NET ZERO 2050 Towards a Net-Zero industry in Europe

MATERIAL ECONOMICS

INDUSTRIAL TRANSFORMATION 2050

Pathways to net-zero emissions from EU heavy industry

IN COLLABORATION WITH

VUB IES INSTITUTE FOR EUROPEAN STUDIES

Wuppertal Institut

SUPPORTED BY

UNIVERSITY OF CAMBRIDGE INSTITUTE FOR SUSTAINABILITY LEADERSHIP

CIFF CHILDREN'S INVESTMENT FUND FOUNDATION

eit Climate-KIC

Climate-KIC is supported by the EIT, a body of the European Union

ENERGY TRANSITIONS COMMISSION

European Climate Foundation

RE: SOURCE

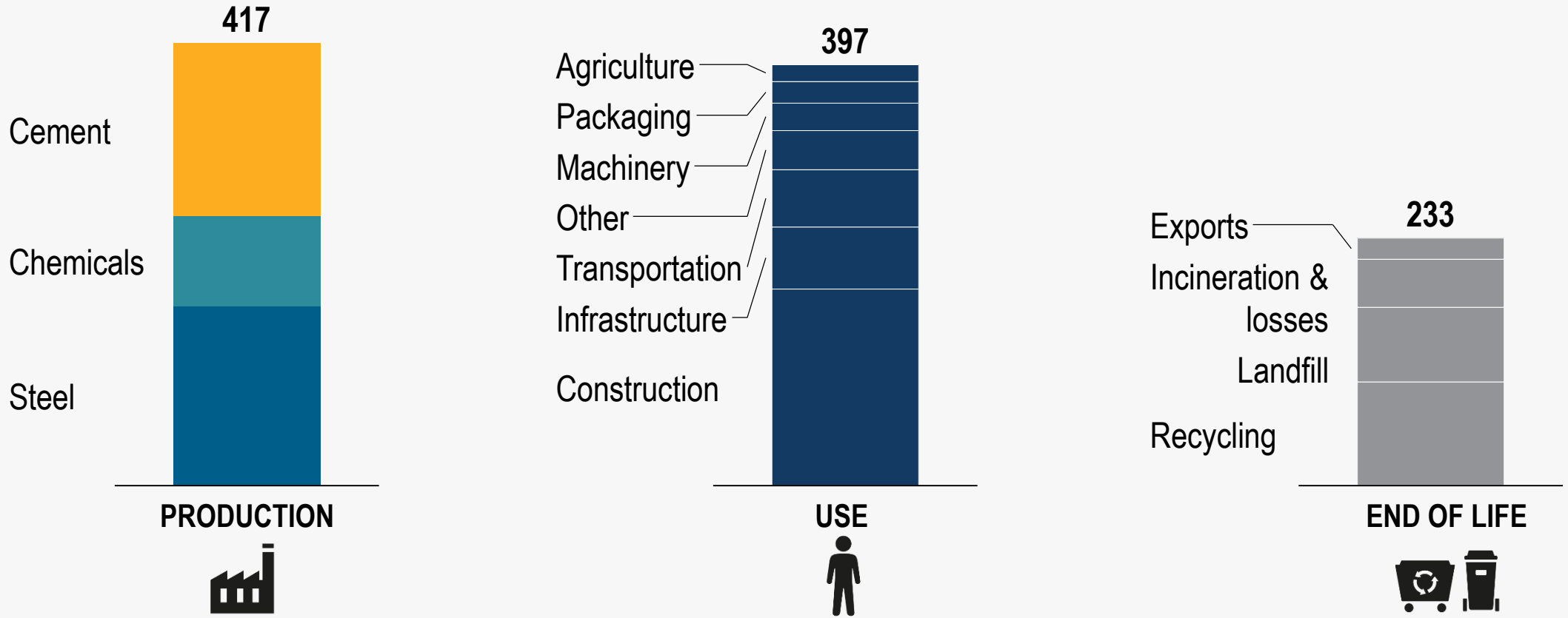
With support from VINNOVA Swedish Innovation Agency, Swedish Energy Agency, FORMAS, Strategic innovation programmes

