McKinsey & Company

Accelerating ESG journey for Chemical players

ICPE –
International Conference on Plastics & Sustainability

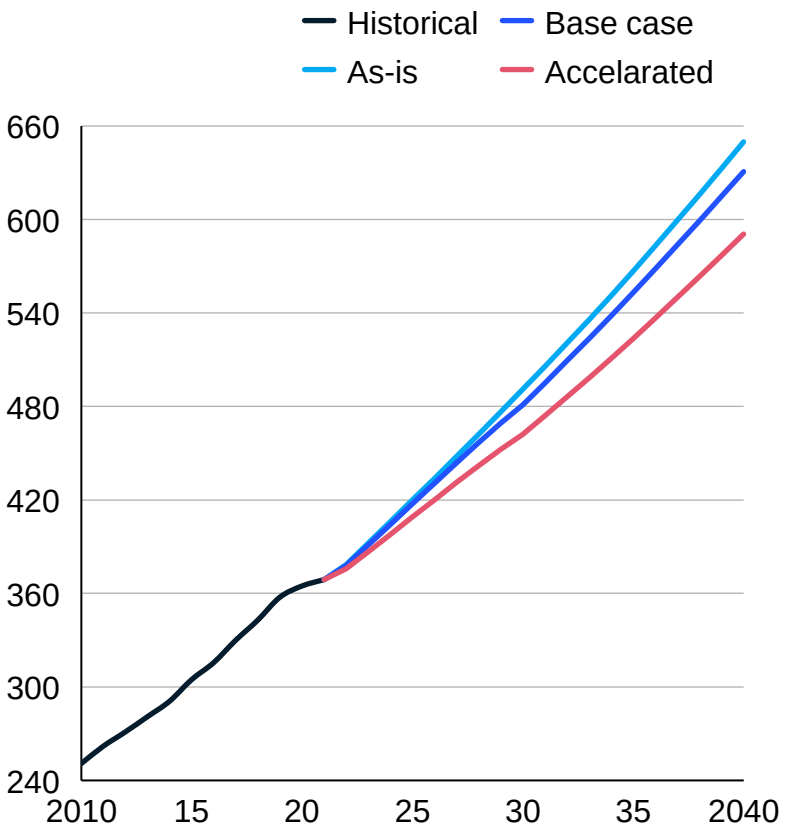
February 2023

PetroChemicals have shown strong historic growth and a significant profit pool

Petrochemicals have shown a very robust historical growth of ~1.3x GDP, going forward expect demand growth ~0.8-1.1x GDP

Figures to be updated

Petrochemical demand by scenario[1], MTA



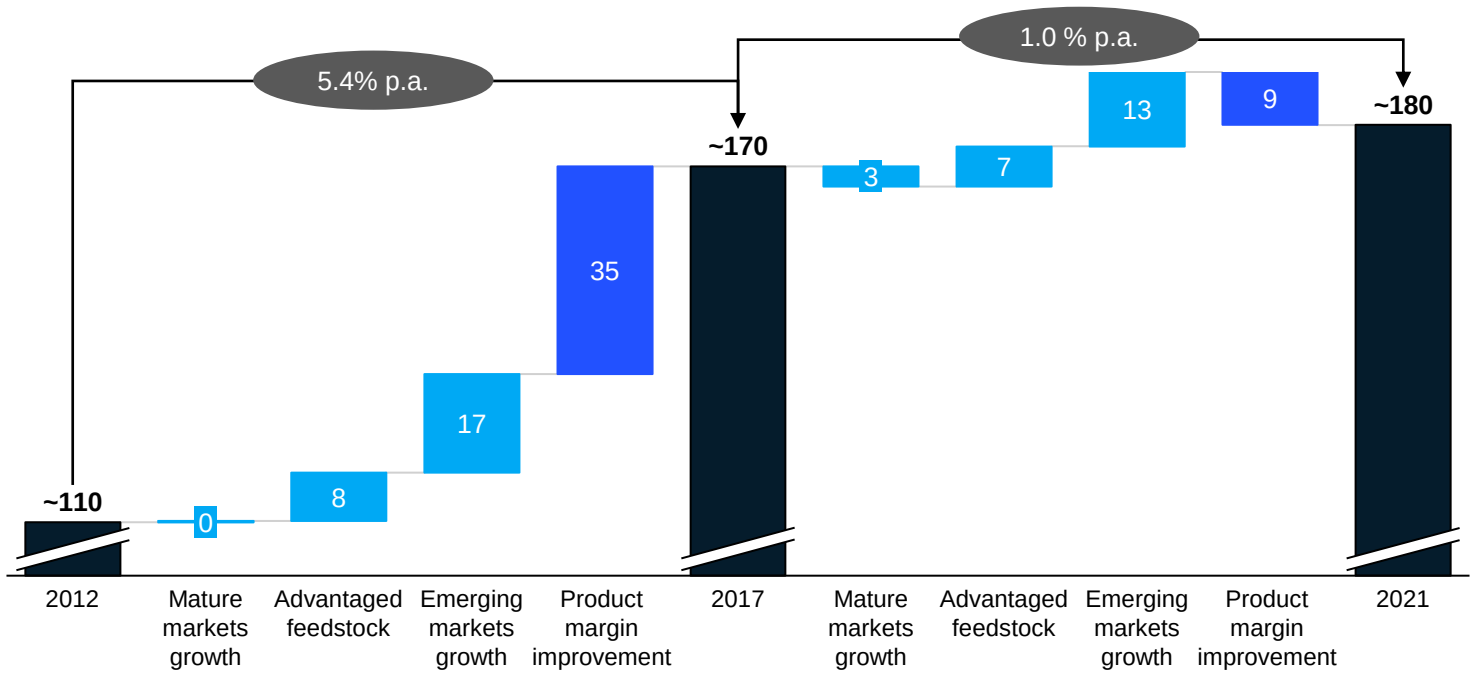
Scenarios	2040 Volume (MTA)	GDP multiple	CAGR 21-40	Demand pressures	Key drivers of demand
Historical (2010-2021)		~1.3x			Rapid rise in single-use plastic for packaging China emerged as a demand center with growth >2x global GDP
As-is	~650	1.1x	3.0%	Reduction, elimination	Demand generation in emerging markets, increasing imports in Southeast Asia, India and Africa Decreasing demand in fast-moving plastics partially offset by demand for structural / rigid plastics
Base case	~630	~1	2.8%	Reduction, elimination Substitution Packaging simplification Recycle & Reuse	
Accelerated	~590	0.8-0.9	2.5%	Increasing substitution, refilling and downgauging levers to absolute limit to meet sustainability push	

1. Demand for polymers includes – HDPE, LLDPE, LDPE, PP, PS, EPS, PVC, PET, Polyester fiber, PA6, PA66 and PC

Source: CI demand, IHSM

Petrochemical industry profit pool was growing significantly in the past 10+ years

Petrochemicals industry profit pool EBITDA[1,2] ,USD bn



1. Includes the 37 biggest chemical across the chemical value chains. Does not include the products which are made as the co-product from other route (stream cracker, refining operations) 2 Main products by value chain are – C1: Methanol and Acetic acid; C2: Ethylene, PE, MEG, PVC and intermediates; C3: on-purpose Propylene, PP, PO/PG, ACN, AA; C4: Butadiene, ABS, MMA, PBR; C6: on-purpose Benzene, styrene, Cumene, PS, Nylon 6 , Nylon 6,6, PC, PET, MX, PX, TDI and Phenol

Source: McKinsey Chemical Insight, IHS, ICIS, McKinsey analysis

Advantaged feedstock – e.g., new projects in ethylene based in NA and ME

Emerging market growth – across all petrochemicals (CE, SA, Africa, India, SEA and China)

Margin pool – Driven by steep industry cost curve and occasional market tightness, margin has improved (on average across regions and chemicals)

