Reinventing Asia Pacific

Embracing a circular economy for a resilient tomorrow

December 2024

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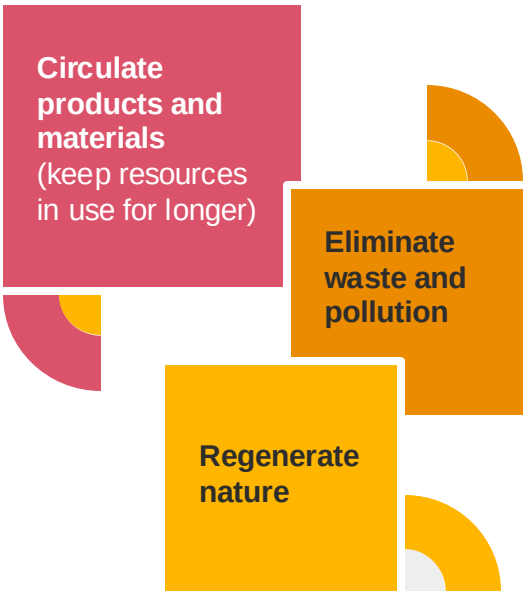
What is a circular economy?

A circular economy (CE) is a system designed to recapture waste as a resource and regenerate nature. It focuses on keeping products and materials in circulation through processes like maintenance, reuse, refurbishment, remanufacture, recycling and composting.

Core principles:



Key drivers and benefits:

- Cost savings and efficiency
- Resource scarcity and volatility
- Competitive advantage
- Risk mitigation
- Innovation and resilience
- Long term sustainability
- Collaboration and partnerships

The circular economy unlocks value through **five key innovative business models**, helping organisations operate more economically and sustainably:

Circular supplies	Resource recovery	Product life extension	Sharing	Product-as-a-service
Supplying fully renewable, recyclable or biodegradable resource inputs to replace linear resource approaches and phase out the use of scarce resources.	Recovers embedded value at the end of a product life cycle to feed into another one. This promotes transformation of waste into value through innovative recycling and upcycling services.	Allows the extension of products and assets' life cycle through repairs, upgrades, remanufacture or remarket. Additional revenue can be generated due to extended usage.	Facilitates the sharing of products which increases productivity and user value creation.	Provides an option for products to be used by customers through a lease or pay-for-use arrangement.

Why choose a circular economy?

Asia Pacific's growth, global manufacturing hub status and quality of life is under threat

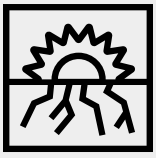
- The region stands at the forefront of the triple planetary crisis: climate change, pollution and biodiversity loss. It contributes nearly half of the world's emissions with three-quarters stemming from manufactured exports (Asian Development Bank and OECD).
- Asia Pacific leads in global plastic production and pollution. The region produces 51% of the world's plastics (Plastics Europe). In Southeast Asia, microplastic intake is among the highest in the world, with individuals consuming up to 15g per month – equivalent to three credit cards (Cornell University).
- Climate change further exacerbates the region's vulnerabilities, threatening food security and triggering mass displacement, which could affect up to 48.4 million people in East Asia and the Pacific, and 40.5 million in South Asia by 2050 (International Organization for Migration).

Climate change

Falling short on decarbonisation

20x faster

the rate the world needs to decarbonise in 2023 to limit global warming to 1.5°C

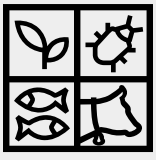


Severe weather

conditions are increasingly impacting the region, from record temperatures to devastating floods