SITRA

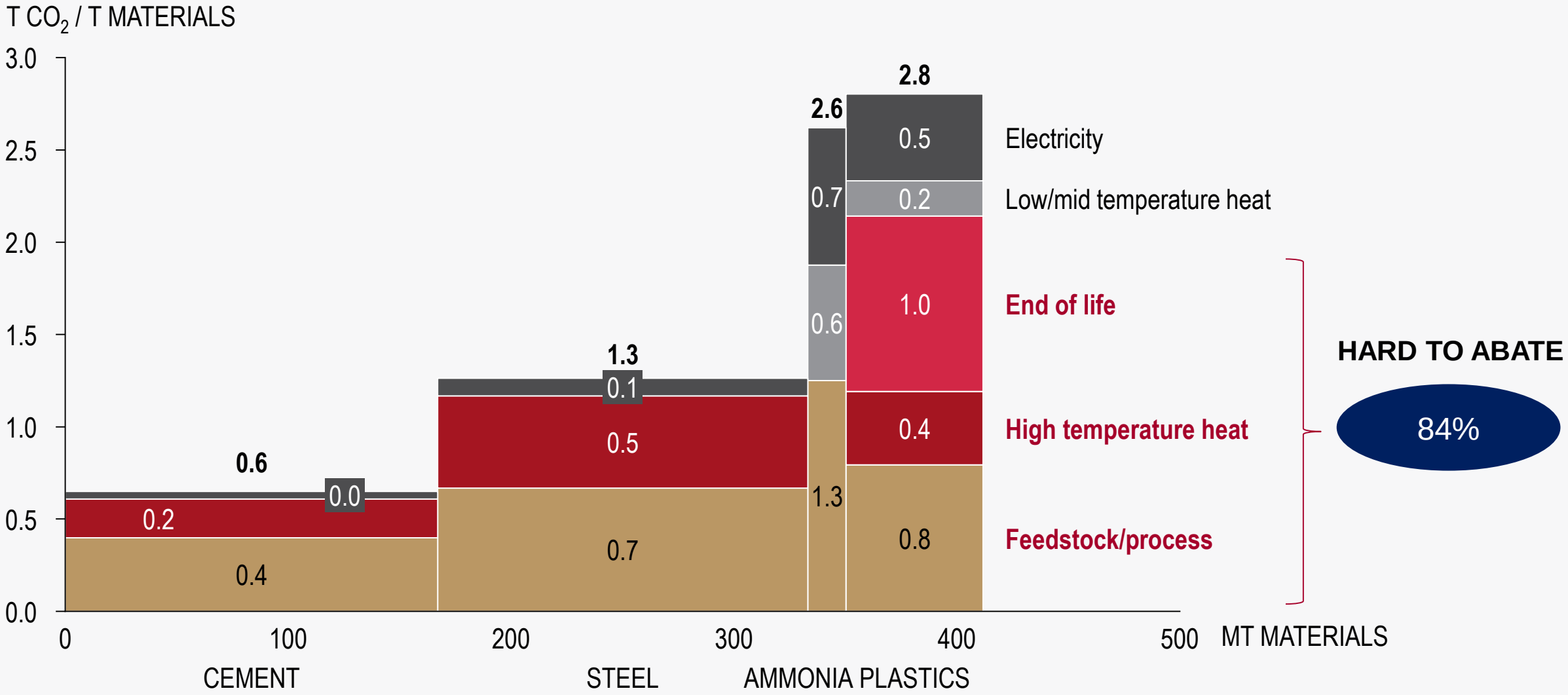
400 Mt OF STEEL, CEMENT, AND CHEMICALS ARE USED EACH YEAR

PRODUCTION, USE AND END OF LIFE VOLUMES

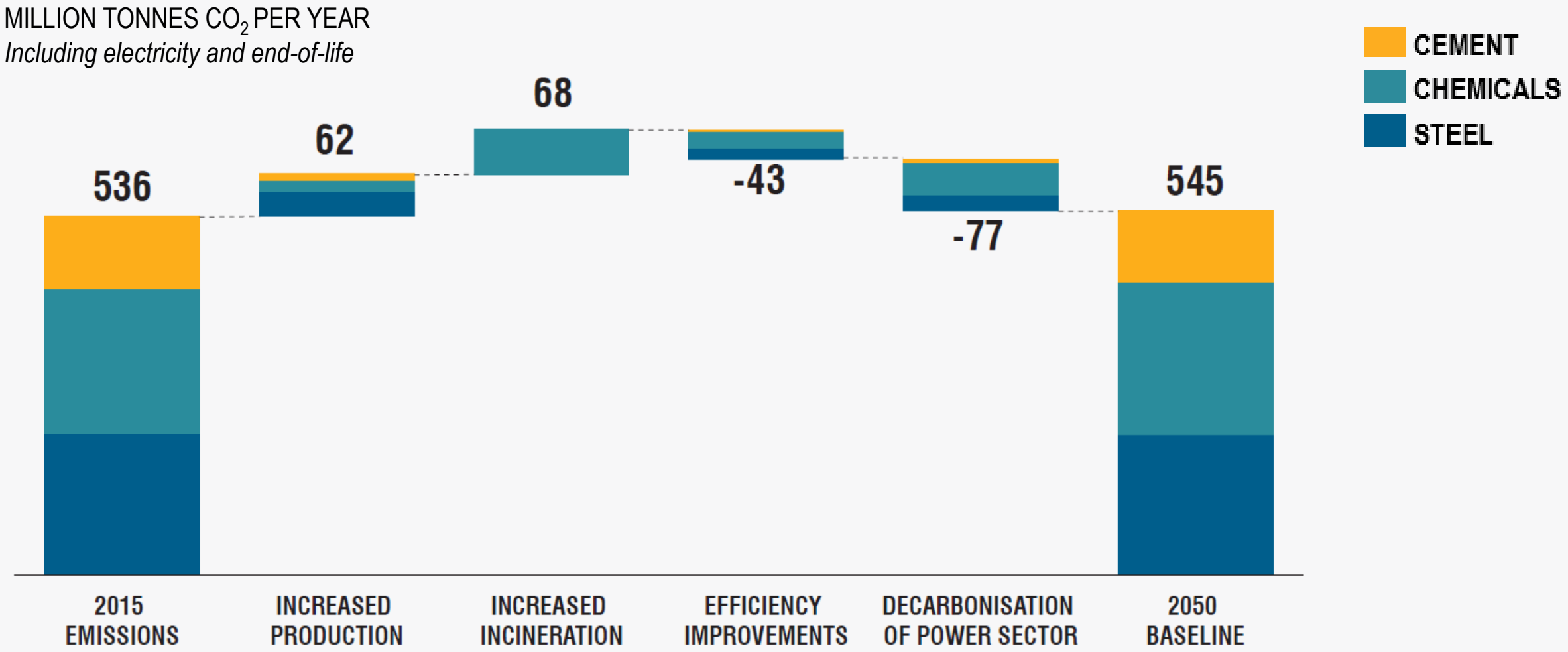
MILLION TONNES



84% OF EMISSIONS ARE 'HARD TO ABATE'



