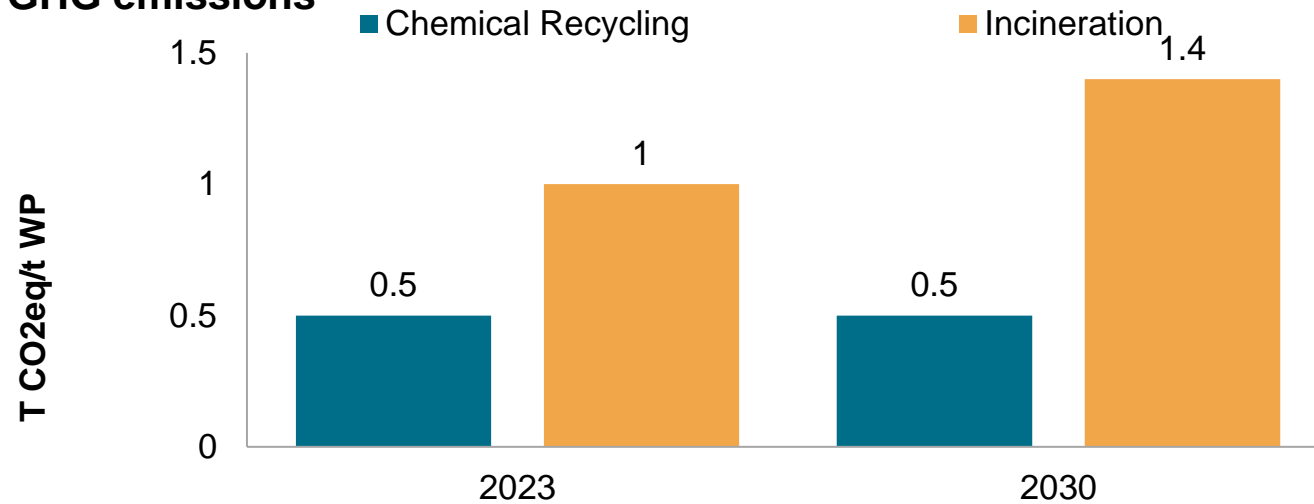


- A significant reduction in carbon emissions is achieved when comparing the emissions produced by the mechanical recycling process of HDPE and PP against the production of this same polymers by conventional means^{1,2} by approximately 15 – 20 times.
- Total emissions include the following as defined:
 - Scope 1: Process emissions
 - Scope 2: Electricity emissions
- Mechanical recycling’s advantage relies on avoiding emissions via fuel and complex process technologies which involves high energy intensity resulting in increased emissions. (Scope 1)

Data compiled: Oct 2023
 1 Integrated: Includes Unipol PE in addition to ethylene via ethane steam cracking or naphtha Coolbrook process.
 2 Integrated: Includes Unipol PP in addition to propylene via Naphtha steam cracking or STAR PDH.
 Source: S&P Global Commodity Insights

Carbon intensity: Chemical recycling

GHG emissions



Analysis of chemical recycling emissions consider the following steps:

- Preprocessing
- Liquefaction
- Upgrading
- Refining of waste plastic into drop-in feed

From a carbon footprint standpoint, chemical recycling presents an alternative against emissions generated by incineration.