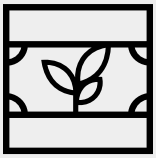
Biodiversity loss

Decline in biodiversity poses a financial and environmental threat



45% decline

in the region's biodiversity from 1970 to 2016



53%

of the region's economic value is moderately or highly dependent on nature

Pollution/waste

Surge in waste generation

71%

projected increase in the region's annual waste generation from 2016 to 2050

Over 70%

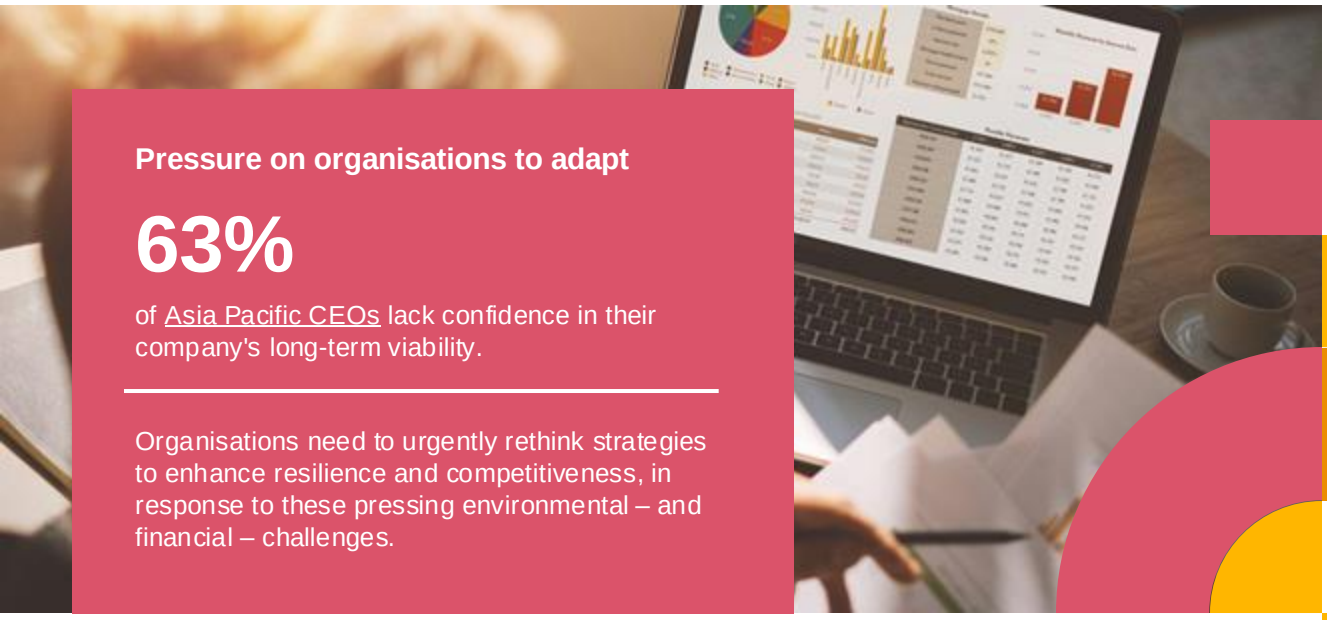
of the world's mismanaged plastic waste will come from the region by 2025

51%

the region's share of global plastic production in 2022

Sources: Plastics Europe, PwC, Statista, United Nation Environment Programme (UNEP)

Why choose a circular economy? (cont'd)



Pressure on organisations to adapt

63%

of Asia Pacific CEOs lack confidence in their company's long-term viability.

Organisations need to urgently rethink strategies to enhance resilience and competitiveness, in response to these pressing environmental – and financial – challenges.

A circular economy tackles emissions, cuts pollution/waste and revives nature

Lower emissions

By keeping products and materials in use for longer, the production of goods and waste is minimised, which reduces emissions from resource extraction, processing and disposal.

Cutting pollution / waste

Pollution and waste are reduced by decreasing the need for raw materials, manufacturing of new products and their disposal.

Reviving nature

Consumption of virgin resources is limited and waste reduced, which helps to preserve natural habitats, landscapes and support biodiversity.