BASELINE: CO_2 EMISSIONS REMAIN AT MORE THAN 500 Mt CO_2 PER YEAR



FOUR STRATEGIES FOR NET-ZERO EMISSIONS FROM INDUSTRY

MATERIALS EFFICIENCY AND NEW BUSINESS MODELS

Reducing materials per product, or increasing lifetime and utilisation

58-171 Mt CO_2

MATERIALS RECIRCULATION AND SUBSTITUTION

Using end-of-life materials as input, or switching to low-CO_2 alternatives

82-183 Mt CO_2

NEW PROCESSES

Shifting to new core production processes and feedstocks

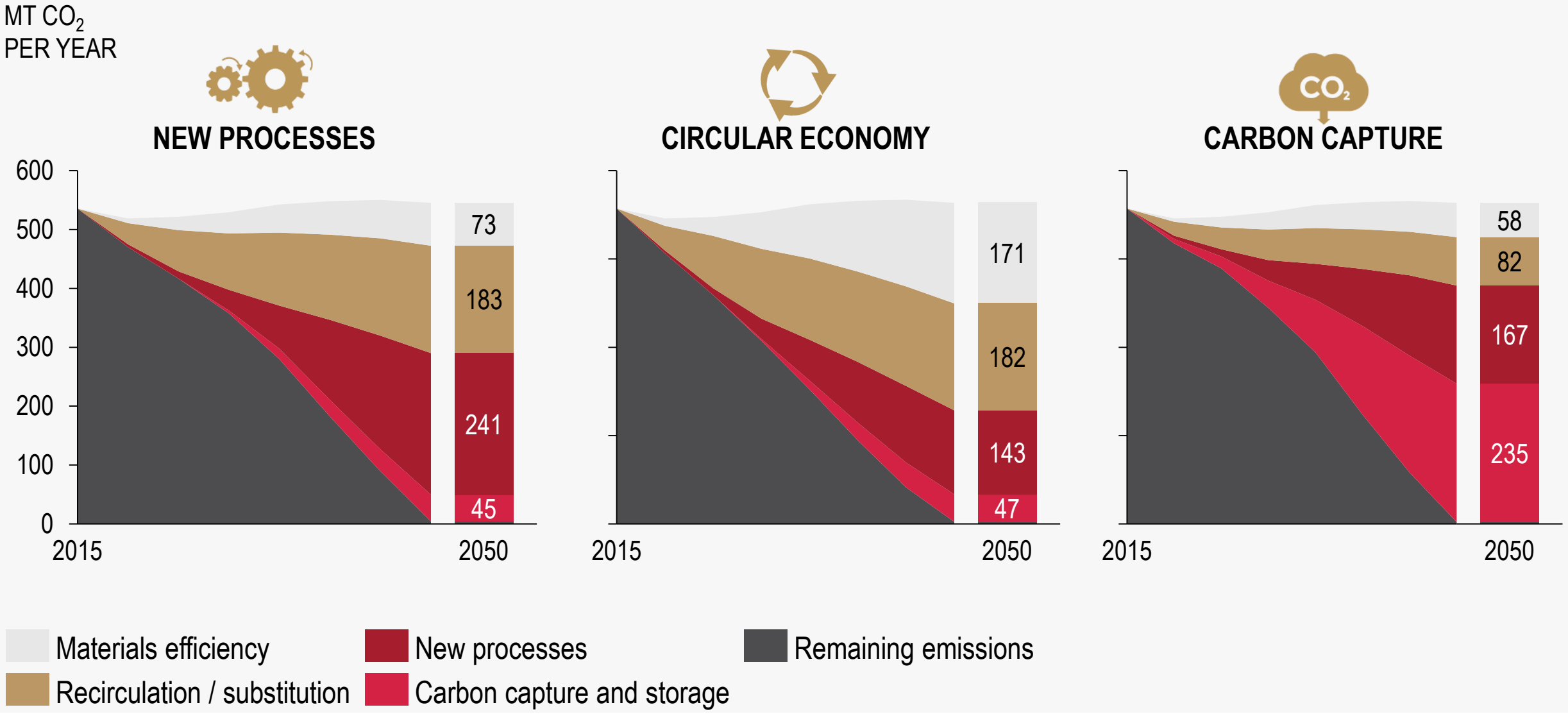
143-241 Mt CO_2

CARBON CAPTURE

Capture and storage of CO_2, or use of captured CO_2 in industrial processes

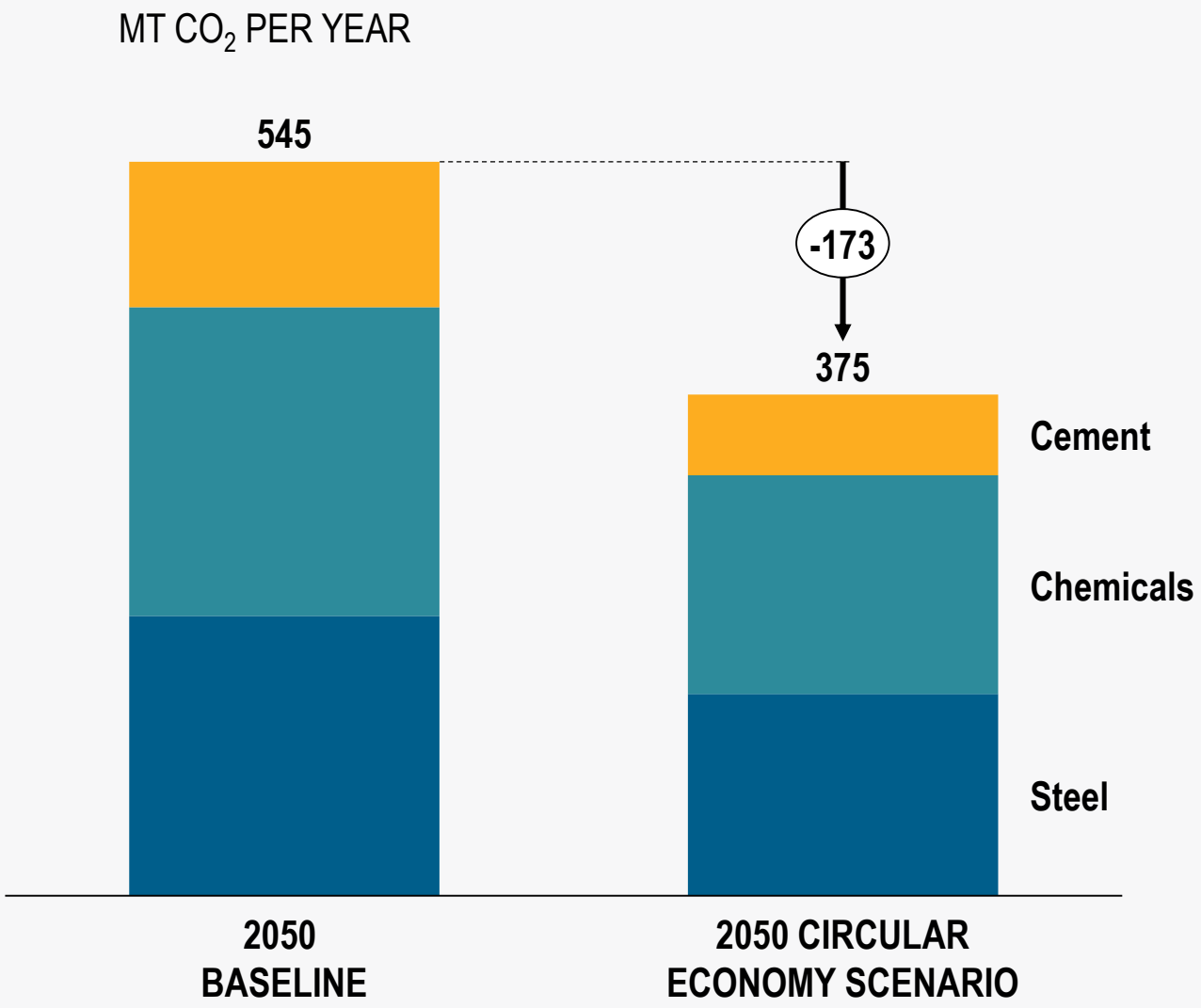
45-235 Mt CO_2

THREE PATHWAYS FOR NET-ZERO EMISSIONS IN 2050



MATERIAL ECONOMICS

MATERIALS EFFICIENCY CAN CUT EMISSIONS BY 31%



OPTIMISED MATERIALS USE

- *Optimised materials use in construction*
- *Reduced over-use and over-specification*
- *Precision agriculture reducing fertiliser use*
- *Optimisation of concrete recipes*