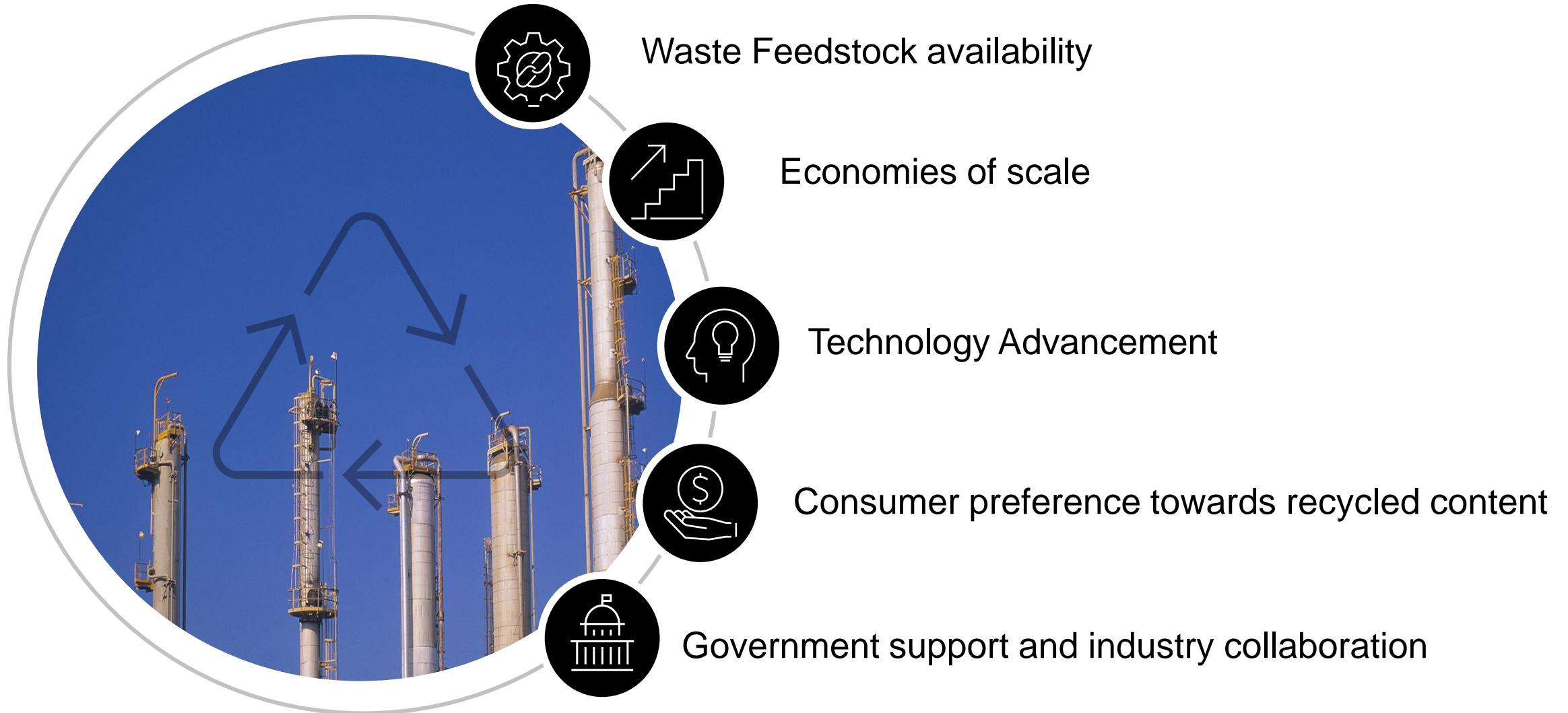
Data compiled: Oct 2023
Source: S&P Global Commodity Insights and research from Neste.



While all members of the value chain are motivated to move towards circularity, each participant will be driven by their own unique challenges and opportunities

Consumer	<ul style="list-style-type: none">• Safe and good quality product that is affordable and convenient whilst supporting an effort to improve the environment
Waste management	<ul style="list-style-type: none">• Monetize waste management companies' “waste” product, while increasing their supply and capability to meet downstream customer needs – e.g., well segregated materials, downstream integrated processing to supply a more valuable and consistent product, etc.
Technology	<ul style="list-style-type: none">• Consistent quantity and quality of recyclable plastic, build new plants with increasing capacity to reach required scale while increasing the flexibility of processing hard to sort post-consumer plastics.
Resin producers	<ul style="list-style-type: none">• Increasing quantity and consistent quality feedstock with an ability to meet ESG commitments with existing operations/infrastructure.
Converters	<ul style="list-style-type: none">• The middleman trying to meet the needs of the brand owners, converters will need increased quantity and consistent raw materials to deliver safe, food contact applicable, flexible / rigid packaging material.
Brand owners	<ul style="list-style-type: none">• Public relations to support brand owners' increasing sales, consistent quality and available quantity to meet stated environmental packaging requirements and company commitments.
Financing / Facilitation	<ul style="list-style-type: none">• Financing in many forms, from private equity looking for a profitable, environmentally focused investment to governments and nongovernmental organizations focused on funding plastics circularity.• Facilitation is required to coordinate a connection with various parties to set up necessary agreements to meet each participants' needs and/or to form ventures or new businesses to manage operations.

Circularity... key requirements



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