According to United Nations Environment Programme (UNEP), by 2050, transitioning to a circular economy can lead to:

19%
cut in annual global greenhouse gas (GHG) emissions

17%
improvement in resource efficiency
(This results in reduced material processing and lower production of pollution and waste)

12%
decrease in global natural resource-use

Source: UNEP

Executive Summary

Highlights from PwC's study: Advancing a circular economy in Asia Pacific

Triple bottom-line impact on the economy, environment and society

To see how shifting to a circular economy (CE) could impact our region, we undertook a macroeconomic modelling analysis. Transitioning to a CE model in Asia Pacific could yield substantial benefits for the economy, environment and society.

If a circular economy were fully applied today in Asia Pacific*

Boost GDP by
US$339.6bn

+1.1 percentage point to GDP growth

Reduce carbon emissions by **1.7Gt**

-7.2% in carbon emissions

Create
15m new jobs

+1.0 percentage point to employment growth

Over the long-term to 2050

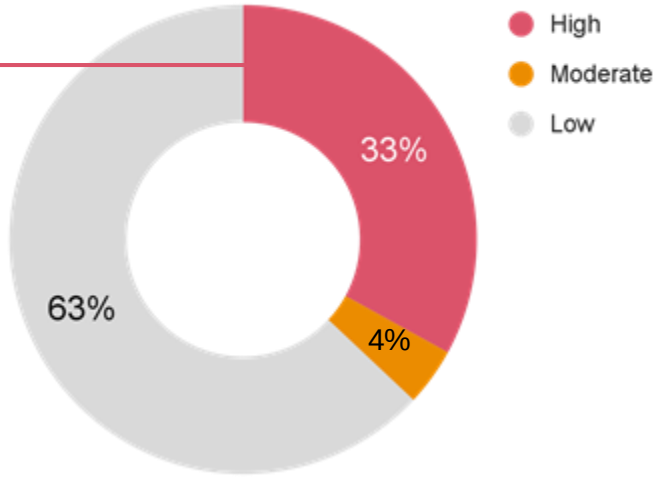
Reduce carbon emissions by
19%
According to UNEP

Impact on the economy (GDP)

33%

of the Asia Pacific economy could be highly impacted by a CE due to a shift in economic activities:

- **Away from high-carbon-intensive sectors** like mining, quarrying and manufacturing
- **Toward low-carbon-intensive sectors** such as maintenance, repair and operations (MRO), and recycling (e.g. waste management)



* The results presented are a snapshot of the potential impacts if CE were applied today, reflecting the outcomes over a oneyear period. The CE scenario model uses 2022 economic data for each of the 14 Asia Pacific territories selected and applies changes to material inputs. We have not specified a timeline for the realisation of this scenario, as the transition to a CE is occurring at varying rates across different sectors, making precise date predictions challenging.

Highlights from PwC's study: Advancing a circular economy in Asia Pacific (cont'd)

Projected GDP expansions

13x for MRO sector

5x for recycling sector

21% for construction sector
(driven by infrastructure expansion to support rising MRO and recycling activities)

A corresponding increase in emissions is expected for these sectors.

However, the carbon intensity of the MRO and recycling sectors remains **50% to 70% lower** than extractive and manufacturing sectors. The adoption of renewable energy can further mitigate this increase in emissions.

Sectors disrupted by the CE transition

- Mining and quarrying
- Petroleum, chemical and non-metallic minerals (PC&NM)
- Metals and equipment manufacturing

40%
of the region's carbon emissions come from these sectors, making them critical targets for decarbonising the economy

>20% reductions
in carbon emissions are projected for each of these sectors

10% to 25%
projected decline in these sectors' GDP

This underscores the economic and employment challenges posed by a CE transition.

To mitigate economic losses:

These sectors must integrate MRO and recycling activities, which offer high growth potential and lower carbon intensity.

Job disruption

The impact on jobs could be pronounced in certain sectors, particularly given the region's informal economy. This makes it crucial to enable a 'just transition' for workers.