GHG emissions and plastic waste put PetChem under pressure

Plastics use is subject to pressure, particularly in packaging

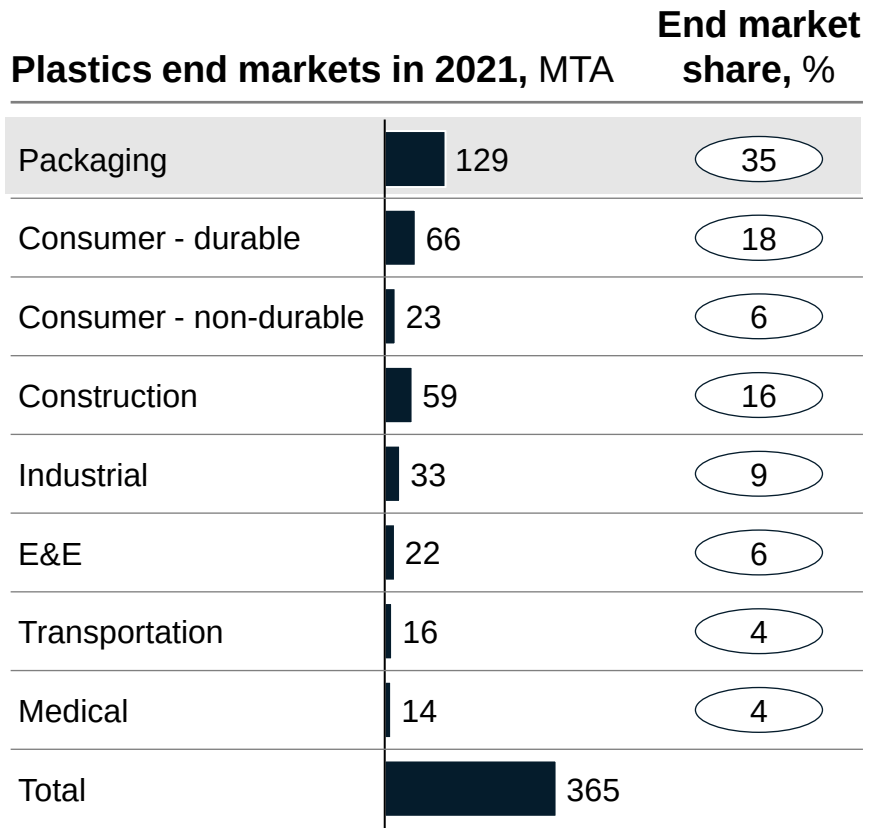
Most evident headwinds today

Rapid rise of fast-moving applications has led to **post-consumption waste problem**

Many (100+) countries responding to plastic waste with various **regulatory measures,** primarily targeting packaging**:**

- Limitation of use (bans)
- Change of packaging design (reduce the overall amount of new material used to produce one container)
- Recycling and reuse (use recyclable materials)

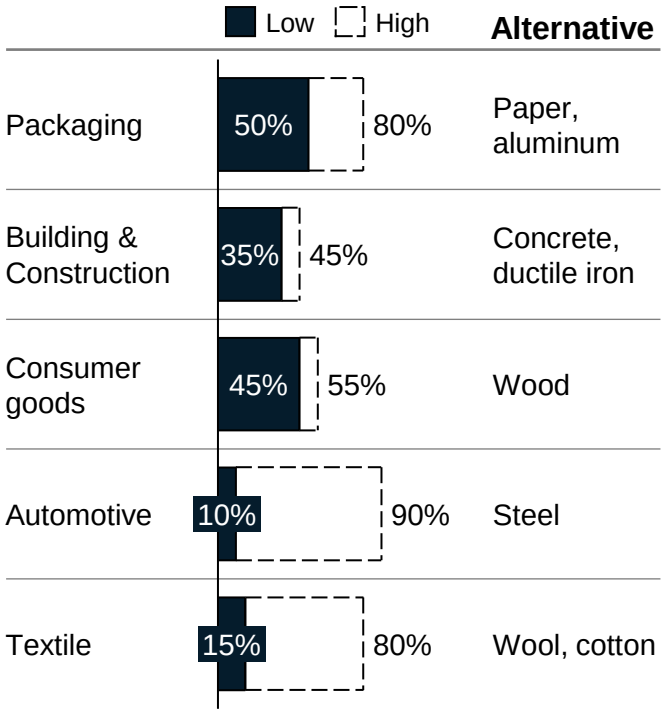
Plastics are exposed to diverse group of end markets – not only packaging



Plastics' many benefits suggest strong continued use, but also push for decarbonization

Plastics have often lower GHG emission footprints than alternatives
(incl. in packaging applications)

GHG emissions
(above plastic), %

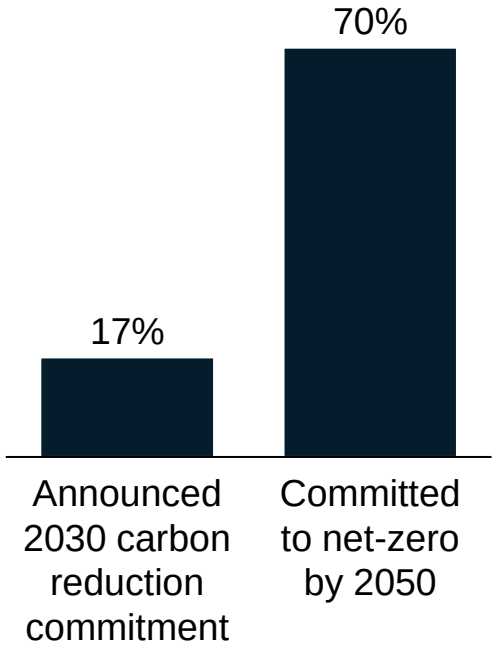


To maintain plastics competitive advantage, industry should further decarbonize
(and work on reducing waste)

- Given lower GHG profile, plastics will continue to have significant use across broad sectors
- The benefits to health and safety (e.g., food spoilage, sanitation, medical usage) of plastics cannot be ignored – or replaced
- However, with slow circularity buildout, waste continues being a concern
- **Petrochemical companies** should **focus on decarbonizing** plastic and **address waste problem** to maintain plastics value proposition

Companies are already acting on decarbonization

% of top 100 petrochemicals companies who have:



Selective decarbonization measures NPV positive – but often dependent on CO2 price

Example of MACC for decarbonization

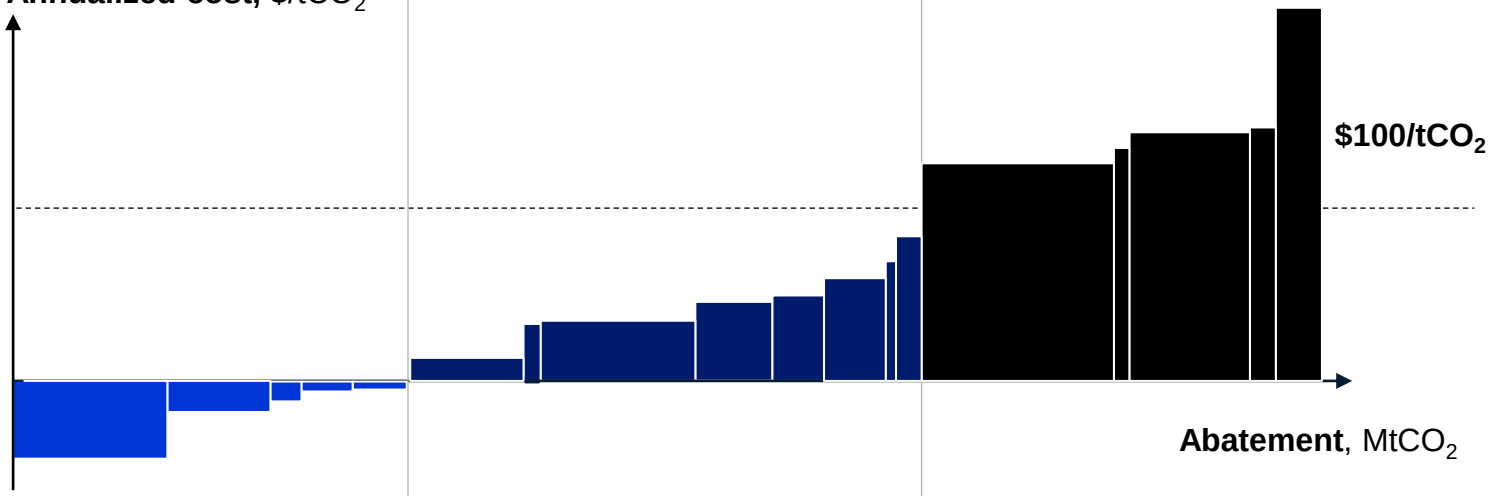
Illustrative

No regrets - immediate

Near-term bets

Long-term bets

May require near-term action



NPV-positive today

Improve equipment energy efficiency

Use green feedstocks with committed customer premiums

NPV positive dependent on CO_2 price

Source renewable electricity - requires **modest expectations of future CO_2 price** (~$100/tCO$_2$)

