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WORLD
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Circular Economy + Climate Initiative

Global Technology
Governance Summit

6.-7. April 2021



Circular Economy + Climate

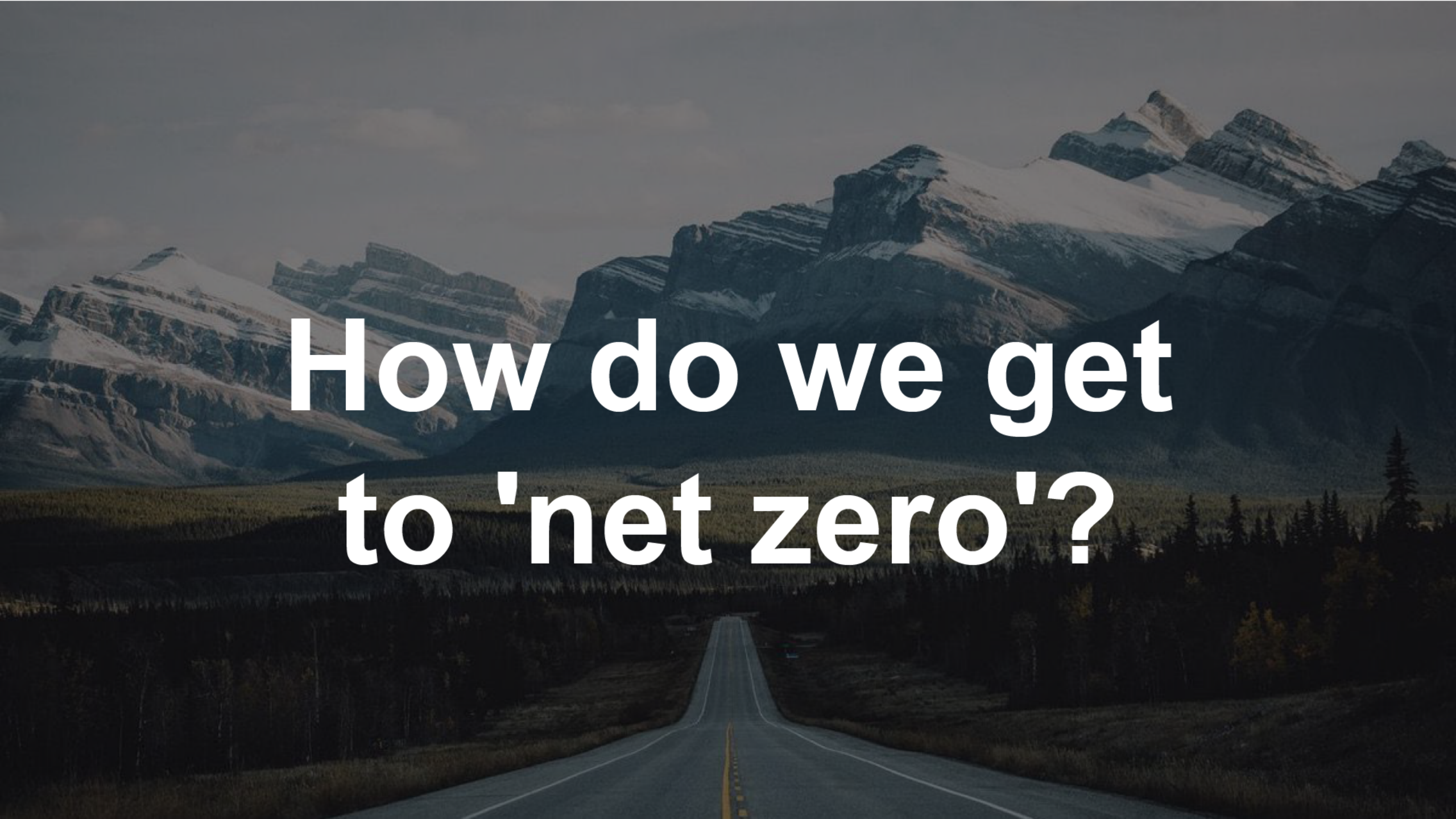
Global Technology
Governance Summit,

6.-7. April 2021

Getting to net-zero

The Circular Economy opportunity

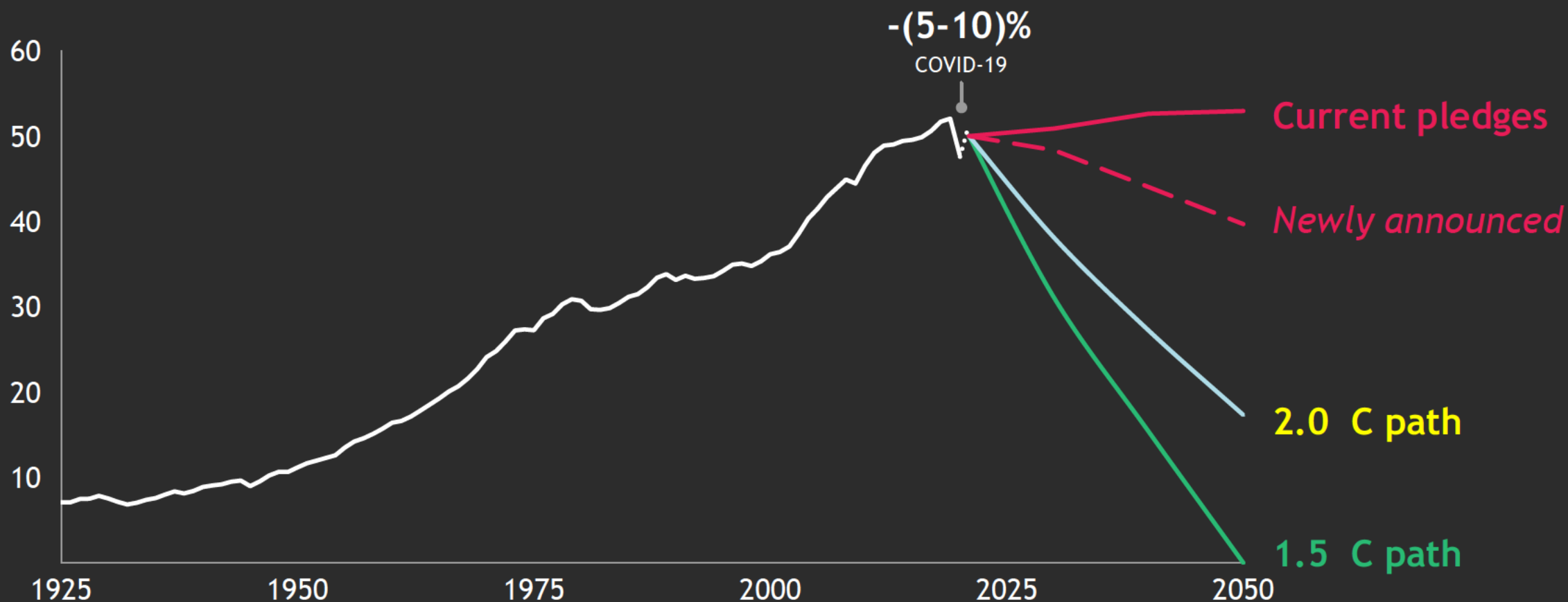
Case examples

A scenic landscape featuring a long, straight asphalt road that stretches from the bottom center towards the horizon. The road is flanked by dark, dense evergreen forests. In the background, majestic mountains with significant snow cover rise against a cloudy, overcast sky. The overall tone is somber and contemplative.

**How do we get
to 'net zero'?**

It is a big challenge, and we are not on course

Global net CO₂e emissions and paths (Gigatons per year)



Note: Current pledges assumes countries decarbonize further at same annual rate that was required to achieve NDCs between 2020 and 2030; 2.0°C path assumes 25% reduction by 2030 and net-zero by 2070; 1.5°C path assumes 45% reduction by 2030 and net-zero by 2050

Source: EDGAR 5.0, FAO, PRIMAP-hist v2.1, Global Carbon Project, IPCC, UNEP Emissions Gap Report, WRI, Nature (May 2020), BCG