REDUCED WASTE

- *Reduced scrap formation in manufacturing*
- *Reduced cement waste through prefabrication*

RE-USE

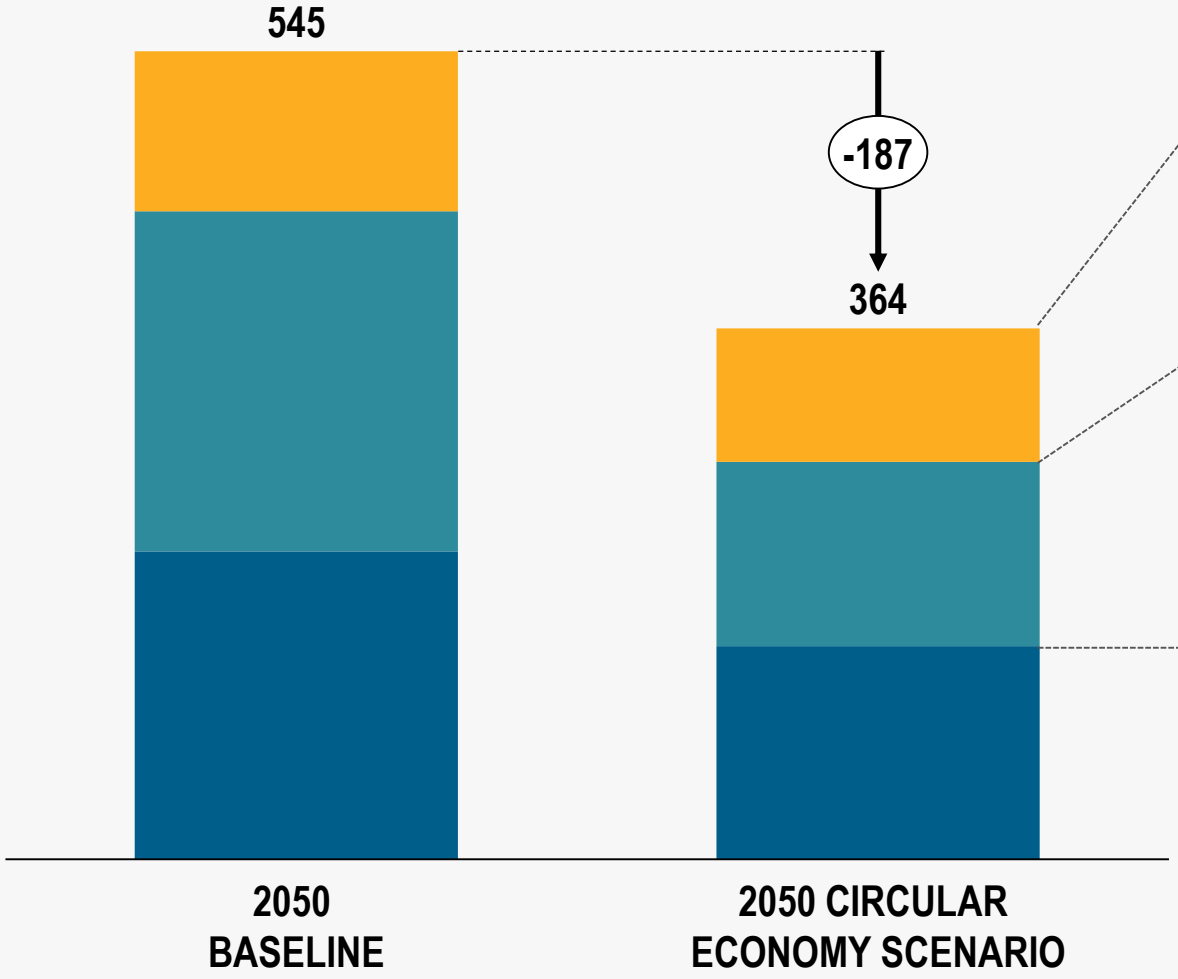
- *Remanufacturing*
- *Reconstruction and re-use of building components*

NEW BUSINESS MODELS

- *Shared mobility*
- *Product-as-as-service business models*

MATERIALS RECIRCULATION AND SUBSTITUTION CAN CUT EMISSIONS BY 33%

MT CO_2 PER YEAR



CEMENT
- *Substitution with clinker alternatives*
- *Substitution of concrete with wood*
- *Increase cement recycling*

50%

CHEMICALS
- *Mechanical and chemical recycling for societal carbon loop*
- *Substitution with fibre-based alternatives*

65%

STEEL
- *Reduce copper pollution*
- *Increase scrap collection*

70%

NEW PROCESSES AND FEEDSTOCK ENABLE DEEP CUTS TO CO_2

STEEL

- Hydrogen direct reduction
- Direct smelting ironmaking
- Blast furnace + CCU
- Electrowinning
- Electrification of reheating