Not yet NPV positive

Replace natural gas with low-carbon hydrogen - requires expectations of **significantly higher CO_2 price**

Fully decarbonized products with **price premium or external funding**

Timing of decarbonization efforts will differ by region

Europe:

- Full decarbonization rolling out under current trajectory
- Small plants likely uneconomical to decarbonize

NA:

- Potential for bifurcation with liquid crackers more incentivized to decarbonize for use with pyrolysis oil
- Decarbonized plants to fulfill export to Europe

Asia:

- Barring significant shifts in regulation, unlikely to decarbonize significantly by 2040

Investments slightly leading regulation changes may capture higher value

Most investments require finite renewable resources (e.g., feedstock, electricity, carbon storage) with **competition from other heavy industries** decarbonizing more quickly (e.g., steel) – **players may need to act quickly, or risk being left out**

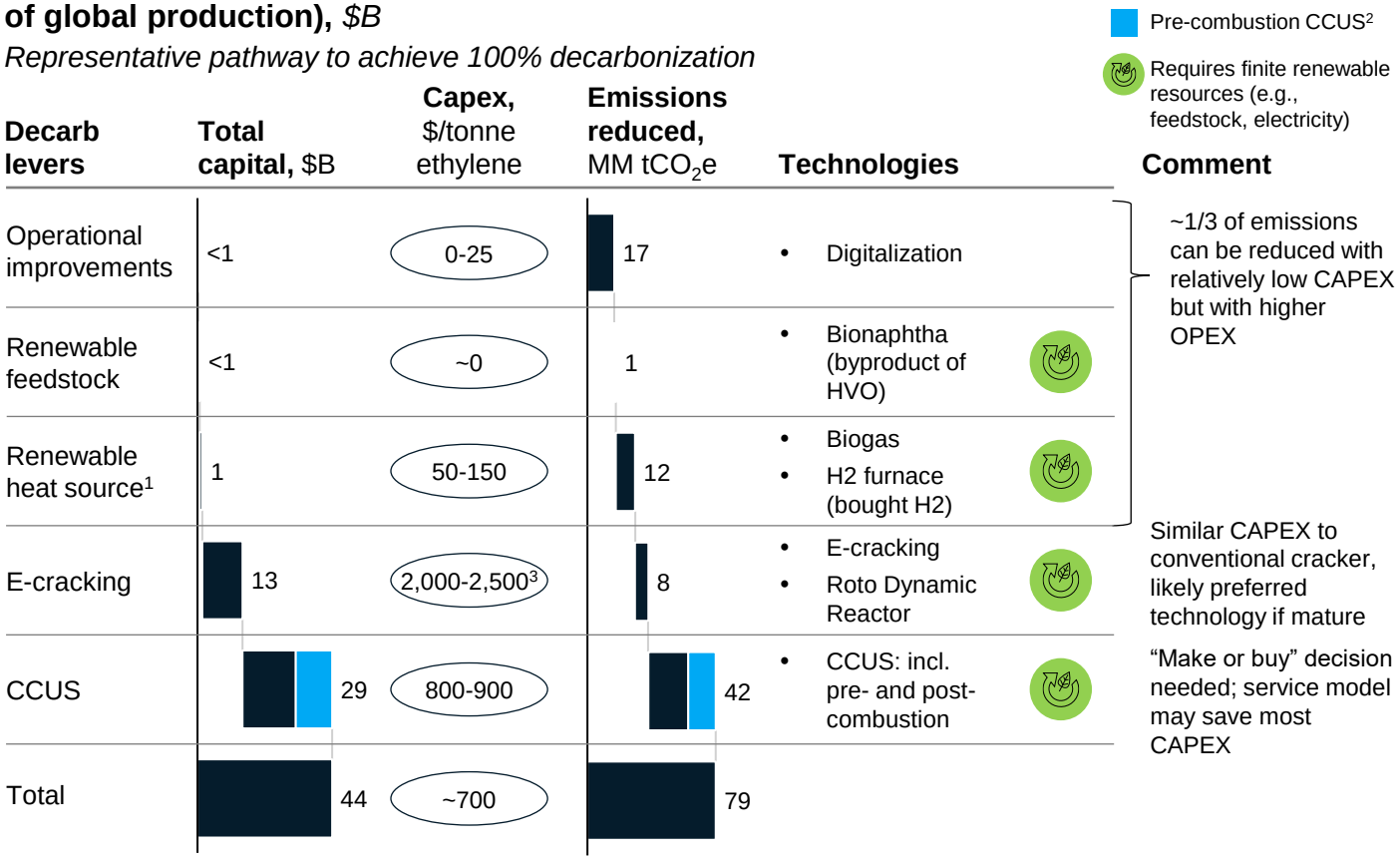
Source: McKinsey Sustainability Insights Strategy Analytics

Decarbonization cost for petrochemical companies can be paid for by tapping into value creation areas

Multiple technologies to decarbonize, some requiring significant capex…

Capital needed to decarbonize ethylene production in NA & WE (~33% of global production), *$B*

Representative pathway to achieve 100% decarbonization



… investment could return capital through four mechanisms

Energy efficiency and throughput improvement

0-20% of decarb from NPV positive projects today

Carbon price avoidance

Up to 70% decarbonization NPV positive with $100/tonne CO_2 price – more at higher CO_2 price

Non-decarbonized CO_2 cost baked into product price

Subsidies and government incentives

Direct subsidies, tax incentives, and/or grants expected to offset remaining capex

Low-carbon price premium

Low-carbon premium expected to pay for remaining decarbonization in some (but not all) plants

1. Incl. electrifying crackers with renewable energy, switching fuel to sustainable options like hydrogen or biogas
2. Pre-combustion CCUS incl. blue hydrogen, gasification of coal, etc.
3. CAPEX to build a e-cracker greenfield, current estimated at 1.5 MM Euro/MW electricity or ~$500/ton ethylene for the furnace

Source: CARB, McKinsey Chemical Insights & McKinsey Sustainability Insights Strategy Analytics

Sustainable products and energy transition can expand overall value creation in petrochemicals

Preliminary

Associated most closely with Energy Transition

GHG emissions and abatement actions

Sector emissions, Gt CO_2e, BTA (2020)		Actions
Power	19	Renewable power requirements
Industry	10	Greener products, emissions reduction, process optimization
Transport	8	Renewable fuels standards and electrical vehicles
Buildings	4	Policies for low carbon construction materials
Agriculture	6	Soil management as a carbon sink
Waste	3	Landfill methane capture and CCS at energy-from-waste

Opportunity for the petchem industry to capture value

EV

Innovation in **components** and **battery case** plus further **vehicle light weighting** are expected to increase demand for polyamides

- **EV contains** on average **18kg** of **PA6/PA66** versus 8kg for ICE vehicle

Clean energy

As **clean energy (solar, wind)** use proliferates, demands for chemicals in these applications are expected to increase

Between 2020 and 2040,

- **EVA demand** from solar will increase from **300 to 4600 KTA**
- **Epoxy demand** from wind will increase from **100 to 1100 KTA**

Hydrogen

Replace carbon-intensive feedstock or fuel with green (or blue) hydrogen

- **Net-zero crackers** using hydrogen as heat source
- **Methanol** production using hydrogen and captured carbon (and potential derivatives)