New formal jobs created:		Jobs displaced:		Net new jobs:
153m jobs	–	**138m jobs**	=	**15m jobs**
10.5% of the region's workforce		9.5% of the region's workforce		

Highlights from PwC's study: Advancing a circular economy in Asia Pacific (cont'd)

Strategic transformation to unlock corporate value

As highlighted earlier in 'What is a Circular Economy?', organisations can unlock value through **five key innovative CE business models**:

1 Circular supplies | 2 Resource recovery | 3 Product life extension | 4 Sharing | 5 Product-as-a-service

Unlocking value through five key CE business models offers **substantial opportunities for value capture, creation and protection:**

New markets' opportunities

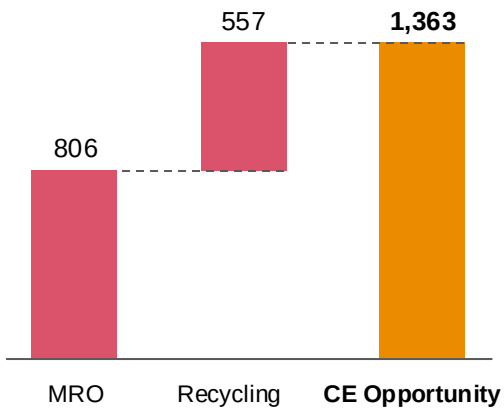
Cost savings

Reduced climate impact

Improved market pricing and positioning

Mitigating climate-related regulatory risks

GDP increases for MRO and recycling sectors in a CE scenario (US$bn)



Challenges and enablers to a circular transition

Driving the transition to a CE requires a multifaceted approach.

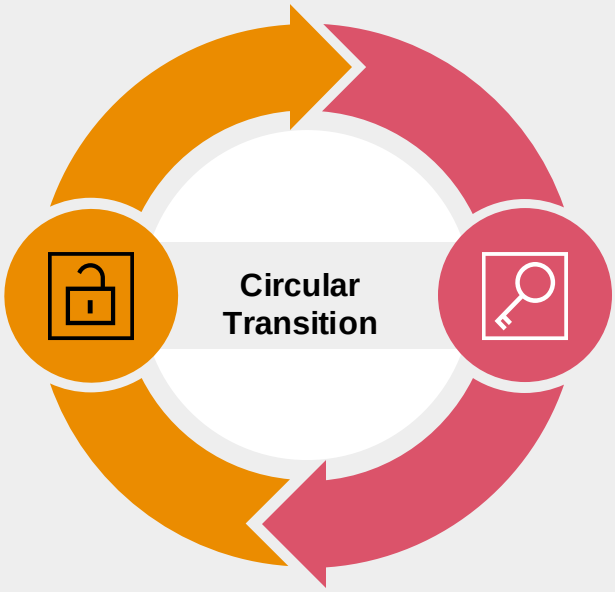
Challenges

Changing mindset and perception

Scaling-up

Economic and labour displacement vs. just transition

Costs of circular economy materials and products



Enablers

Building awareness and communication

Standards, incentives and sustainable financing

Designing and using technology and data

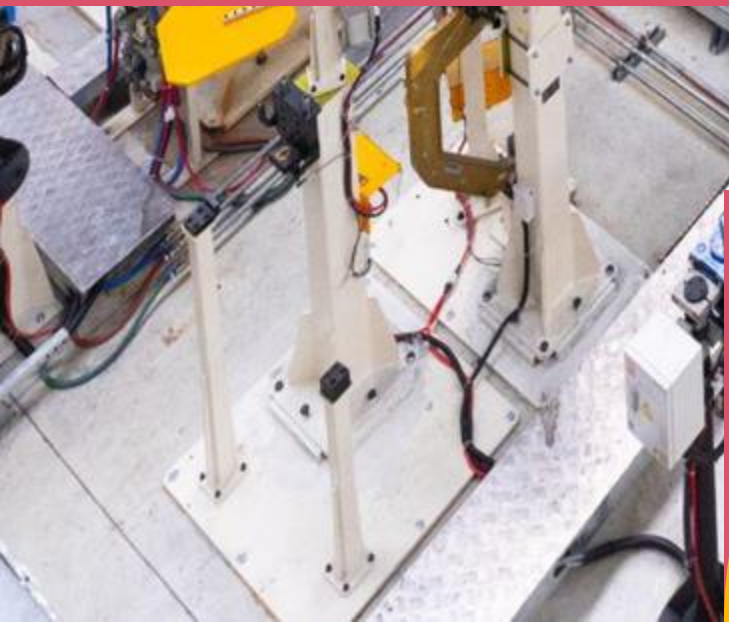
Collaboration, ecosystem thinking and integration