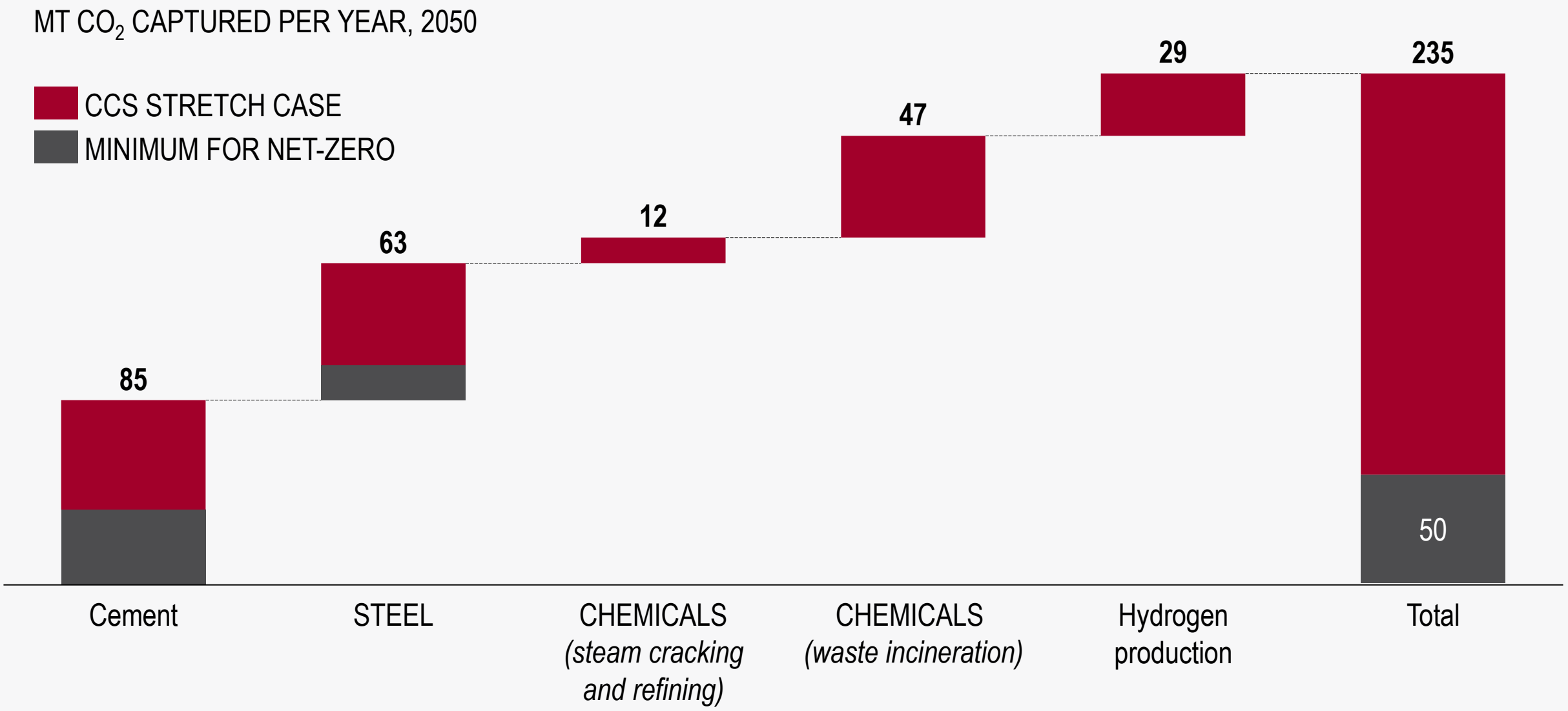
CHEMICALS

- Chemical recycling
- Bio-based plastics
- Electrification of crackers
- New platforms (methanol to olefins)
- Reprocessing of by-products
- Novel bio-polymers
- New catalysts

CEMENT

- Electrification (*sintering, calcination)*
- Novel binders
- Separation of process CO_2

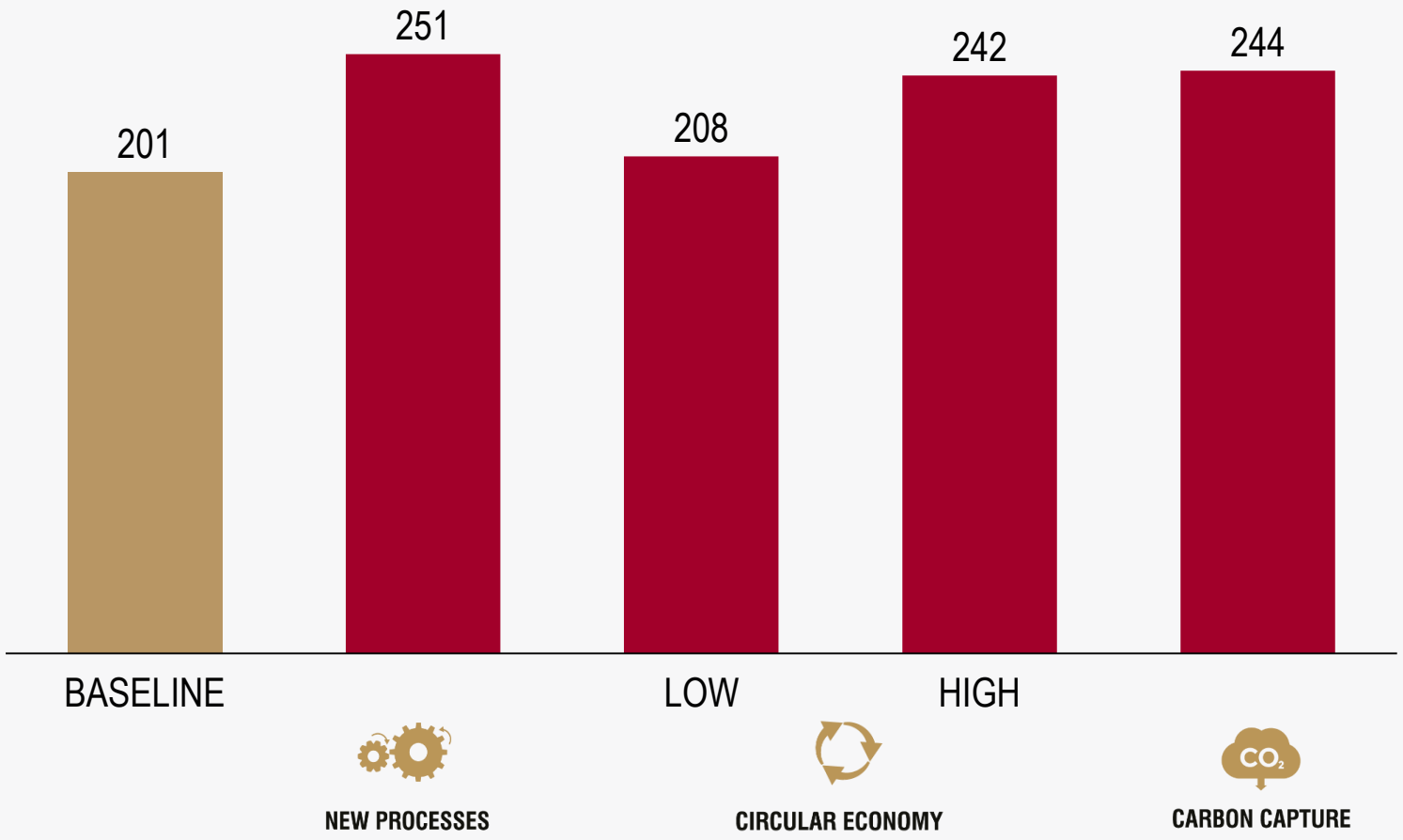
CCS COULD BE USED ACROSS INDUSTRIAL PRODUCTION (STRETCH SCENARIO)