| Power

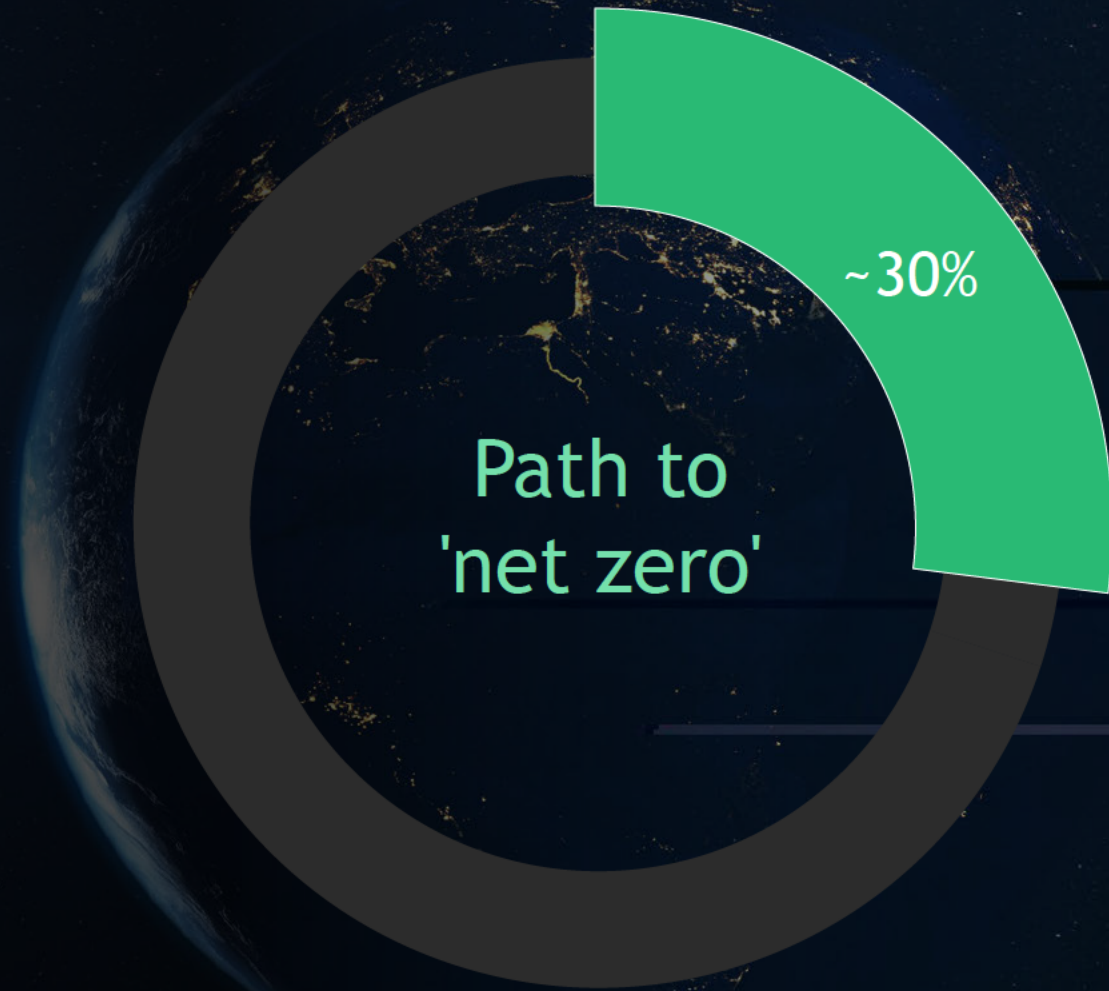
| Industry

| Transport

| Land use

| Buildings

| Other



Path to
'net zero'

~30%

>4x renewable generation by 2050
plus investments in grid, storage

Scale up nuclear where possible
At least 2x, acc. to IEA

Shift backup plants to Hydrogen
working as “seasonal storage”

Capture carbon from remaining fossil plants
with CCUS

| Power

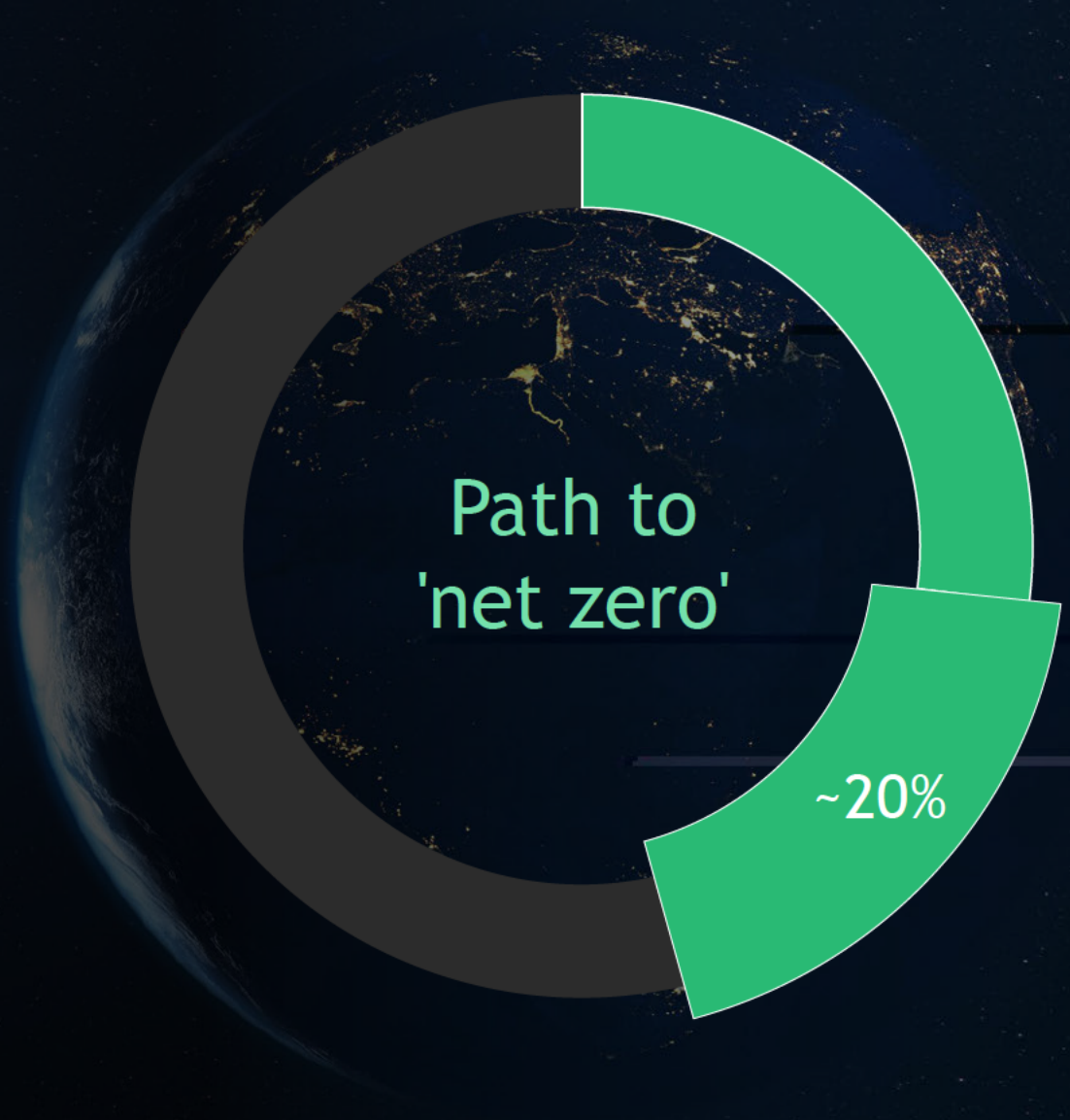
| **Industr**

| Transport

| Land use

| Buildings

| Other



Path to
'net zero'

~20%

Embrace circularity
by maximizing re-use of material waste

Increase efficiency
to reduce energy demand

Switch to renewable fuels
from coal, oil & gas to biomass, power & H₂

Use low-carbon hydrogen
in fertilizer production, refining, petchem etc.

Switch production tech
especially in steelmaking, to H₂-DRI

Capture CO₂ from processes
esp. in cement, steel, chemicals

Power

Industry

Transport

Land use

Buildings

Other

Path to
'net zero'

~15%

19%

Increase public transport
and more efficient modes for logistics

Push efficiency
across all modes of transportation

Electrify passenger cars
mostly through battery vehicles

Electrify trucks
using batteries, fuel cells, or catenaries

Green fuels in aviation and shipping
e.g., bio, e-kerosene, green ammonia

Power

Industry

Transport

Land use

Buildings

Other

Stop deforestation
for new agriculture, esp. in tropics

Optimize fertilization
Less fertilizer, nitrification inhibitors, ...

Improve soil management
Higher efficiency, cover cropping, ...

Use manure for energy
by converting it to biogas, ...

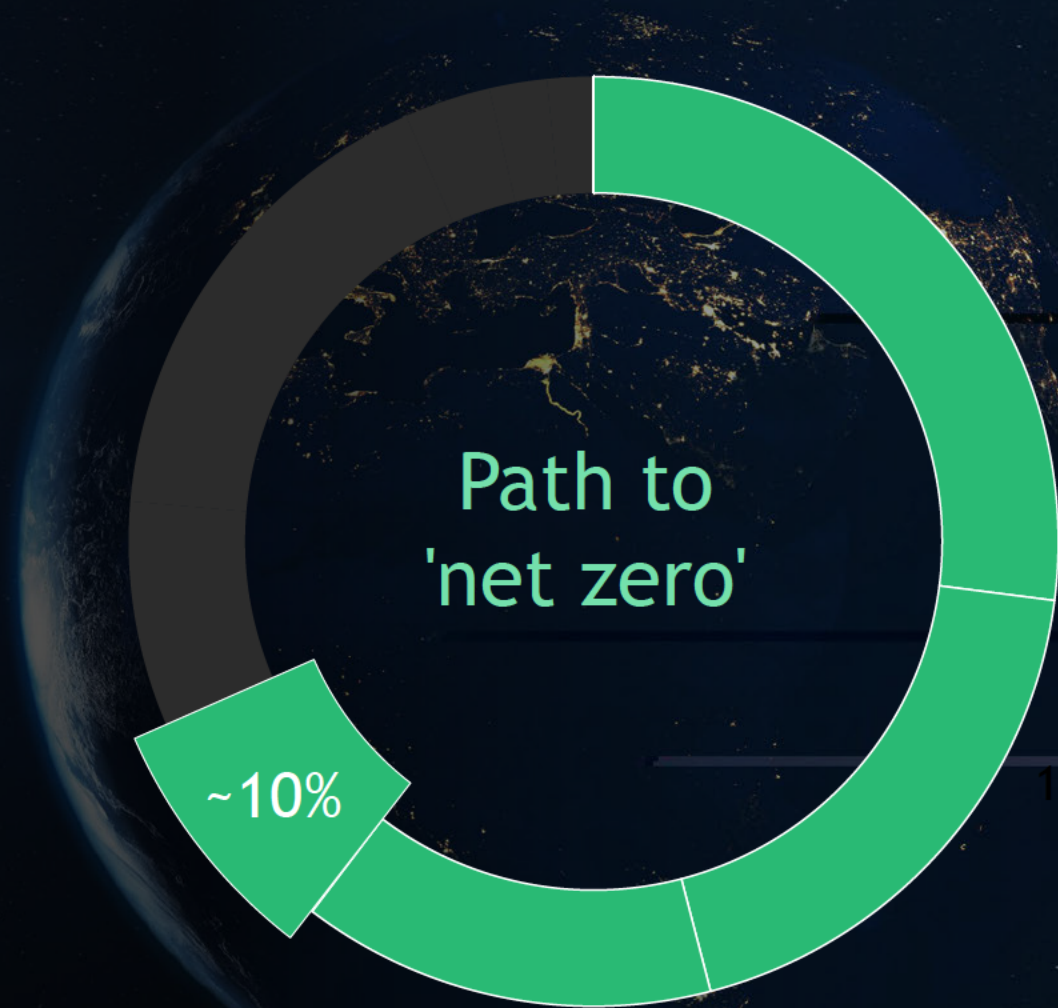
Optimize feeding
of livestock to reduce methane