Ammonia

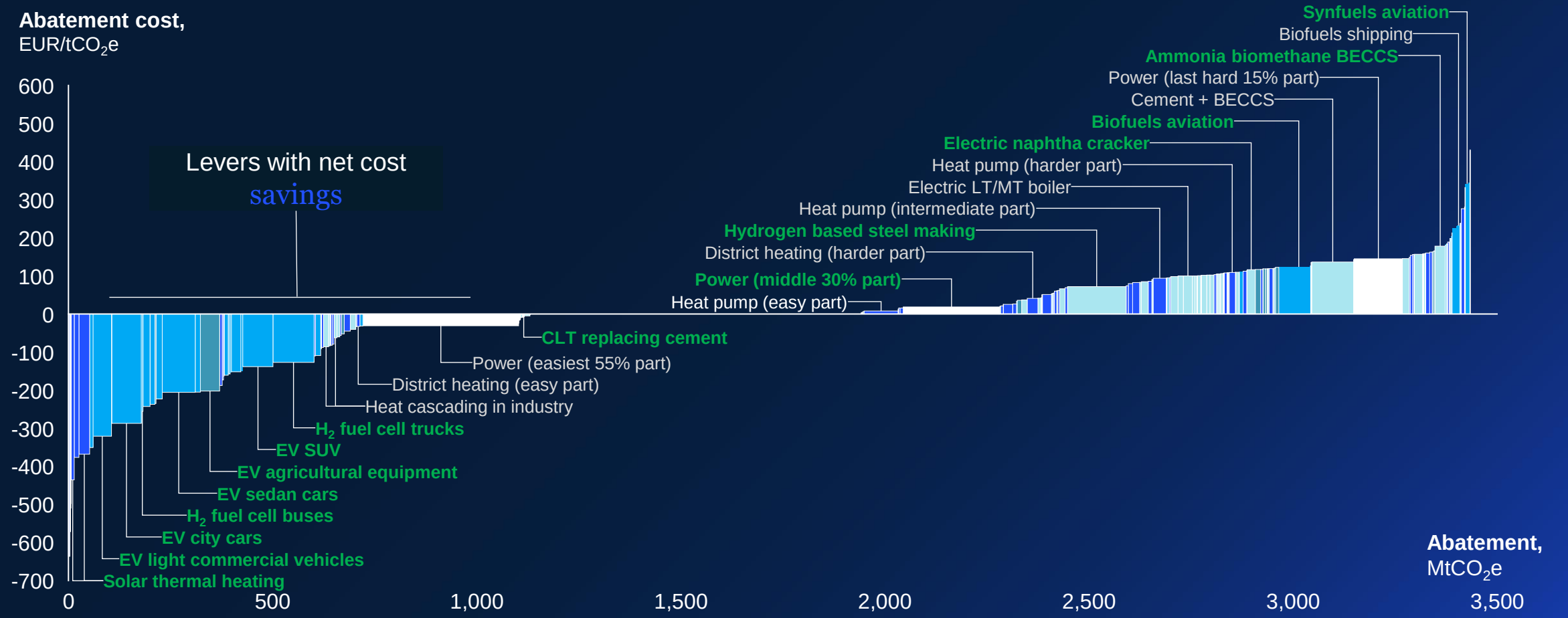
Produce green (or blue) ammonia

- Use ammonia **as hydrogen carrier**
- Supply ammonia to customers to produce **low-carbon fertilizer**

Source: Company information, Cone Communications, Morgan Stanley, Global Energy Perspective, Climate Trace

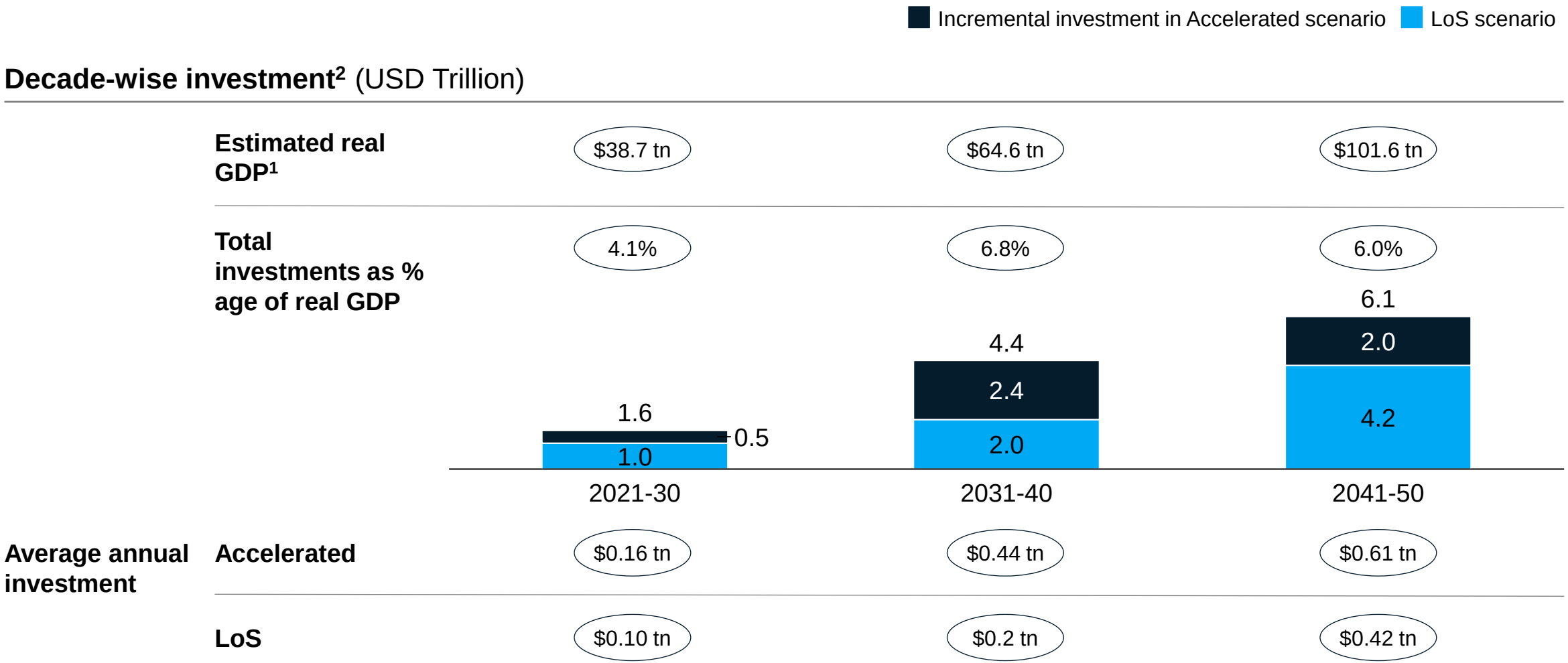
Chemicals critical for carbon abatement

2050 EU abatement curve – pathway to climate neutrality



Source: McKinsey

Investment of $12 trillion is required for India's decarbonization – creating a huge opportunity for chemical players



1. EUI data used for GDP forecast
2. Capex calculations derived from bottom-up models for power, steel, cement, other industries, transport, agriculture, NBS, CCUS, hydrogen and material circularity

ESG score yet to improve for Indian chemical player

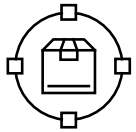
ESG is the lens to rate sustainability level of companies…

Not exhaustive

Sustainability

Waste/ water management
Climate strategy
Decarbonization

Environmental



Sustainable supply chain
Welfare policies
Philanthropic actions

Social

Board diversity
Executive remuneration
Controversies management

Governance

ESG is the lens used by investors' to read sustainability by analyzing 3 dimensions: Environmental, Social & Governance

Indian chemical companies sometimes lag their global peers in ESG performance

Above peer average — Below peer average

		Indian companies						Global companies						
		Comp 1	Comp 2	Comp 3	Comp 4	Comp 5	Avg. top 10	Comp 1	Comp 2	Comp 3	Comp 4	Comp 5	Avg. top 10	Avg. top 50
Environmental	**Climate strategy**	42	42	45	40	54	24	93	84	90	90	80	81	50
	Water-related risks	74	25	0	25	25	15	100	100	100	100	70	86	30
	Operation eco-efficiency	83	77	29	58	57	37	78	67	73	52	67	59	40
Social	**Product stewardship**	89	53	0	33	57	28	96	92	86	89	63	77	34
	Human capital development	77	73	28	60	71	43	88	89	74	68	70	76	42
	Customer relationship management	73	55	8	100	100	34	0	90	90	76	100	79	28
	Occupational health & safety	30	21	32	22	30	15	54	65	46	61	78	47	26
Governance & Economics	**Codes of business conduct**	92	88	52	65	72	55	98	94	82	86	89	82	52
	Innovation management	74	50	4	29	62	24	100	87	84	80	99	78	24
Overall ESG score		66	54	27	43	53	32	82	77	75	77	74	70	38

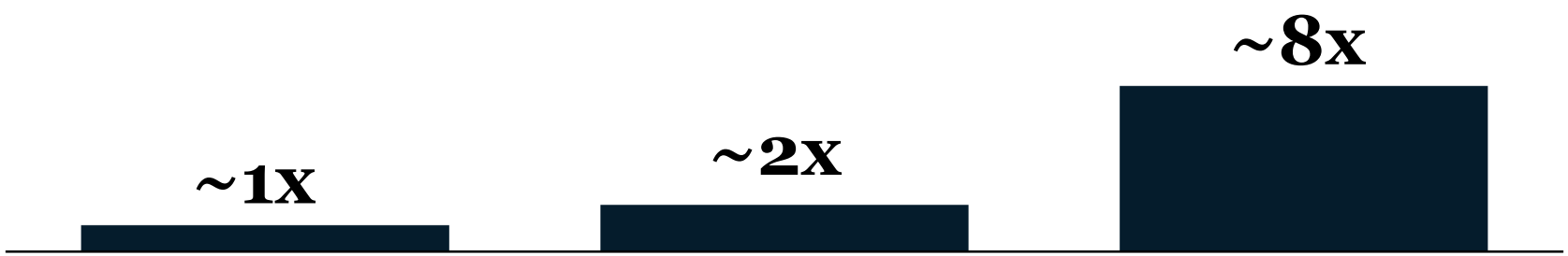
Top 50 Indian and global companies on market capitalization taken; S&P ESG data was only available for 10 of 50 Indian companies and 43 of 50 global companies.
Note: Comp stands for Company