Developing capabilities and supporting a just transition

1

Introduction

Circular solutions for the triple planetary crisis



1. Circular solutions for the triple planetary crisis

The linear economy's take-make-use-dispose approach to consumption poses one of the most pressing existential threats of our time. It's driving climate change, pollution/waste and biodiversity loss – a triple planetary crisis.

In this report, we share our modelling analysis of how a circular economy (CE) could make a positive impact on the economy, jobs, industries and emissions in Asia Pacific. We'll guide you on how businesses can transition to a CE model, providing a roadmap for sustainable development in our region.

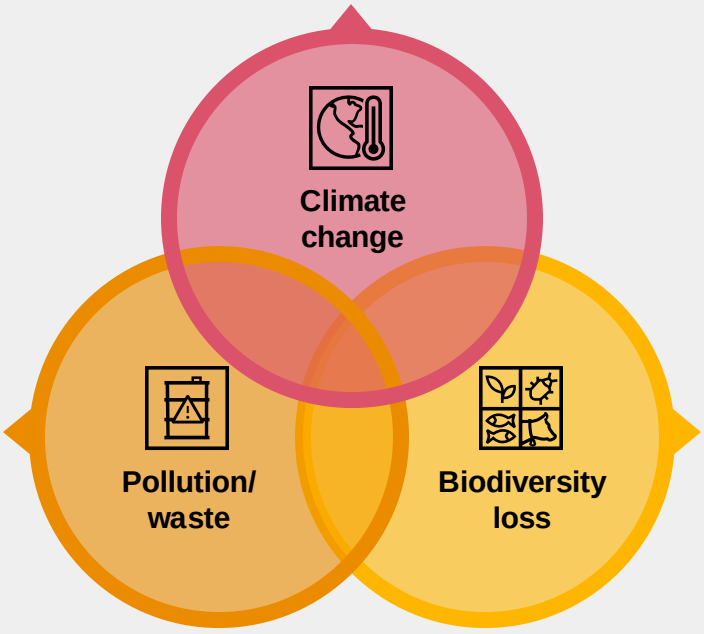
Figure 1: The triple planetary crisis

Climate change

- 2.5°C to 2.9°C temperature rise projected this century from climate pledges, nearly double the 1.5°C Paris Agreement limit.[1]
- The world must now decarbonise 20 times faster to limit warming to 1.5°C above pre-industrial levels.
- Asia Pacific carbon emissions from energy consumption rose by 4.7% in 2023, significantly higher than the world average of 1.6%.[2]

Pollution/waste

- Global annual waste management cost to nearly double to US$640.3bn as municipal solid waste is projected to grow by 81% from 2023 to 2050.[3]
- Asia Pacific's annual waste generation is projected to increase by 71% from 2016 to 2050.[4]



Biodiversity loss

- > 90% of water stress and biodiversity loss is attributed to material extraction and processing.[5]
- 45% decline in biodiversity observed in Asia from 1970 to 2016.[6]
- 53% of Asia Pacific's economic value is moderately or highly dependent on nature, posing financial risk.