Plant-based diet
e.g., through meat & dairy alternatives

Path to
'net zero'

~10%

19%



| Power

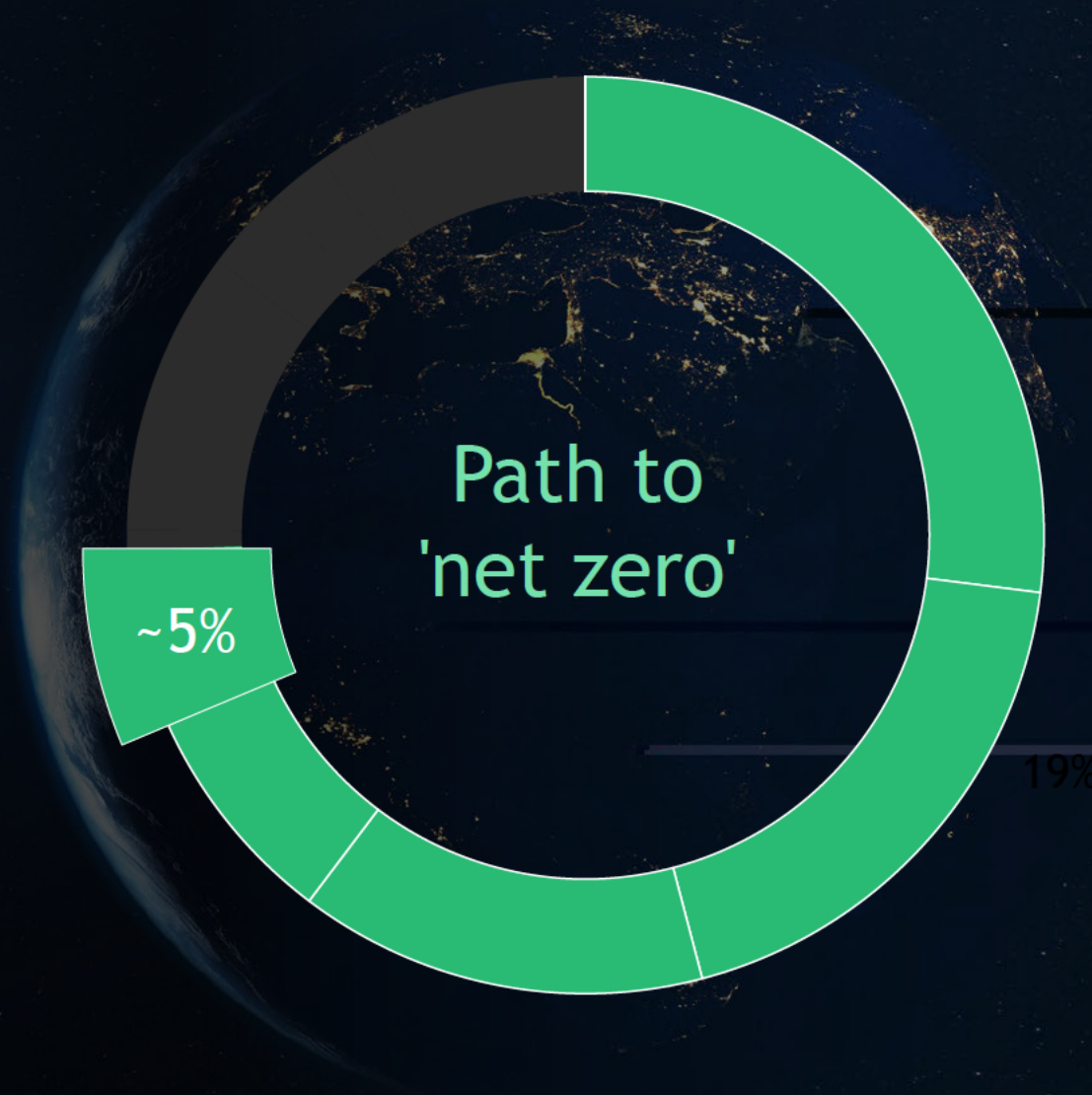
| Industry

| Transport

| Land use

| **Buildings**

| Other



Path to
'net zero'

~5%

Increase building standards
to ensure 'net zero' new build

Accelerate building renovations
to reduce energy demand

Increase appliance efficiency
in lighting, cooling, heating, ...

Replace fossil boilers and cooling
with heat pumps, district heating and cooling...

Power

Industry

Transport

Land use

Buildings

Other

Avoid and recycle waste

Reduce waste for landfilling and incineration

Zero landfilling

of biogenic and mixed waste

Capture landfill and sewage gases
and use it for power and heat generation

Eliminate methane fugitives

Identify, report, repair methane leakage

Capture excess methane
at exploration sites

Reduce demand for fossil fuels
through measures in other sectors

~10%

Path to
'net zero'

Power

Industry

Transport

Land use

Buildings

Other

Plus: Remove at least 5 Gt of CO₂/a from the atmosphere

~10%

Path to
'net zero'

Re-forestation
and re-cultivation of mangroves, peatland,...

Soil sequestration

Bioenergy-CCS

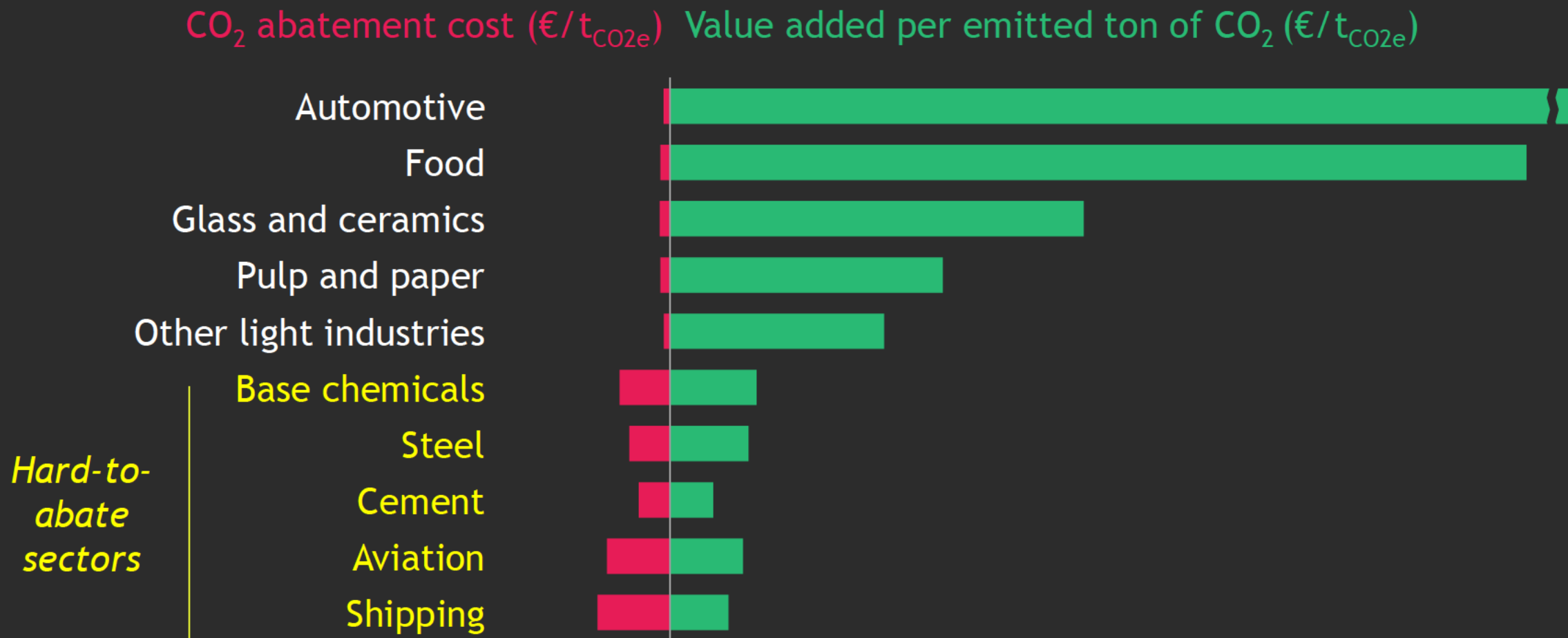
Enhanced weathering

Biochar

Ocean fertilization

Direct air capture

Some sectors find it hard to move alone



Note: Abatement costs and value added refer to Scope 1 and 2 emissions
Source: Mission Possible (2018), company reports, Prognos, IEA, Oxford Economics, BCG