Source: S&P 2021, https://www.spglobal.com/esg/solutions/data-intelligence-esg-scores

Chemical companies with exposure to sustainability tailwinds also command premium

Preliminary

Median EV / revenue for representative pure play companies



Sustainability HEADWINDS	NEUTRAL	Sustainability TAILWINDS
• Oil & gas	• Consumer	• EVs, energy storage
• Single-use plastics	• Infrastructure	• Water reduction
• ICE automotive	• Automotive	• Bio-based consumer products
• Guns, ammunition, tobacco	• Electronics	• Energy efficiency
• Chemicals w/ increasing regulation	• Food	• Renewable energy, fuels, feedstocks
	• Ag	• Natural ingredients
	• General packaging	• Carbon capture
	• Industrial	• Circular packaging
	• Bio-based industrial intermediates	
	• Healthcare	

Exposure to sustainability tailwinds commands premium. Investors assign premium for sales that enable end markets and are not solely focused on the sustainability of the chemicals sold

Outsized valuation benefit given to sustainability tailwinds. Investors assigning asymmetric benefit to sustainability tailwinds as opposed to the penalty assigned to sustainability-headwind markets

Most companies will have a mix of revenue tied to these categories. It is important to consider the composition of a company's end market alignment. Companies will receive a boost in value from portion of end market revenue aligned to sustainability tailwinds

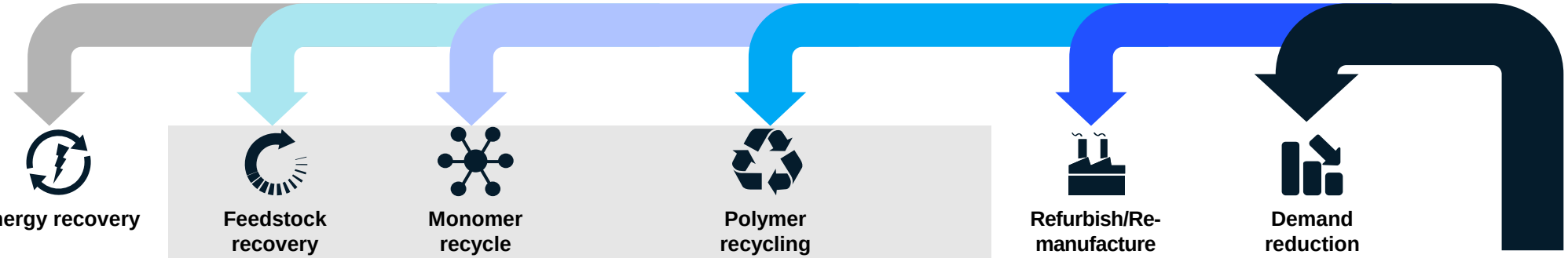
Source: Company investor presentations, Corporate Performance Analytics™, a McKinsey Solution

Circularity as an opportunity

9+ million tons of plastic waste is dumped in our water ways each year creating on ocean of plastic

Differentiated value chain impact, with mechanical decreasing upstream demand and pyrolysis requiring conventional capacity

Plastic recycling



Recovery type	Energy recovery	Feedstock recovery	Monomer recycle	Polymer recycling	Refurbish/Re-manufacture	Demand reduction
Process type	Incineration	Thermal (Pyrolysis/ gasification)	Chemical (hydrolysis/ hydrocracking)	Mechanical or chemical (solvent-based)	Dis-assembly / re-assembly	
Product chain	Energy	Feedstock	Monomer	Polymers	Compounds	End product → USAGE → Disposed product
Volume recycled in 2040, MTA		Recycle ~9 MTA PE by pyrolysis	Recycle ~0.85 MTA PET by solvolysis	Recycle ~16 MTA HDPE and ~8 MTA PET[2]		
Upstream volume impact in 2040, MTA		Displaces ~6 MTA (~1%) naphtha demand	Displaces ~0.6 MTA of PTA and ~0.2 MTA of MEG demand	Displaces demand for ~12 MTA of virgin PE (~6%) and ~6 MTA of virgin PET[2] (~7%)		
Value chain impacted		Liquid crackers modified to adapt to recycled feedstock (pyrolysis oil)	Virgin PET capacity modified to adapt to recycled monomer (e.g., BHET, DMT)	Upstream demand eliminated for ethylene (~13 MTA) and PX (~3 MTA)		

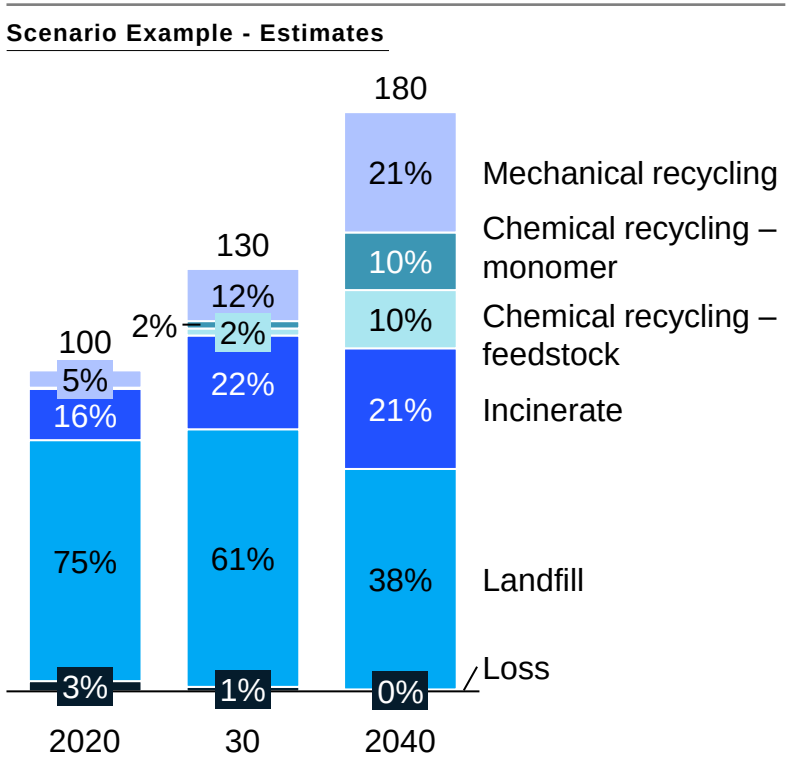
1. Base case scenario, China, NA and Europe in 2040
2. regardless of grade, e.g., bottle vs fiber

Source: McKinsey analysis

Circularity volumes, prices to shift as market develops; pockets of market attractive early on

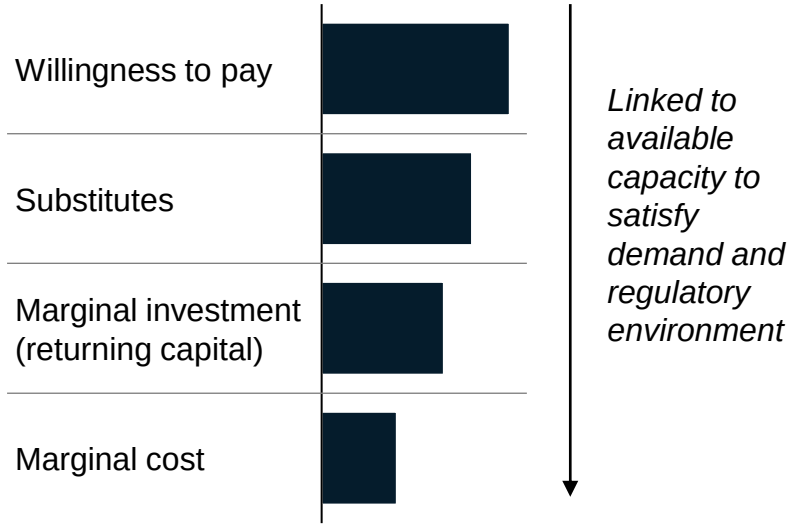
Volume increase: recycling may increase to **40% disposition of plastic waste by 2040**, resulting in **$30-55 Bn value pool**