COST INCREASES BUT WITH LIMITED END-USER IMPACT

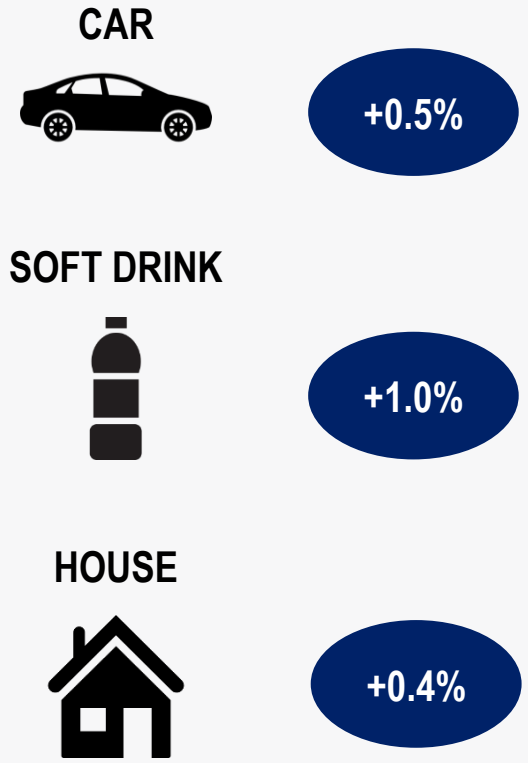
COSTS OF MEETING NEEDS INCREASE COMPARED TO BASELINE…

BILLION EUR PER YEAR, 2050



…BUT END-USER COSTS INCREASE <1%

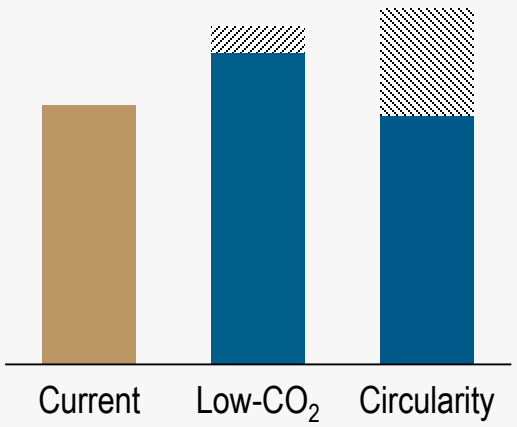
% INCREASE



THE COST OF PRODUCTION INCREASES FOR ALL MATERIALS

STEEL

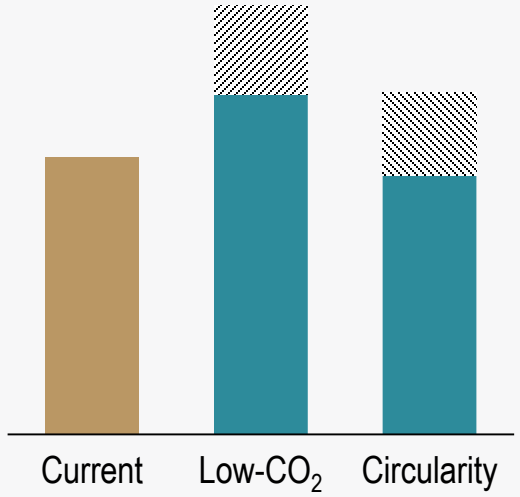
+20-30%



6-57 EUR / t CO_2

PLASTICS

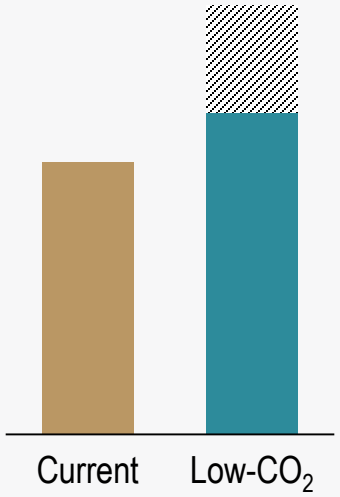