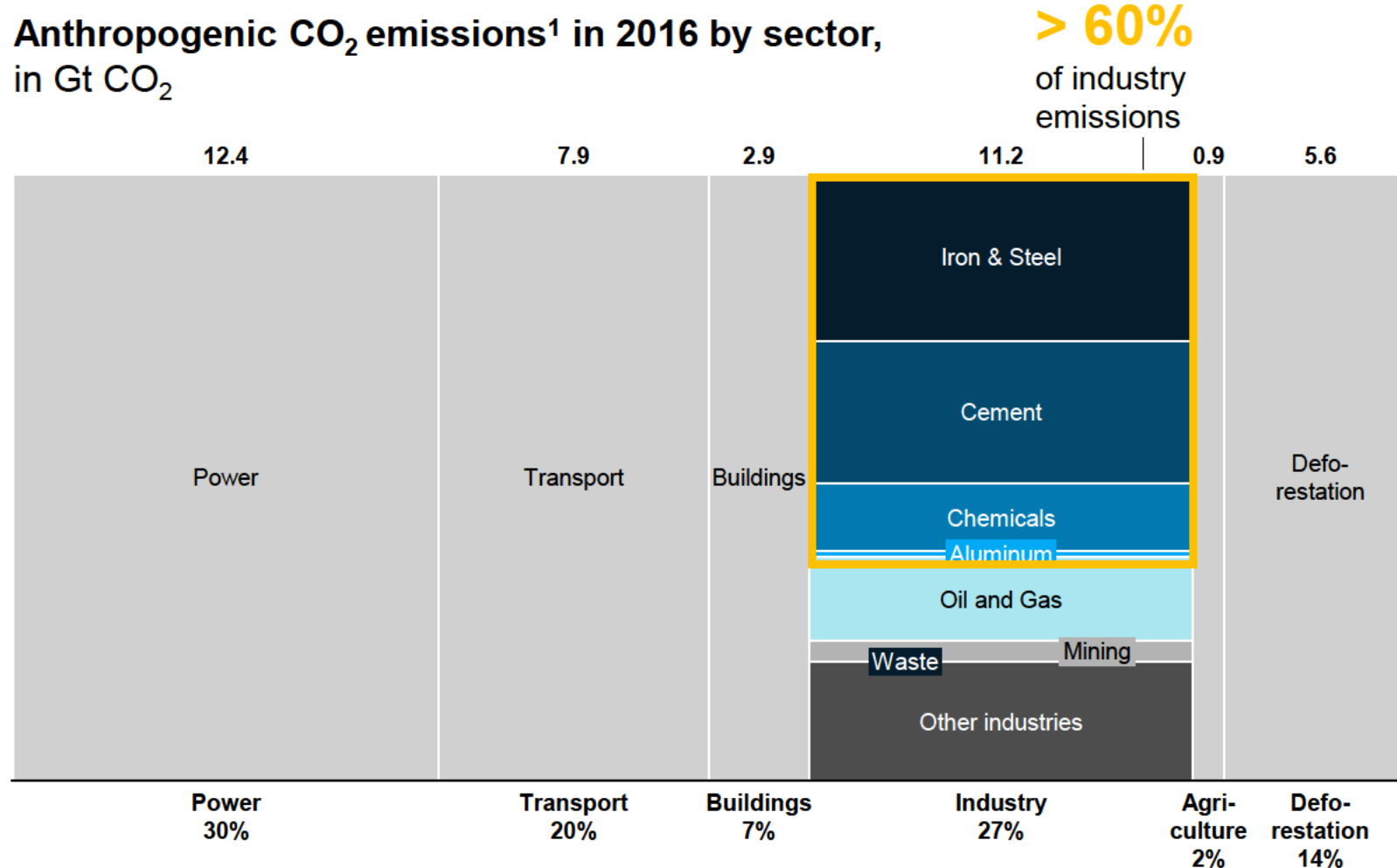
By working horizontally zero upstream emissions become possible at low end-costs: the supply chain opportunity

Indicative



Industry deep dive: The majority of industry emissions comes from 4 material groups

Anthropogenic CO₂ emissions¹ in 2016 by sector, in Gt CO₂



Industry accounts for **27% of all global CO₂ emissions**

Within industry, 4 material groups account for the majority of Scope 1 emissions:

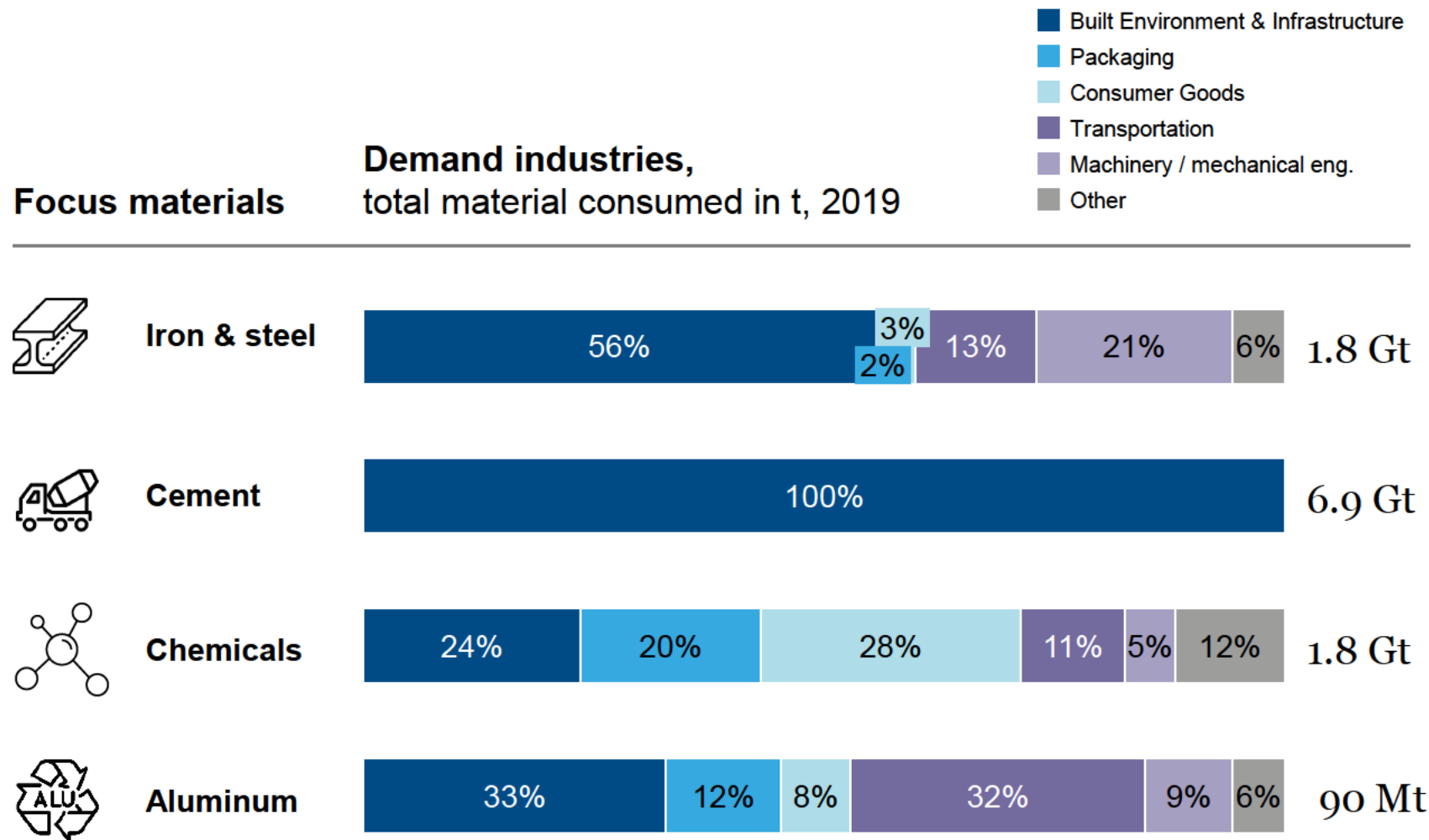
- Steel: **28%**
- Cement: **24%**
- Chemicals: **11%**
- Aluminium: **1%**

Material production expected to increase in business as usual scenario

To **meet decarbonization targets**, decoupling strategies of growth from resource consumption and new business models are required

1. Excludes non-CO₂ GHG emissions

Demand industries that use the 4 focus materials as input play a vital role in implementing circular economy approaches



Built Environment and infrastructure with largest material demand (top demand sector for 3 of the 4 materials)