Potential evolution of plastic waste
indexed to 2020



Price shift: As market matures, pricing may shift from customer willingness to pay toward cost of production

Price
$/t recycled product



If regulation rewards carbon reduction or recycling, substitute could be virgin plus monetary value of those factors

We expect plastic waste disposition to vary across regions, with Europe leading growth in recycling, followed by Northeast Asia (excl. China) and North America

Mechanical and chemical recycling are likely complementary solutions, enabling access to larger plastic waste volumes

Factors affecting trajectory include consumer behavior, technology development, brand owner pledges and regulation

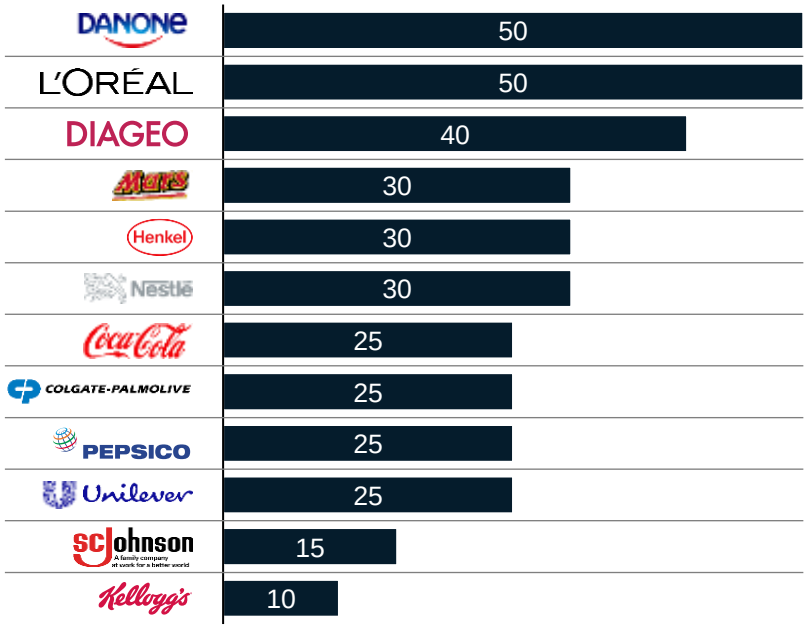
Value capture will vary over time – participating early may drive higher returns than entering late

Source: McKinsey plastic waste stream model

Circular will drive additional value in petrochemicals

Demand growth: driven by public commitments to include recycled content

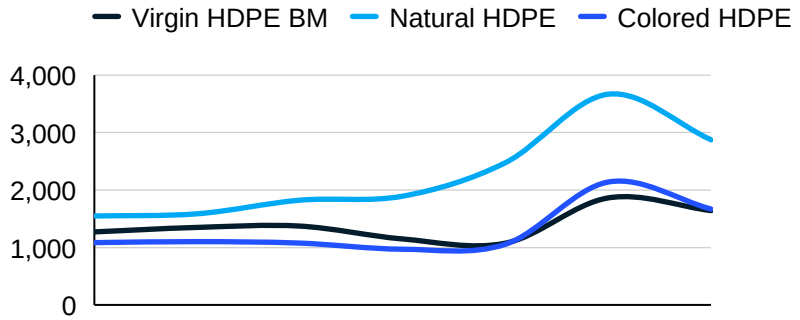
Recycled content pledge, %



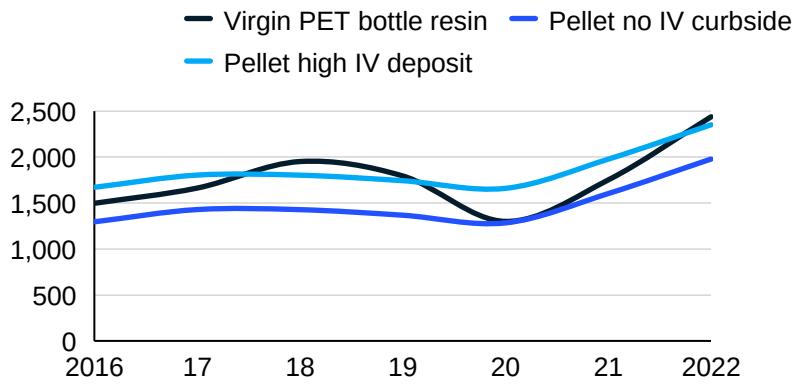
Legislation has incentivized recycling (e.g., EU 800 Euro/t tax on non-recycled material)

Premium pricing: pricing for high quality recycled material has exceeded virgin material

US recycled and virgin HDPE, $/tonne



US recycled and virgin PET, $/tonne



With these forces, companies need to participate – but key questions for investment:

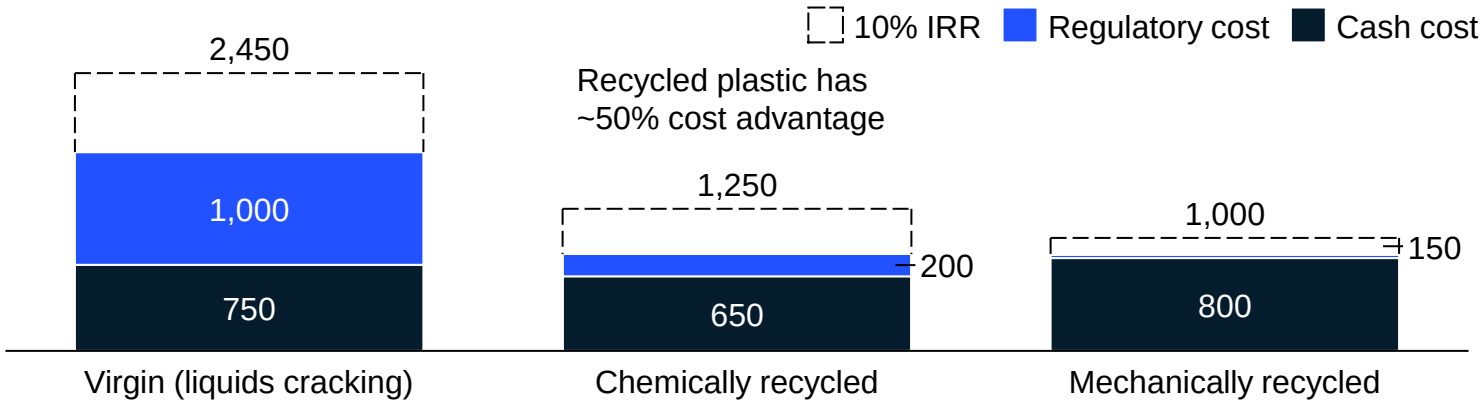
- When to participate
- Where to participate
- How to think about size vs. existing business

Further implications for conventional production (as circular grows, how will this affect need for conventional supply)

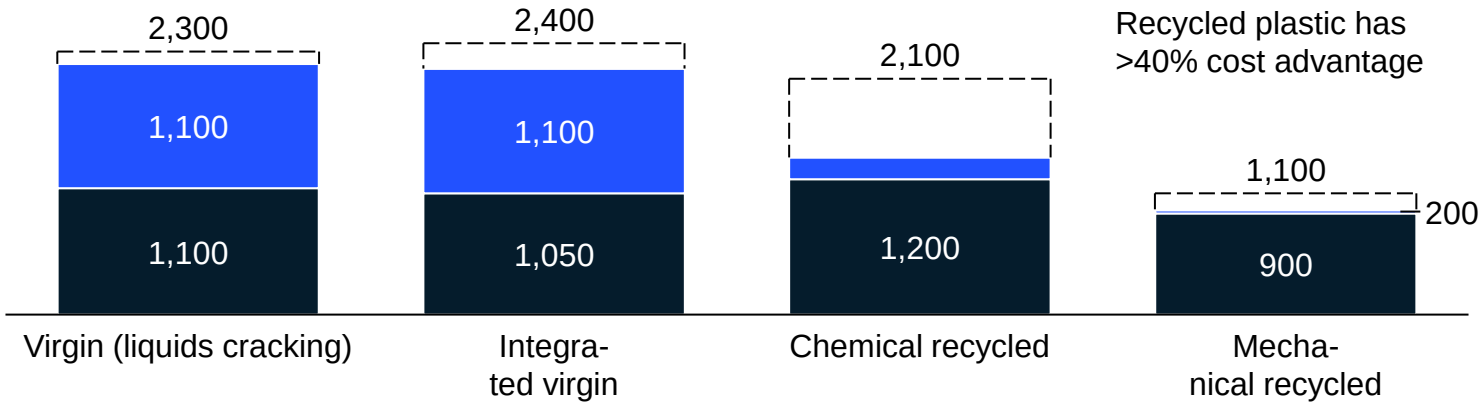
Source: Ellen MacArthur Foundation, OPIS