+20-55%



32-139 EUR / t CO_2

AMMONIA

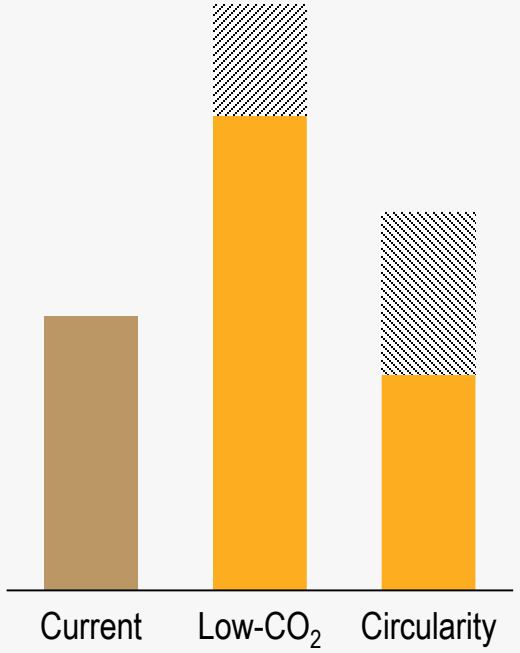
+15-60%



39-215 EUR / t CO_2

CEMENT

20-115%



28-89 EUR / t CO_2

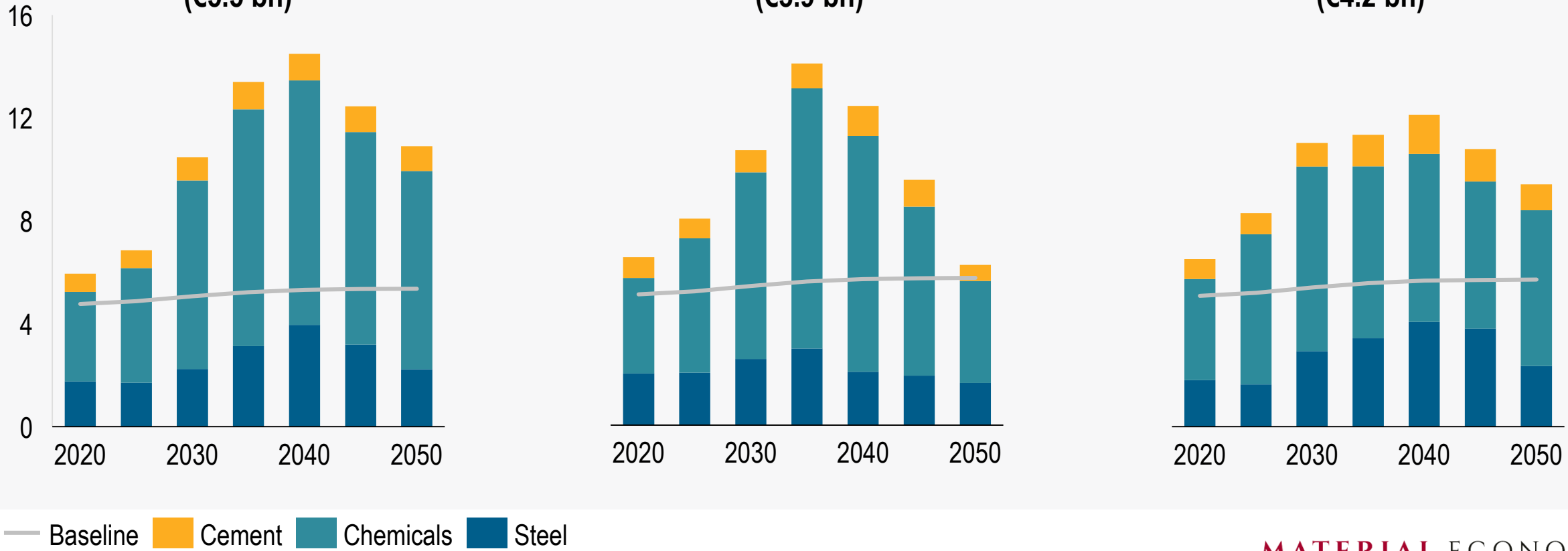
INVESTMENT NEEDS INCREASE BY 76-107% ACROSS THE PATHWAYS

BN EUR PER YEAR

NEW PROCESSES
+107%
(€5.5 bn)

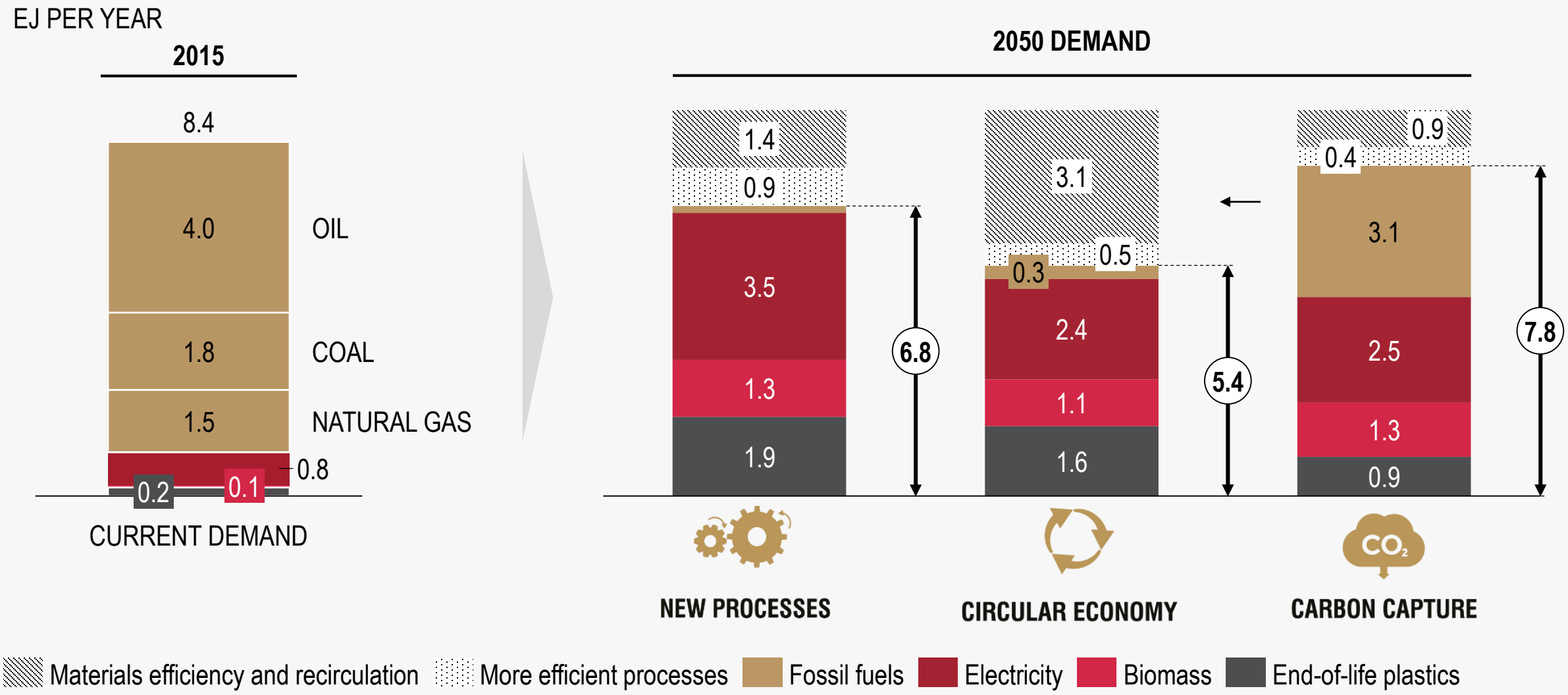
CIRCULAR ECONOMY
+76%
(€3.9 bn)

CARBON CAPTURE
+81%
(€4.2 bn)