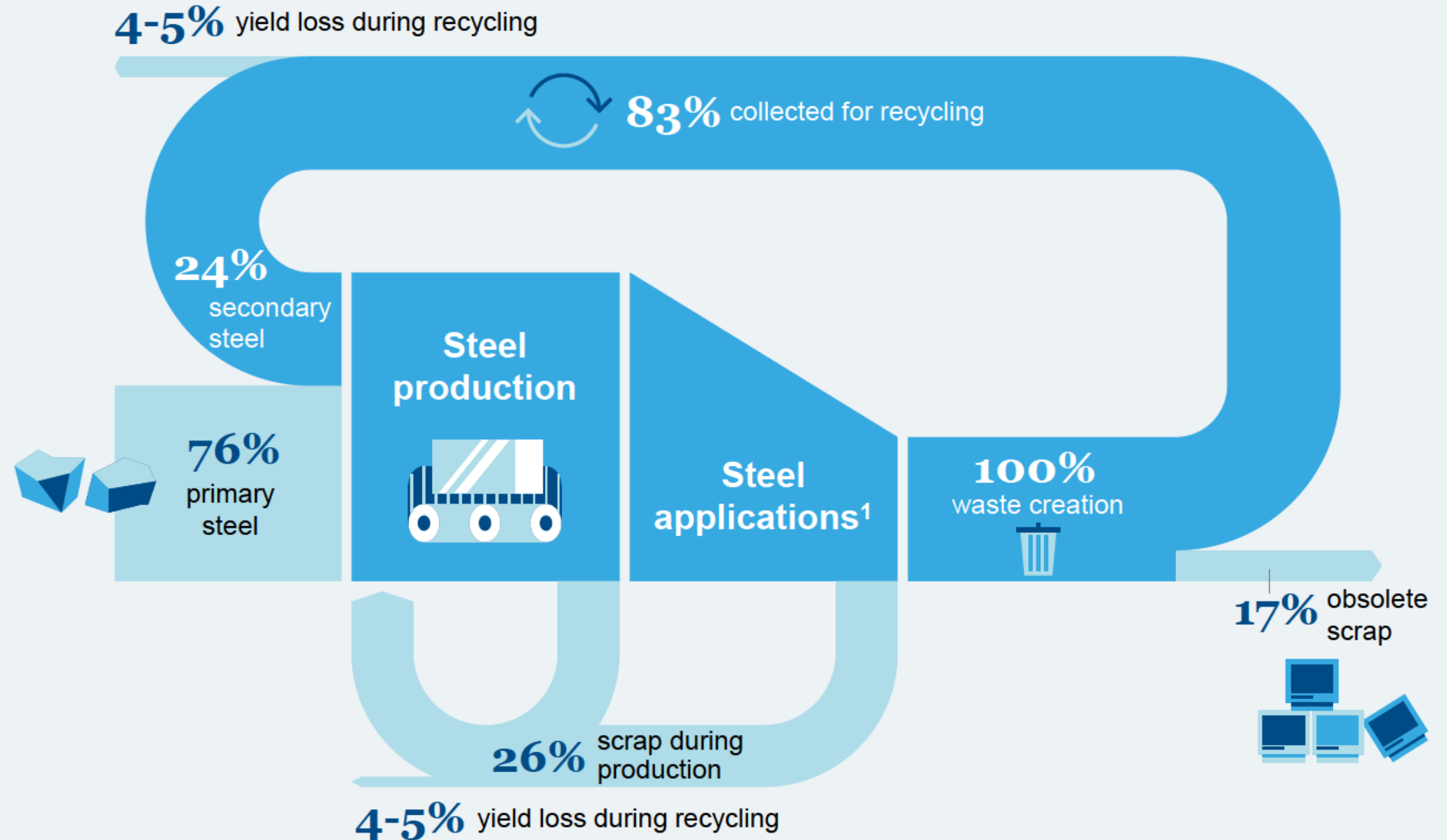
Transportation sector with **second highest use** of focus materials, largely **driven by Aluminum**

Almost **50% of produced chemicals** are used in **consumer products** (either in packaging or the goods themselves)

Steel example

**Recycled steel
accounts for
~25% of
material in new
steel production**

World steel flows, 2019

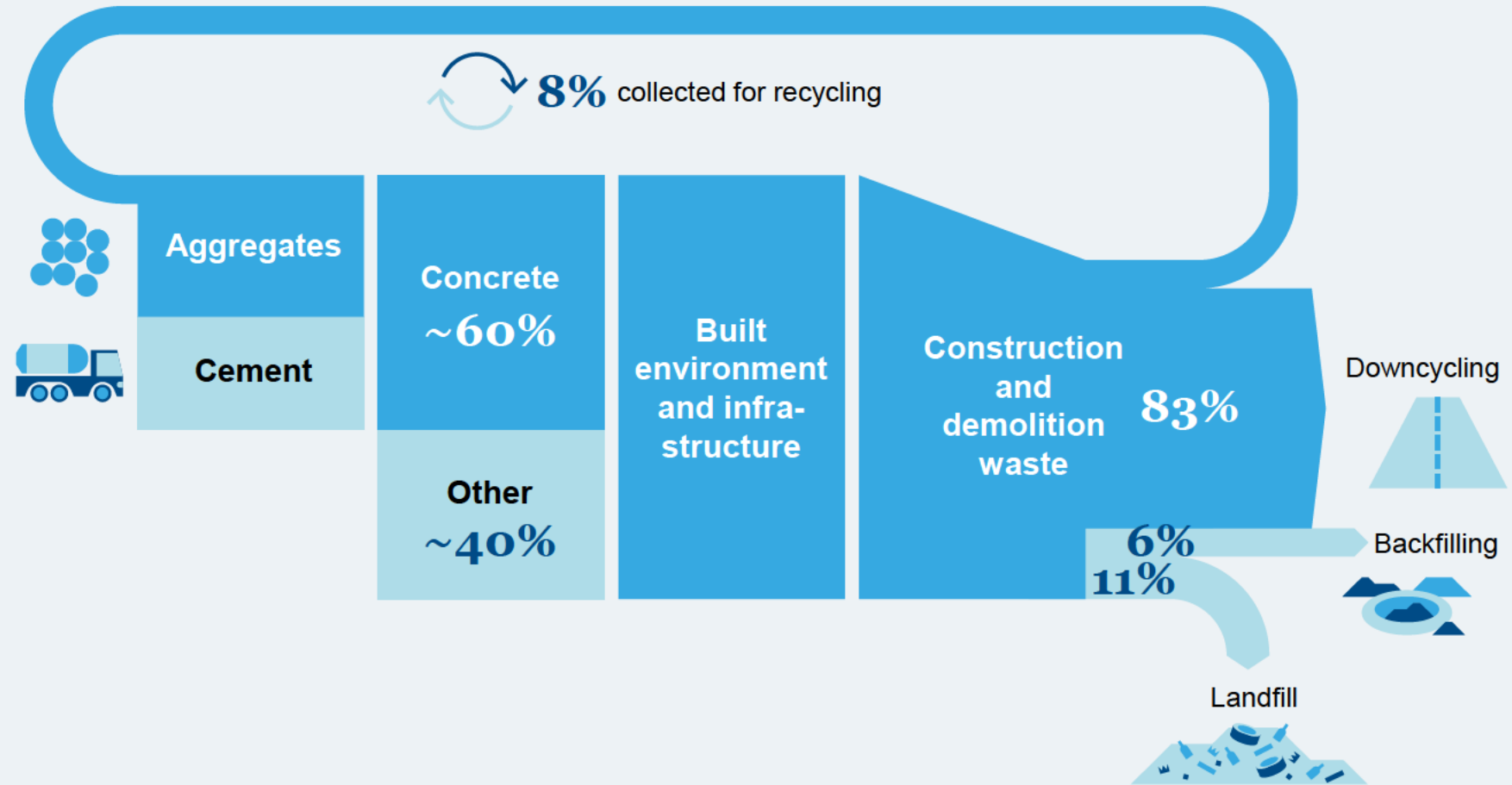


1. Reduction is due to two factors: 1) a part of durable steel applications do not turn into waste and 2) waste created today is coming from applications that were produced 20-30 years ago, when demand for steel was lower

Cement example

Only a small fraction of Buildings and Infrastructure waste is recycled into new concrete

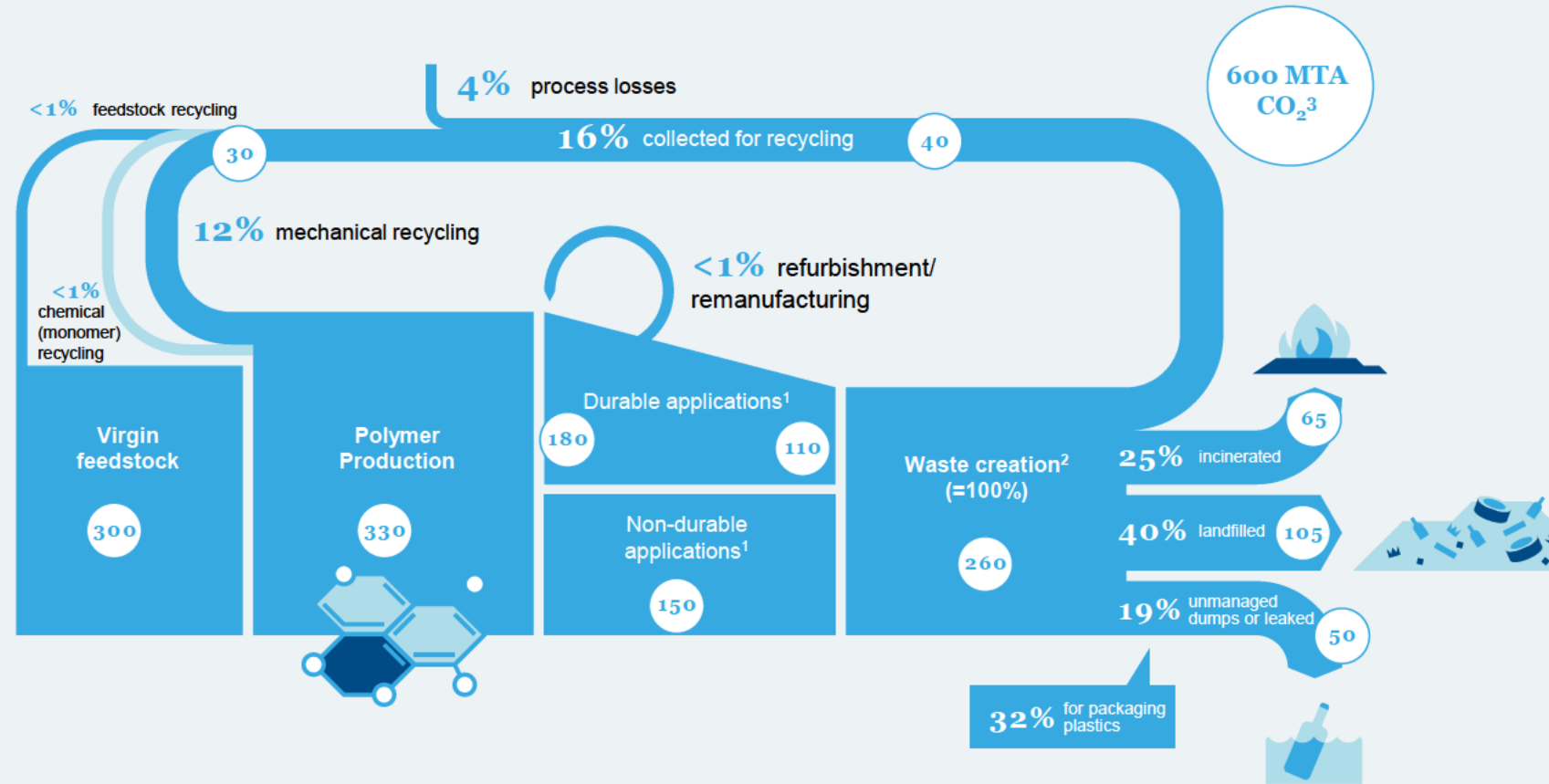
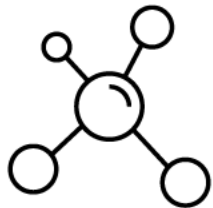
World concrete flow, 2016