Today a recycling new build in Europe – with the strongest taxes & EPR schemes – returns capital faster than virgin

Full cost of PE in 2019[1] (including Tax & EPR applied in Europe)



Full cost of PET in 2019 (including Tax & EPR applied in Europe)



1. Crude oil price: ~$65/bbl, pre-COVID senario

Source: McKinsey Chemical Insights

Cost position supports further buildout of recycling in Europe, driven by:

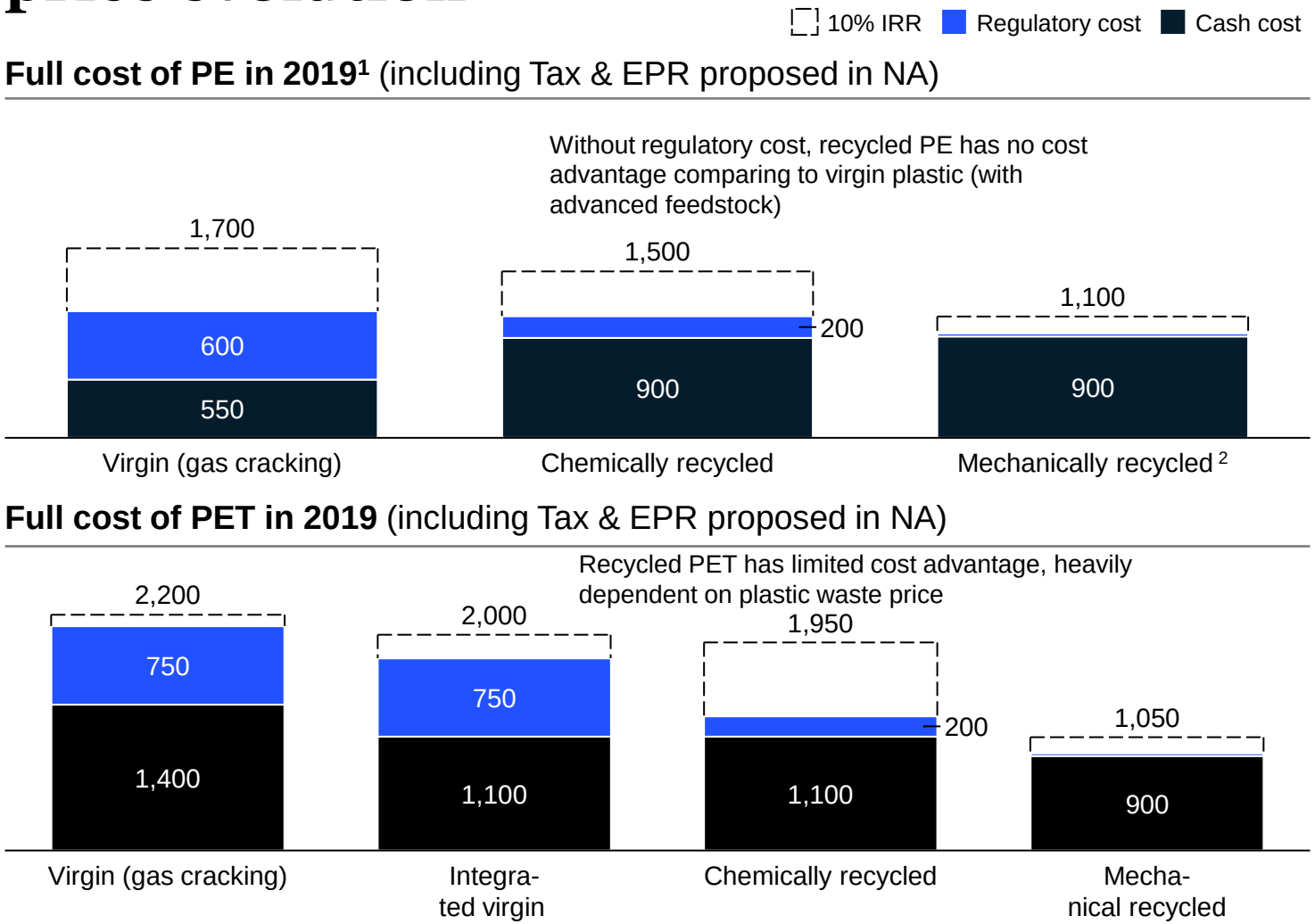
- Regulatory costs (e.g., carbon price, levy for non-recycled plastic)
- Low plastic waste price
- Premium for sustainable products

Value capture across the chain may evolve, including:

- Plastic waste price may increase as demand grows
- Green premium may decrease as recycled plastic supply buildout

Under a reasonable pricing regime, we **expect further build out of both chemical and mechanical recycling capacity in Europe**

In NA, recycling returns likely dependent on regulation and plastic waste price evolution



1. Crude oil price: ~$65/bbl, HH: $2.50/ mmBTU, pre-COVID scenario; waste PE & PET plastic bale price: ~$300

Source: McKinsey Chemical Insights

In NA, recycling unlikely to have significant cost advantage without regulatory support

PE:

- Virgin production likely to remain low-cost with advantaged feedstock
- Liquid crackers could consider adopting circular feedstock to benefit from green premiums

PET:

- Recycling profit relies on low plastic waste prices, may require regulatory support if plastic waste prices rise
- Asia profitability largely impacted by plastic waste price, economics likely to evolve based on waste infrastructure buildout

Significant recent activity in Advanced Recycling globally

Investment Activity	Polymer Types	Technical Maturity	Geographic Footprint	Example Participants
Significant activity since 2022[1]	**Polyethylene (PE) & Polypropylene (PP)**	Developing technology, commercial-scale announcements and builds	• Europe (primary) • North America • Northeast Asia	TotalEnergies, DOW, Shell, Chevron Phillips Chemical, Neste, SABIC, Honeywell, Braskem, Plastic Energy, ExxonMobil, MURA Technology, OMV
	Styrenic Polymers (PS)	Not fully commercialized, plans for initial pilot-scale investments / demonstrations	• Europe (primary) • Northeast Asia (primary) • North America	INEOS STYROLUTION, eni, Denka, TRINSEO, AmSty, agilyx
	PET (incl fiber)	Not fully commercialized, plans for initial pilot-scale investments / demonstrations	• Europe (primary) • North America	CARBIOS, INDORAMA, interzero zero waste solutions, EASTMAN, NextChem Maire Tecnimont for Energy Transition
	Polypropylene (PP) only	Only one primary technology licensor (PureCycle)	• Northeast Asia	PURECYCLE TECHNOLOGIES, SK innovation, Mitsui Chemicals Group
Limited activity	**Polyurethanes (PU)**	Technology under development	• Europe • Northeast Asia	EVONIK Leading Beyond Chemistry, covestro, Microwave Chemical