Sources: Energy Institute, International Resources Panel, PwC, UNEP, World Bank

In Asia Pacific, the triple planetary crisis is hitting hard. We produced 51% of the world's plastic in 2022 and 81% of oceanic plastic waste.[7,8] By 2025 it is projected that over 70% of the world's mismanaged plastic waste will come from our region.[9] Electronic waste is another major issue globally, having surged by 82% from 2010 to 2022, making it the fastest-growing waste stream.[10]

Increasing resource scarcity is adding to the pressure, driving up prices and stressing supply chains. Human consumption now requires the resources of 1.7 planets, pushing Earth Overshoot Day to August 1 — the date when humanity's demand for ecological resources and services each year exceeds what Earth can regenerate in that year.[11]

We urgently need to act. PwC's Net Zero Economy Index shows that while we reduced carbon intensity by 1.02% in 2023, the world needs to decarbonise 20 times faster if we are to limit global warming to 1.5°C. To achieve a sustainable world, we must overhaul how we consume, build, manufacture and transport.

For Asia Pacific, the world's fastest-growing region and a global manufacturing powerhouse — contributing 48.5% of global manufacturing output — this transformation is both vast and complex.[12] It goes beyond any single territory or industry, requiring coordinated efforts from thousands of entities. We need rapid changes on both the demand and supply sides, and at scale.

While this challenge is significant, it also offers tremendous opportunities for creating value. This report explores how we can unlock this value by reinventing traditional business models through a CE. We highlight five key circular business models and share successful case studies. We also discuss the challenges and the necessary enablers to help you transition to a CE.

The market for sustainability is expanding rapidly, driven in part by government intervention. Global ESG assets under management are on track to surpass US$40 trillion by 2030, accounting for over 25% of total global assets under management, according to Bloomberg Intelligence.[13] This growth highlights the increasing financial commitment to sustainability principles.

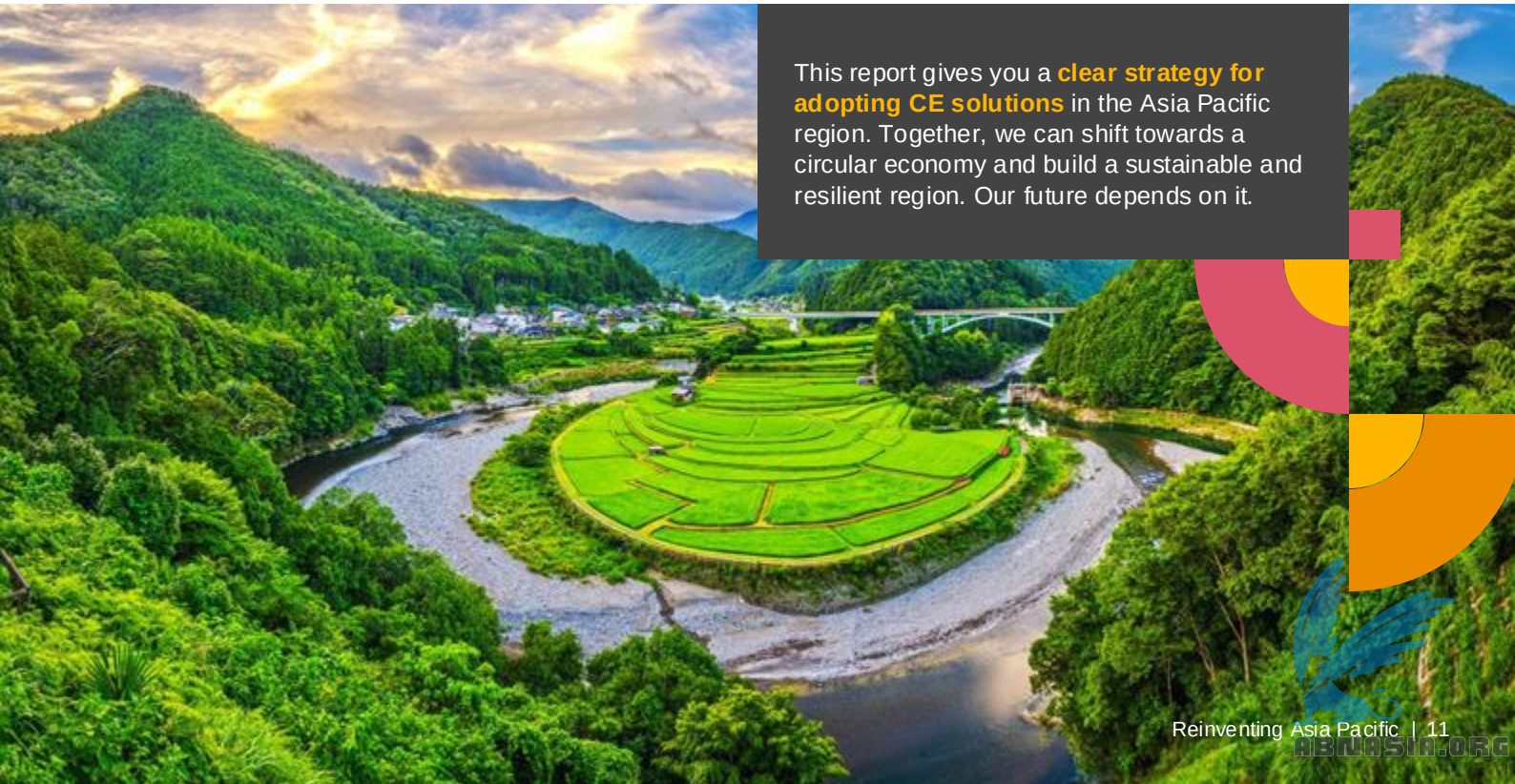
Businesses must transform to create sustained outcomes and remain resilient in changing times. Circular economy interventions, which keep resources in use for longer and promote the use of renewable resources, offer a holistic solution to these interconnected challenges. They reduce waste and pollution, preserve biodiversity and cut greenhouse gas (GHG) emissions.