Chemicals example

Today, ~60% of plastic waste is not recovered or processed

Global polymer flows
2016, MTA



¹ Durable applications with an average lifetime >1 year will end up as waste only in later years, non-durable applications go straight to waste

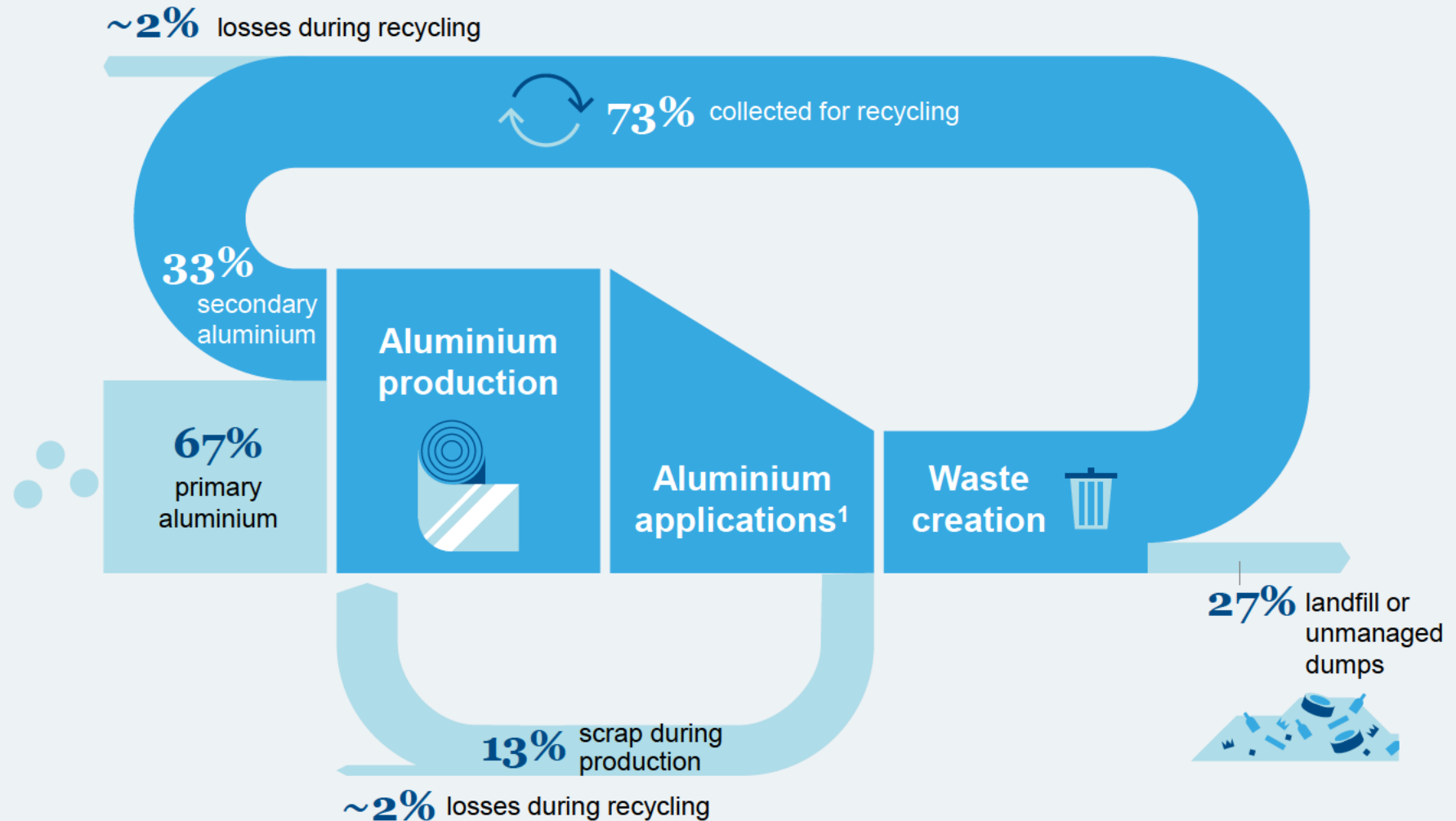
² 150 MT mixed plastic waste from non-durable applications that end up as waste in same year plus 110 MT of mixed plastic waste from production in previous years

³ Total CO₂ production per annum including virgin plastics production but excluding plastic processing

Aluminium example

27% of wasted aluminium is not collected for recycling

World aluminium flows, 2018



1. Reduction is due to long lifecycle of aluminium products (~70% of all aluminium produced still in use), hence >60% of materials become material stock rather than waste

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Case examples

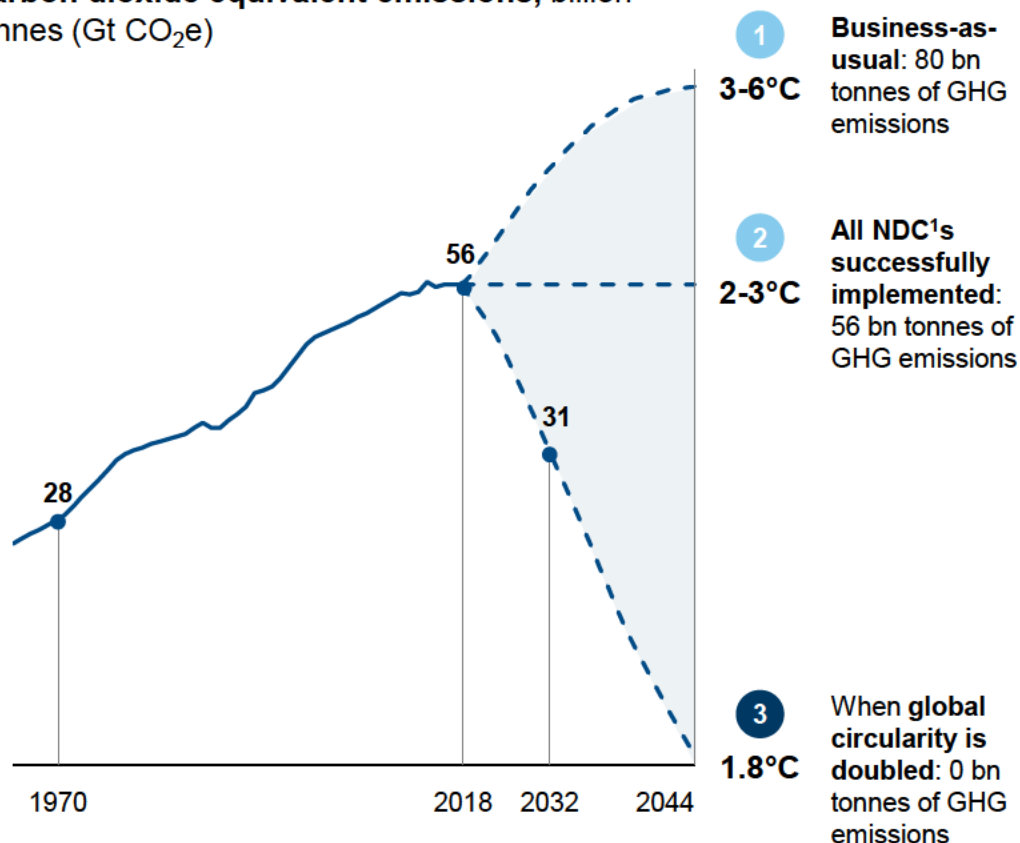
Shift to circular economy can help to keep global warming below 2°

— Trajectory — Projected trajectory ■ Projection range

GHGs and temperature rise scenarios

Circularity Gap report 2021, Circle Economy

Carbon dioxide equivalent emissions, billion tonnes (Gt CO₂e)



1. Nationally determined contributions

Source: Circle Economy – The Circularity Gap Report 2021

- 1 Continuing with **business-as-usual** will lead to a **3-6° temperature increase**

This would have **catastrophic impact**, especially on vulnerable populations
- 2 Fulfillment of **emissions-reduction pledges** by all 194 signatories of the Paris Agreement still leads to **2-3° temperature increase** by the end of the century
- 3 Closing the emission gap from NDCs requires **transformative and systemic change**, which can be achieved through the circular economy

Adding **circular economy solutions** allows us to keep global temperature rise well **below 2°**

4 major levers enable higher circularity in the material flow of heavy industries

Circular Economy levers in heavy industries¹

	Description	Business practice	Example
 Increase product utilization	Maximize use cycles of products / components and increase intensity of use	Offer access & performance	Share office space
		Extend product lifecycle	Refurbish broken consumer goods
		Recover and reuse product components	Design machinery for disassembly
 Replace material / product with circular alternative	Replace one type of material with another that is inherently more circular (either creating the same product or a substitute)	Offer substitute product with improved circularity	Replace steel by cross-laminated timber
		Use more circular (e.g. renewable) feedstock	Replace regular plastics by bio-based plastics
 Reduce material per product	Reduce the amount of material needed per product	Optimize product design	Design lighter car by replacing steel with aluminum
		Produce efficiently	Reduce waste during production process
 Recycle material for new products	Replace virgin material with recycled material	Use recycled materials	Create a trading platform for plastics recyclates