1. As of September 2022

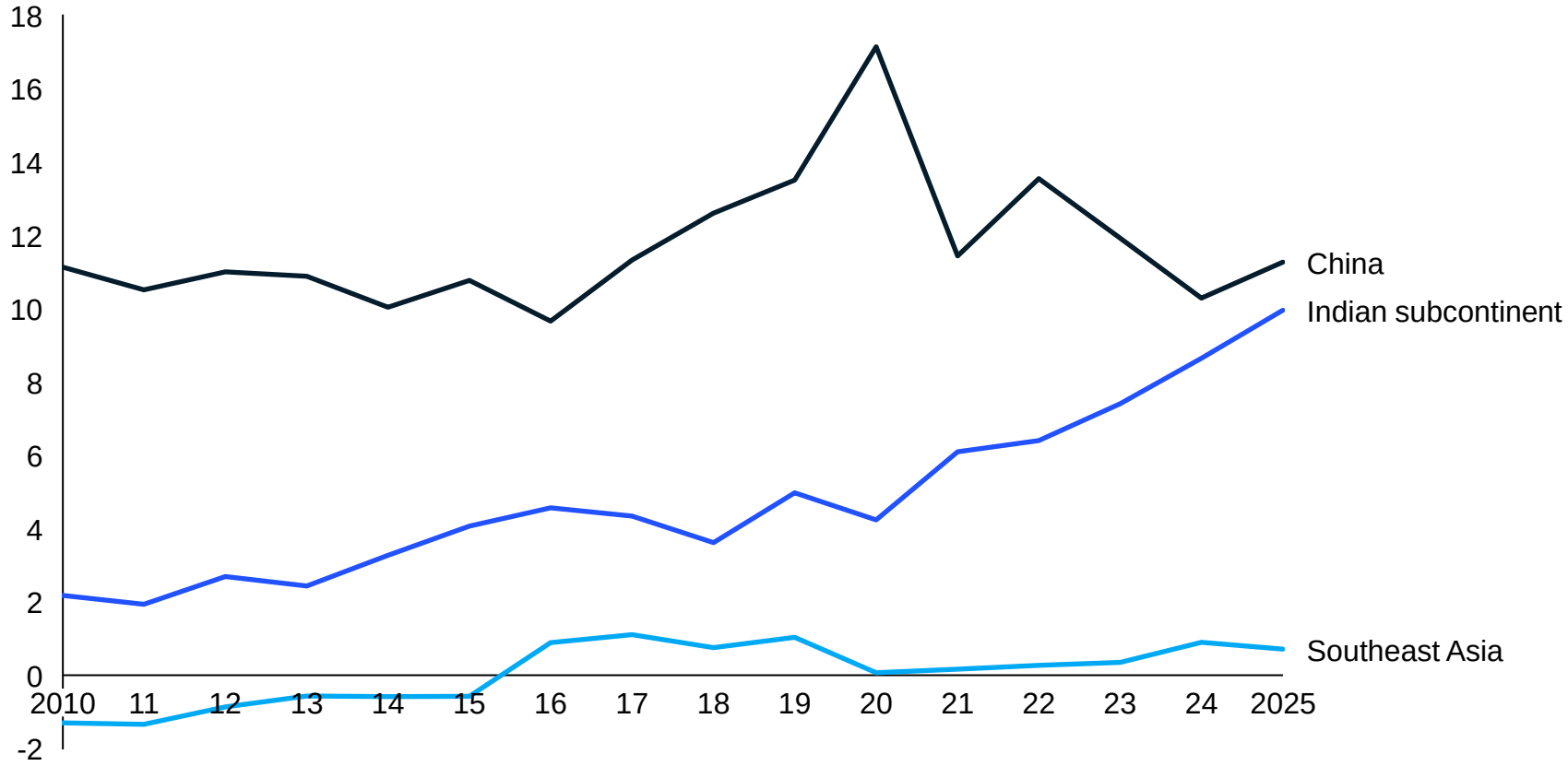
Source: Press Search

Geopolitics

Regional self-sufficiency replacing highest global productivity

Near-term, India will become an increasingly important import destination as China imports decrease

Net polymer imports, MTA



Rising demand in India, with minimal supply additions

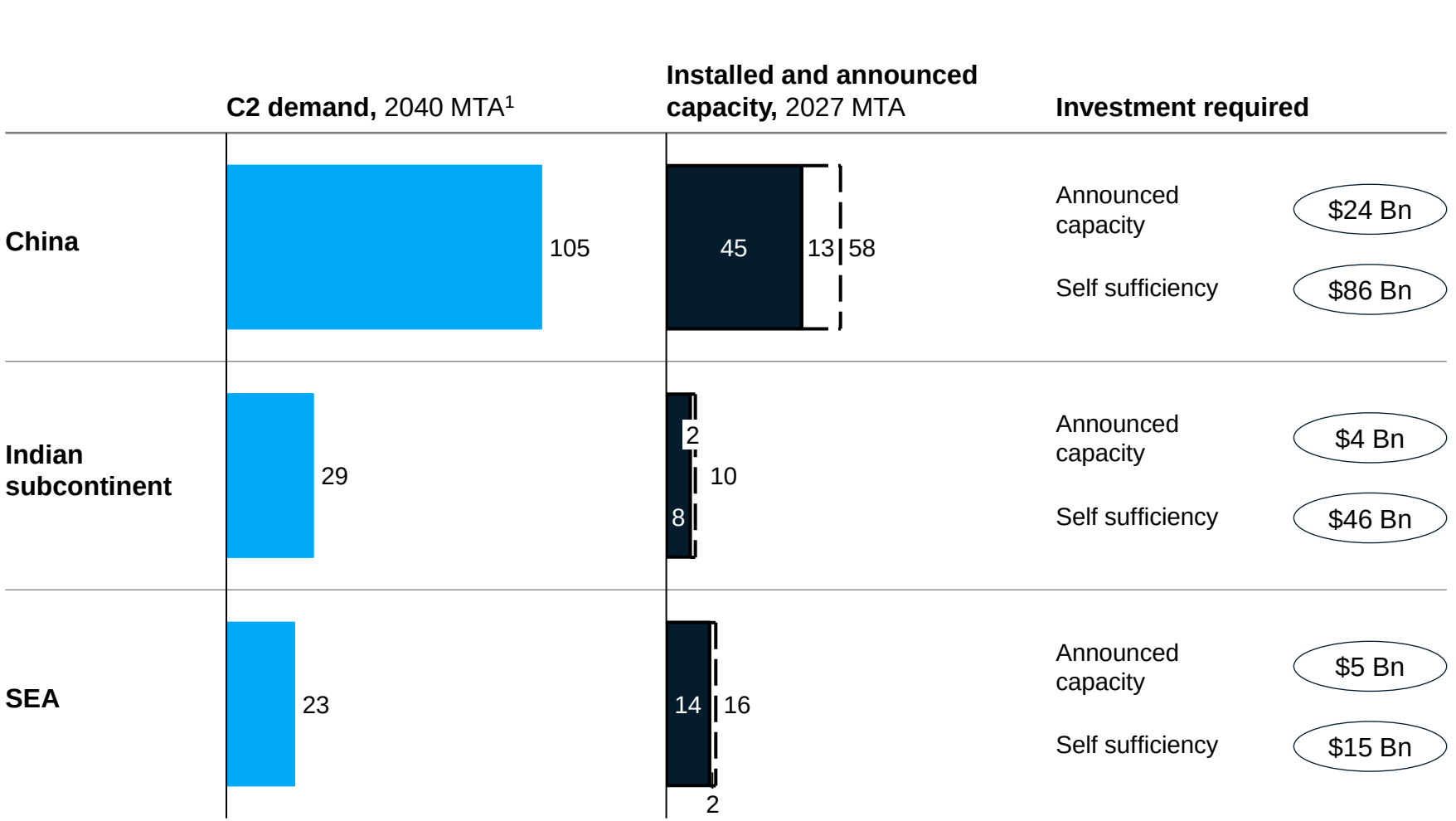
Companies should look to **expand commercial presence in India**

SEA likely to remain regionally balanced

China import volumes expected to decline over the next few years, close to pre-2015 levels, **potential for further decline** as China pushes towards self-sufficiency

Source: IHS 2022 Edition: Spring 2022 Update

Potential further decline in exports to China with continued push towards self-sufficiency in C2 chain, requires ~$110 Bn investment



China and SEA currently have similar cost position with **prices close to cash cost driven by low utilization**

China capacity addition logic to remain unchanged, with push **towards self-sufficiency -** requires >$100 Bn in capex with **limited opportunity for returns**

Overbuild likely to result in **prolonged trough periods**, but **unlikely to disrupt cost-advantaged exports** to China

India and SEA are unlikely to build to meet self-sufficiency, likely to **increase demand for imports**

1. Base case

We see five steps of actions

Grow market-back and go "green"

Drive growth by understanding your customers' needs and drive at scale, market-back product development and end-market exploration

Enable "green" chemical technology to build new businesses at scale

Safeguard value and manage risk

Continue to improve ROIC and drive value creation program

Recognize and proactively manage potential sustainability risks (e.g., regulation, asset devaluation)

Continue to turn your portfolio

Focus your portfolio on building leadership positions in a few chemical segments and ensure orientation towards growth.

Decrease emissions

Migrate all manufacturing facilities to green energy sources, compensate or offset for "unavoidable" GHG emissions, promote your activities

Be agile

Simplify decision making and create an agile way of working to be able to react to changes (e.g., cost inflation) and potential future crises quicker

Cooperate with regulator to safeguard environment for success

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