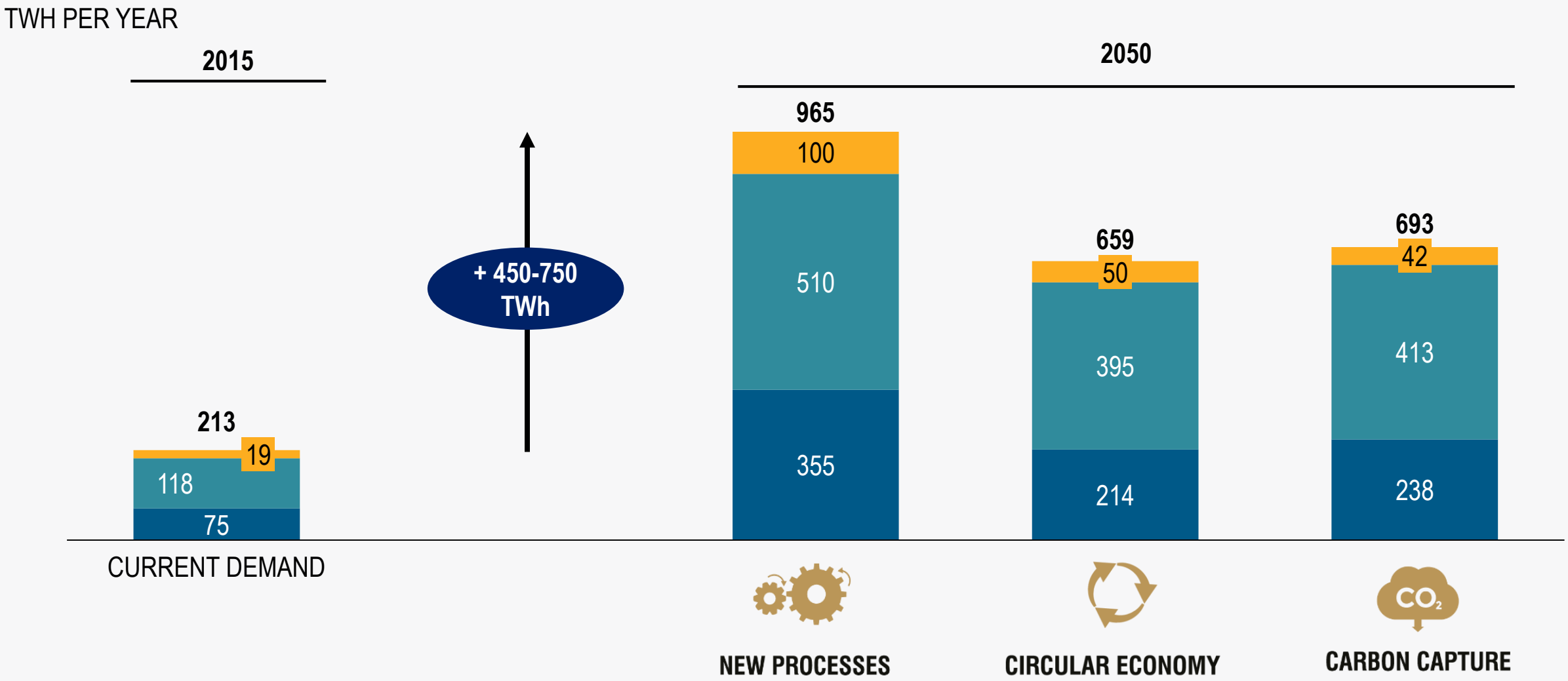


MATERIAL ECONOMICS

A NET-ZERO TRANSITION REQUIRES A MAJOR CHANGE IN INPUTS



NET-ZERO EMISSIONS REQUIRES AN ADDITIONAL 450-750 TWh ELECTRICITY



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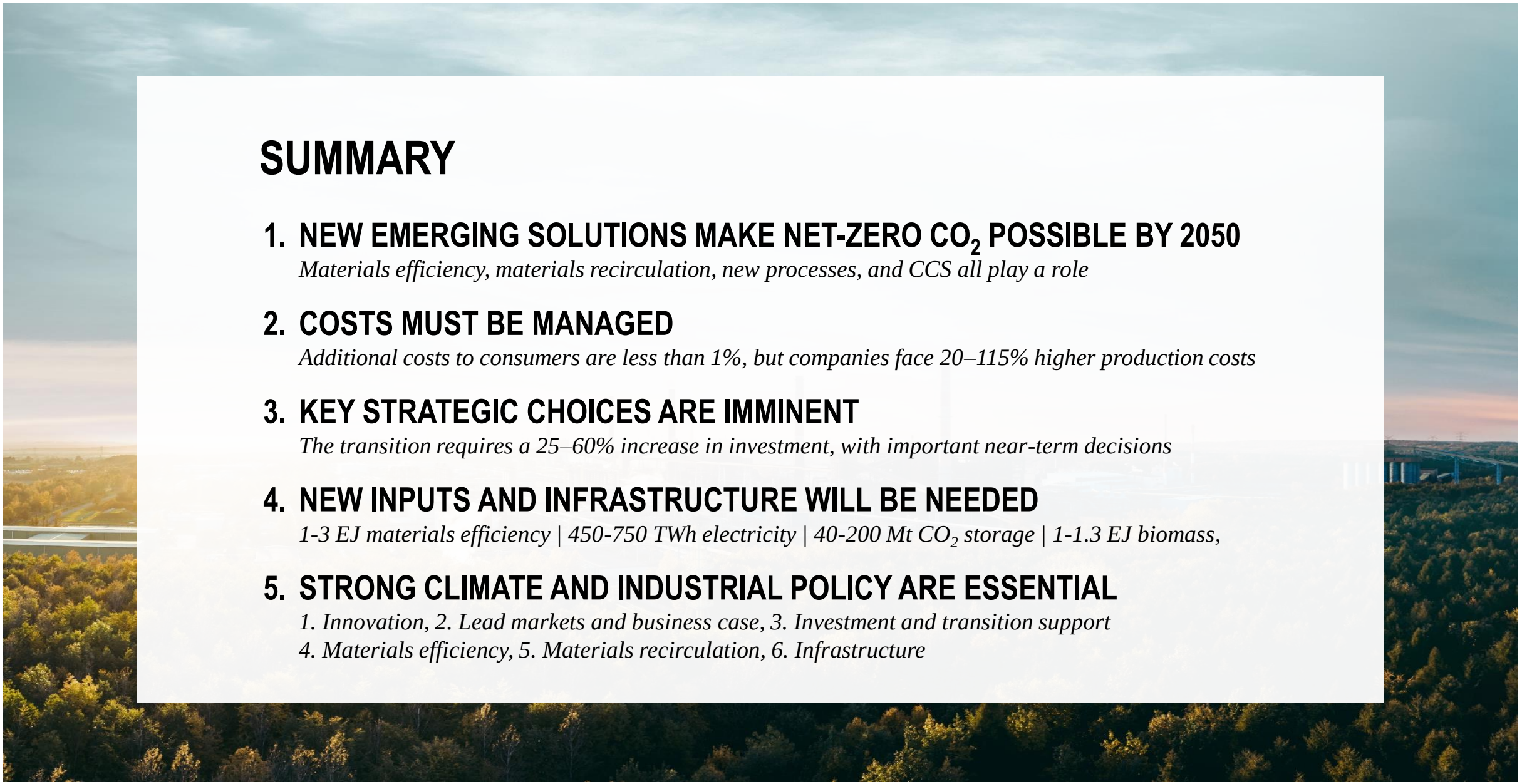

SUMMARY

1. NEW EMERGING SOLUTIONS MAKE NET-ZERO CO_2 POSSIBLE BY 2050

Materials efficiency, materials recirculation, new processes, and CCS all play a role

2. COSTS MUST BE MANAGED

Additional costs to consumers are less than 1%, but companies face 20–115% higher production costs

3. KEY STRATEGIC CHOICES ARE IMMINENT

The transition requires a 25–60% increase in investment, with important near-term decisions

4. NEW INPUTS AND INFRASTRUCTURE WILL BE NEEDED

1-3 EJ materials efficiency | 450-750 TWh electricity | 40-200 Mt CO_2 storage | 1-1.3 EJ biomass,

5. STRONG CLIMATE AND INDUSTRIAL POLICY ARE ESSENTIAL

1. Innovation, 2. Lead markets and business case, 3. Investment and transition support
4. Materials efficiency, 5. Materials recirculation, 6. Infrastructure

THANK YOU

www.materialeconomics.com/publications/industrial-transformation-2050

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