Key enablers to implement and scale business practices, include

- **Policy and regulatory environments**

- **Cross-company collaborations**

- **Technological innovation**

Examples for Built Environment on next pages

1. Circular economy levers are defined in the context of this work as affecting the flow of the materials in scope. Purely energy related measures, e.g. using renewable energy, are considered as out of scope

二次利用未承諾リスト

報告書の題名 Circular Economy + Climate
Initiative Global Technology Governance
Summit

委託事業名 令和２年度地球温暖化・資源循環
対策等に資する調査委託費（GTGS21に向けた調
査及び資料作成等業務）

受注事業者名 WORLD ECONOMIC FORUM

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(様式 2)

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Collaboration models are a key enabling mechanism to implement circular economy approaches



Vertical networks



Horizontal networks



Vertical partnership



Horizontal partnership



Cross-sectoral partnerships



Corporate startup collaboration

Collaboration approaches to enhance circularity

Brings together **multiple players along an industry value chain**

Brings together **players at the same step of the value chain** (competitors)

2 (few) companies at different level of value chain **engage in a deep co-operation**

Co-operation of companies on the **same step of the value chain**

Companies from **different industries** realize a solution together

Big corporate and small Start-up collaborate

Key advantages

Align on common clear Circular Economy goals, material and product composition, and standards

Enhance **understanding of repercussions and interdependencies**

Agree with competitors on specific joint action such as the avoidance of certain materials, phase out of certain practices

Bring together companies with the **same needs**

Create one solution together to **reach scale**

Build on **complementary skills**
Jointly develop **solutions that meet the need of customers**

Bring together **complementary expertise** and competencies

Bring together **complementary expertise** and competencies

Develop **solutions leveraging different needs across industries** (e.g. open loop re-use/ recycling)

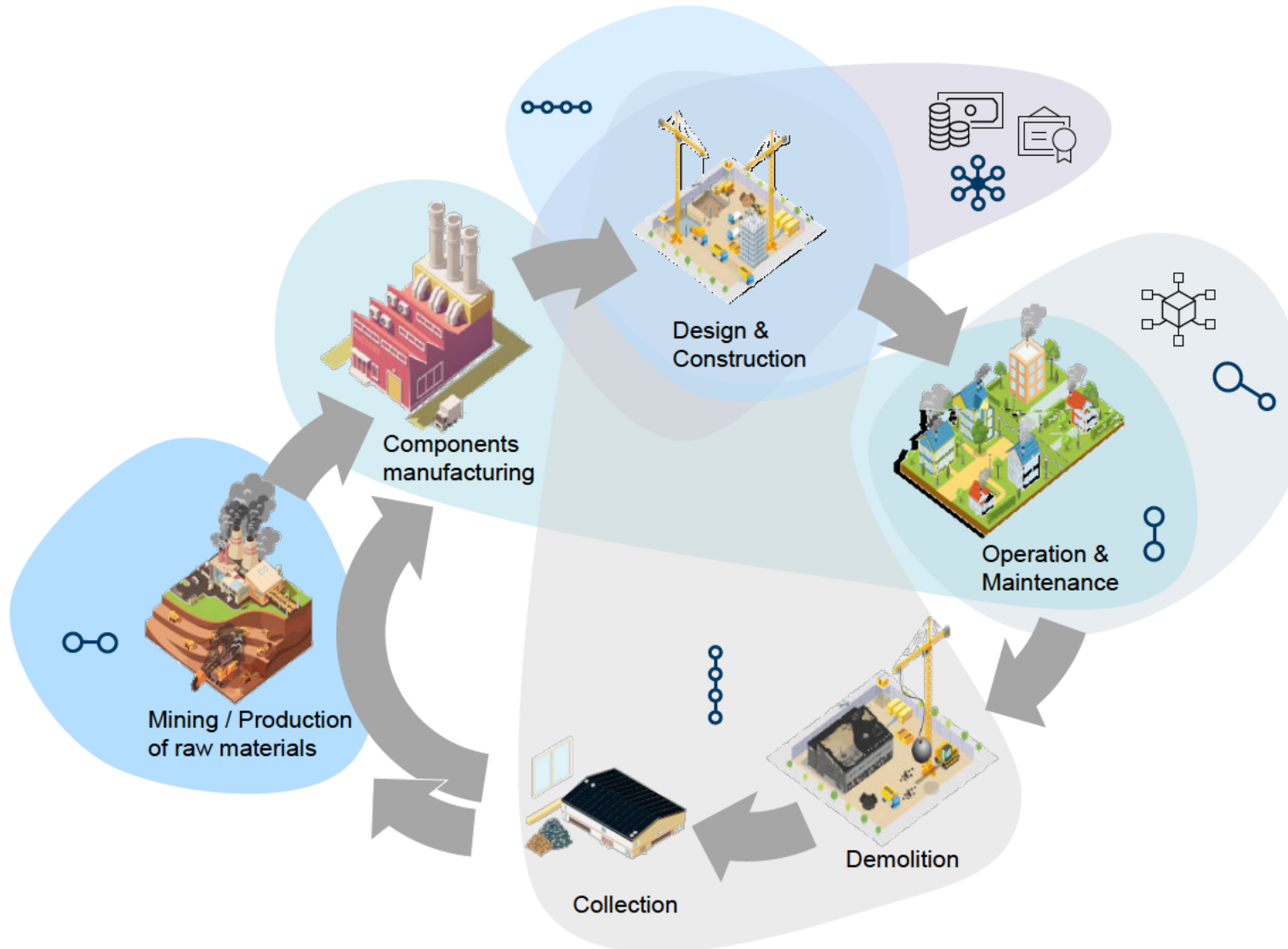
Match **complementary skills**

Rapidly test new solutions, independent from established processes, business values and culture

Adopt **new technologies / IoT services**

Different collaboration approaches in the Built Environment sector enable the realization of new Circular Business Models

ILLUSTRATIVE COLLABORATION EXAMPLES IN BUILT ENVIRONMENT



Industry collaboration

- Horizontal network** of construction companies to agree on **circularity labelling**
- Vertical network** incl. construction, demolition and collection players to create **reuse platform for building components**
- Cross-sectoral collaboration** between building owner, financial institution and digital player to create **material passport** and ensure increased residual value through circular construction
- Horizontal partnership** between producers of raw materials to pool resources for the development of a more **sustainable building material**
- Vertical partnership** between building operators and components manufacturers to establish **product-as-a-service models**, e.g. lift-as-a-service
- Company – startup collaboration** between building owners and digital startup offering solution to **increase utilization of space**

Technological innovations are a key enabler for Circular Economy approaches in the Built Environment sector



AI for material innovation

Using AI algorithms to systematically analyse huge amounts of data on existing materials and their properties to design and test new alloy formulations.
e.g., Accelerated Metallurgy project



Building Material Passport

Digital "material passport" for buildings, specifying the material "stored" in a building to enable material as a service options, facilitate reuse and develop new valuation methods
e.g., Madaster



Stock inspection and recognition

Capture stock of building and assess material composition through drone based image recognition and data analysis



Optimized use of space

Real time analysis of occupancy and smart appliances to facilitate sharing
e.g., intertempi



Material recognition

Using NIR, image recognition and AI to automatically recognize materials from mixed waste such as after demolition to enable sorting for reuse or recycling
e.g., Zenrobotics



Material ID

"Birth certificate" for materials with exact details on material composition, digitally attached to materials and components
e.g., holy grail project in packaging; Circular Fashion ID for textiles



Optimized production

Automation, 3D printing, digital process technology and others for optimized component design and manufacturing processes



Optimized use of appliances

Use smarting metering, connectivity and real time data to enable optimal use of products and service models
e.g., m-use (lift as a service) by Mitsubishi



Digital platforms

Enable reused product and material trading etc. by providing real time information, dynamic pricing, convenience and accessibility and match supply and demand
e.g., Werflink



Tracking and Tracing throughout the value chain

Blockchain technology to track material and optimize processes
e.g., HerenBouw



Digital knowledge access

Readily accessible data and information on materials (e.g. material database, LCA data), toolkits and more for various stakeholders such as architects, developers...
e.g. oekobaudat, oneclicklca, ecoinvent

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Case examples

Signify revolutionizes the way we see lights

Circular lights



Signify is offering **light as a service** to, e.g., airports, factories, offices, schools. They remain **owner** of the lighting systems and are responsible for the maintenance and repair



Signify **collaborates with public entities** such as Schiphol Airport to implement high-profile pilot use cases



Signify achieved 100% **carbon neutrality** in 2020



Madaster creates digital material passports for buildings to improve reuse of components

The Madaster Platform



Madaster creates fully digital **material passports** for buildings and construction objects through which all information on used materials are made transparent and readily accessible anywhere anytime



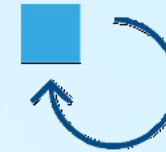
Madaster had built a **strong network** of leading stakeholders from industry leaders to financial institutions, research institutes and design and architecture studios to continuously **improve its product** and **increase its value and usability**



By registering materials, every building becomes a **material bank for the future**. Knowing what materials and products are within the building enables **reuse and recycling of components**, **simplifies** renovations and allows for innovative financial solutions backed by material collateral



Recycle material for new products



Increase product utilization

With m-use, Mitsubishi makes a bold shift to a pay-per-use for its elevator business

M-use



Mitsubishi has launched a full **lift-as-a-service** to their customers with pay-per-use and full servicing. Mitsubishi's goal is to acquire **50% of its division's revenue** through m-use and take ensure that all components of returned M-Use® elevators are recycled and/or reused



The new model is based on **connectivity** and real time data analysis. **Billing** is done on a **per-use** basis and service and **maintenance** is based on this **real time use data**, providing accuracy and optimal care



The **product-as-a-service** model allows for **tailored maintenance** based on actual usage and for control over **optimal reuse** and recycling



Recycle material for new products



Increase product utilization

Maersk certifies its ships with the cradle to cradle passport to improve material recovery

The cradle to cradle passport



The cradle to cradle passport **identifies every component of the ships**, incl. 60,000 tons of steel, making **improved recycling** possible for most materials as well as safe disposal for the rest. Based on this, it will be **possible to reuse nearly all material in new ships**.