According to the United Nations Environment Programme (UNEP), transitioning to a CE by 2050 could lead to:

19% cut in annual global GHG emissions

17% improvement in resource efficiency

12% decrease in global natural resource-use[14]



This report gives you a **clear strategy for adopting CE solutions** in the Asia Pacific region. Together, we can shift towards a circular economy and build a sustainable and resilient region. Our future depends on it.

2

Reinventing Asia Pacific's economy with circularity: PwC study

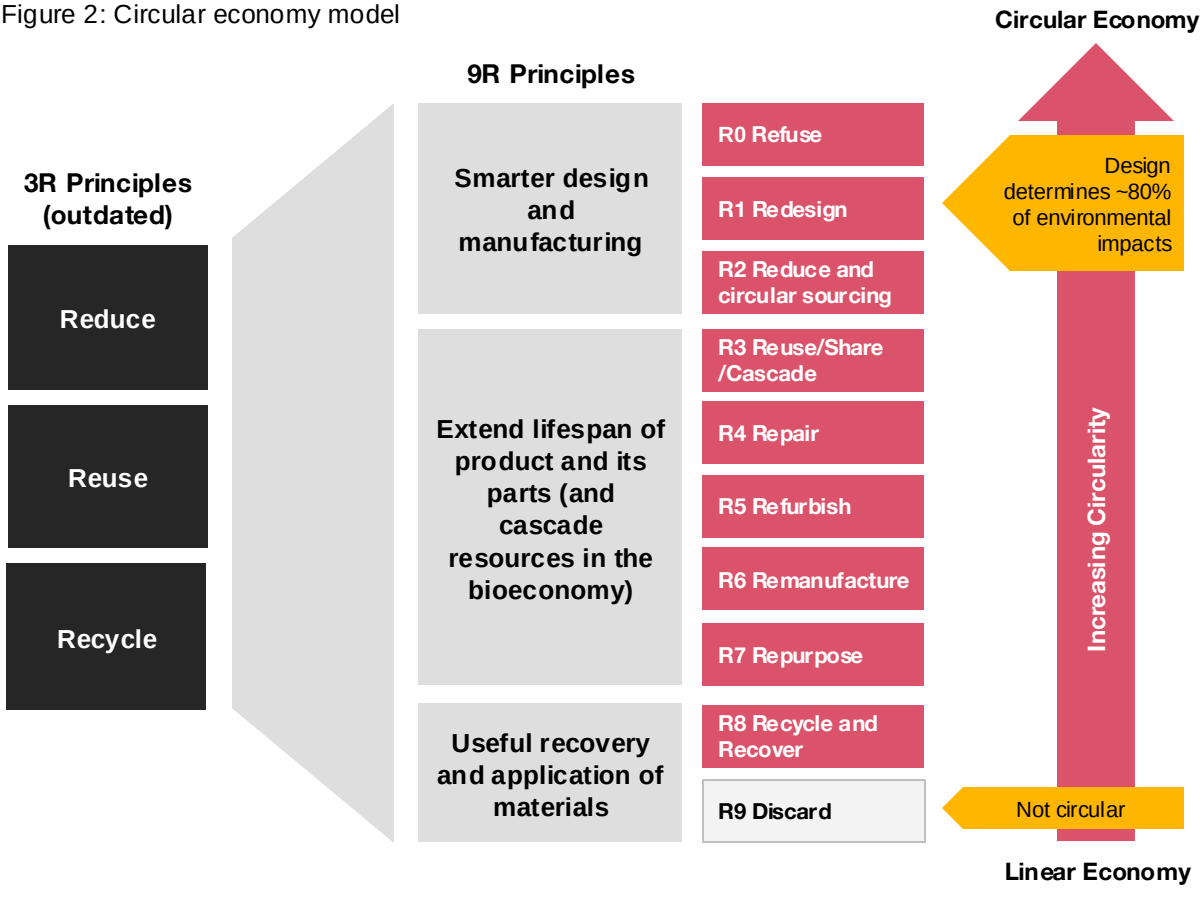
2. Reinventing Asia Pacific's economy with circularity: PwC study

The circular economy is about breaking the connection between economic growth and our reliance on finite resources. It focuses not only on recycling but also interventions in the beginning, middle and downstream of the supply chain including design, material substitution and repair to extend the life of products.

This model changes how we produce and consume by:

- Keeping resources in use for longer, designing out waste (creating products and systems that minimise waste, maximise reuse and recyclability) and bringing materials back into the economy at the end of their life.
- Using circular principles in every step of the production and product lifespan, from sourcing and design to recycling, refurbishment, reuse, maintenance and sharing.

Figure 2: Circular economy model



Note:

R1- R9, part of the 9R Circular Economy Framework. Please refer to page 21 for more details.