An **online database** will be created to show a detailed inventory for each ship. The database can be **updated and maintained throughout the lifecycle** of the ship, and provide improved understanding of the materials at the end of life.



Knowing about the materials in a ship **increases the value for Maersk**, as it increases the resell value and reduces the cost for input materials when reusing the ones from old ships. It has an **impact beyond the shipping industry** in transforming the way steel recycling is dealt with globally.



MAERSK



IKEA launches circular hubs at their stores to boost repair and reuse of their products

Circular hubs at IKEA



As part of its goal to become **people and planet positive**, IKEA strongly pushes **circular innovation** throughout the organization. In their **new circular hubs** now featured in IKEA stores, **used furniture is resold** and **workshops and learning** material is offered to enable customers to take best care of their products



IKEA **leverages user research and innovation** and collaborates with customers to **create circular solutions that work**. The company has piloted a broad range of circular innovations and learns and optimizes them based on real experience



By testing and **piloting a variety of circular innovations**, IKEA **speeds up their internal learning** and builds a **circular strategy** that **address their customers' needs**



Zenrobotics enables automated recognition and sorting of materials for reuse/ recycling

Zenrobotics



Zenrobotics builds **robots** that can **sort a variety of materials** both in existing material recovery facilities and demolition sites. With its robots, they are able to provide a **simple, unmanned sorting process** and makes waste sorting **safer, more accurate** and profitable and **make materials available** for reuse and recycling.



Zenrobotics harnesses the power of **artificial intelligence** to boost the quality and efficiency of waste sorting. The combination of **sensors, heavy-duty robot arms** and **unique AI** enables superior recognition and sorting material



By **leveraging and combining different technology innovations**, Zenrobotics is able to massively improve sorting of materials and thus facilitates the **first crucial step of closing the loop** on variety of materials.

ZENROBOTICS®



**Recycle material
for new products**

Werflink developed a platform for sharing excess construction materials

The Werflink Sharing Platform



Werflink provides a **digital and app-based platform** on which construction companies can **offer their excess production materials**, creating increased transparency on material and component availability in a region. An **analytical backbone** exists to optimize the market efficiency in the long term.



The platform was implemented through a **collaboration between public and private players** within the circular construction industry, as well as a **technology startup** providing the technical backbone



Over 300 construction companies are active on the platform



Reduce material per product

Apple designed robots that can take apart iPhones to recover valuable materials

Daisy and Dave – the disassembly robots



Apple developed Daisy and Dave to disassemble iPhones in a way that **maximizes the recovery of components and materials**. Apple collects old and broken iPhones through trade-in programs from its customers.



Daisy can recover materials from 15 different iPhone models at a speed of **200 devices per hour**. Dave **improves the recovery of rare earths**, steel and tungsten from the disassembled components.



In 2019, over **47,000 tons** of old devices were diverted from **landfill** through the trade-in program. The **aluminum recovered through Daisy** from old iPhones went into making the **cases for new MacBooks**.



P&G lead technology development to tag packaging for sorting and high-quality recycling

The Holy Grail Project



The Holy Grail Project aims to close loops by improving sorting of post-consumer packaging with the help of **chemical tracers and digital watermarks in the form of an optical code**. This will improve both quality and quantity of recycling material.



The project was set up in **collaboration with players along the packaging value chain**, including brand owners, plastic producers, waste collectors and packaging producers and the Ellen MacArthur Foundation.



The project **established a proof of concept**, showing applicability of the technology within existing recycling facilities. It is now being rolled out at larger scale, driven by P&G in collaboration with further industry players.



Recycle material for new products

The Amsterdam Economic Board facilitates public-private partnerships

Public-private partnerships towards the circular economy



The Amsterdam Economic Board **brings together governments, companies and knowledge institutions** in their path to the circular economy



Public-private partnerships enable a **network** of entities to work together on challenging questions that they cannot solve by themselves



One of the many realizations of the Amsterdam Economic Board is the **collaboration between five mattress producers** (Ikea, Beter Bed, Auping, Swiss Sense and Hilding Anders) to take responsibility for the end-of-life of mattresses. Today, already more than 75% of all mattresses are being recycled (compared to 33% before the collaboration)

amsterdam
economic
board



**Recycle material
for new products**

Renault and Suez commit to a strategic partnership through a joint venture, INDRA

The joint venture INDRA



Renault teamed up with Suez, a specialist in the management and recycling of waste, for the **end-of-life treatment of vehicles**



INDRA, the joint venture between Renault and Suez, brings together **complementary assets** in order to optimize the value of end-of-life vehicles



INDRA achieves **95,7%** recuperation of car mass. Moreover, INDRA allows Renault to **scale up** new recycling routes and solutions for better and cost effective dismantling



Terracycle launched the Loop™ initiative to reuse packaging at scale

The Loop™ initiative



Terracycle launched the **Loop initiative**: through a global ecosystem of industry players, consumers receive their products in durable and reusable packaging which is used over and over again



A vertical network of major brands and retailers, including direct competitors, provides sufficient scale for the initiative to succeed



Loop is now available in the UK, France and the US, and **continues to expand** in 2021 with launches in Canada, Japan, Australia and Germany



Reduce material per product

Alpla and BillerudKorsnäs invested in Paboco, to produce sustainable paper bottles

The joint venture Paboco



Paboco, creates paper bottles designed for circularity using renewable materials that harmlessly degrade in nature



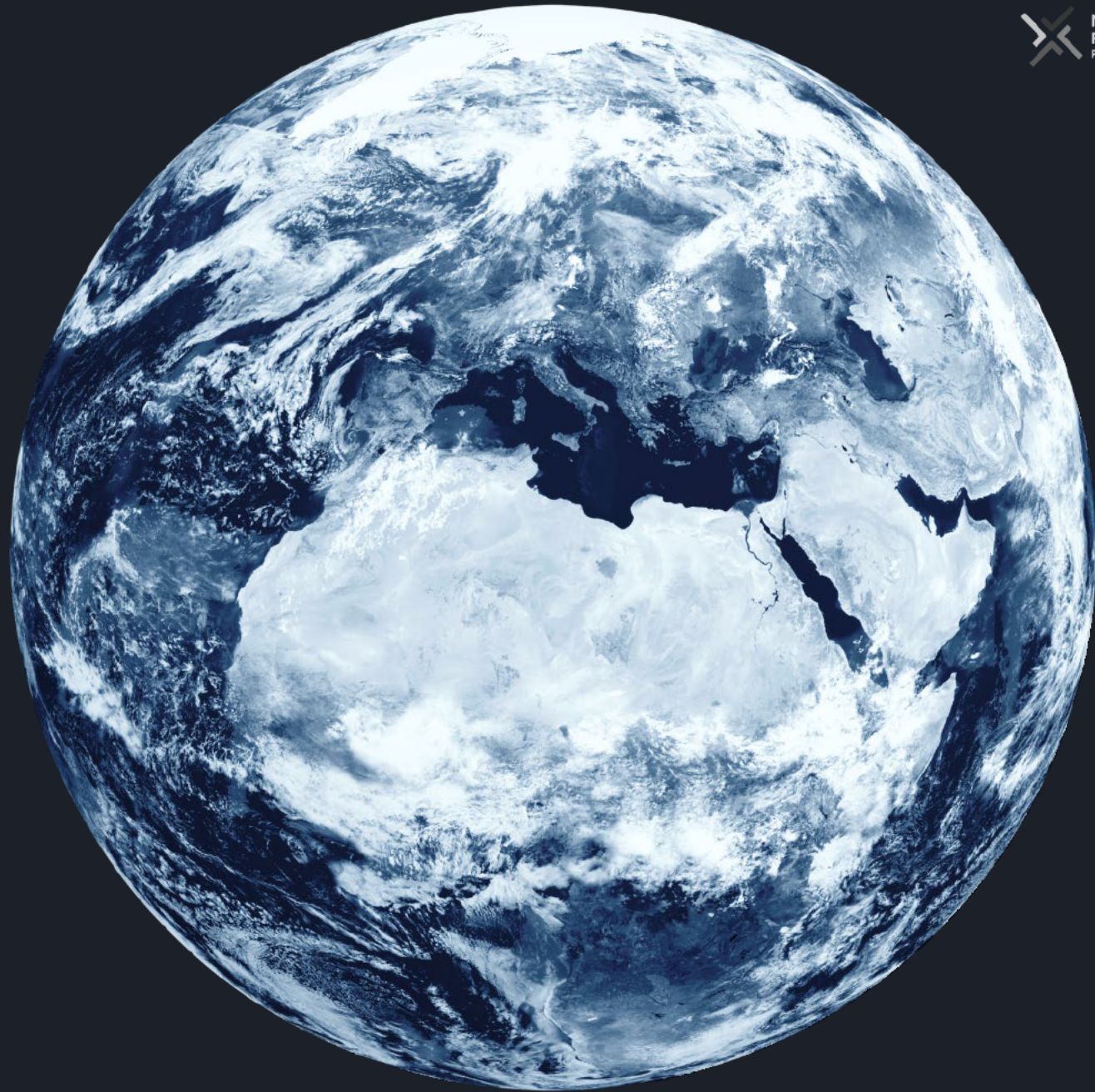
Alpla, a bottle manufacturing specialist, together with Billerud-Korsnäs, a paper packaging material developer acquired startup Paboco. Pooling complementary assets in a **separate startup entity**, allows for fast prototyping of innovative solutions



Through its 'Pioneer' community, Paboco has built up a **considerable network** of champions such as Carlsberg, L'Oréal, Coca-Cola and Absolut



**How can we
make a
difference
together?**



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