Source: PwC analysis

PwC study on circular economy modelling

To see how shifting to a CE could impact our region, we undertook a macroeconomic modelling analysis. Our model examines the long-term impact of this change on our economy, jobs and emissions, showing the potential socioeconomic and environmental benefits of adopting circular economy principles.

It uses input-output (IO) methods to examine changes in production inputs from Asia Pacific territories between baseline and CE scenarios.

A list of the territories we modelled, the scope and limitations of the model can be found in Appendix I.

The results: Circular economy triple bottom-line impact

High-level analysis of the model shows that adopting a CE could boost economic and job growth in the Asia Pacific region while reducing environmental impact and carbon dioxide equivalent (CO2e) emissions. It's a mutually beneficial scenario where sustainable practices not only fuel economic prosperity and social value but also alleviate environmental stress.

Figure 3: Asia Pacific CE modelling summary results – baseline vs CE scenario

	Baseline	CE scenario	Net change	Percentage net change
GDP (US$bn)	29,568	29,907	340	1.1%
FTE (million)	1,449	1,464	15	1.0%
Emissions (Mt CO2e)	23,602	21,898	-1,704	-7.2%

Mt – megatonne
Source: PwC analysis

Comparing the baseline with a scenario where a circular economy is fully implemented today* reveals the following results:

Net GDP increase of
1.1% (US$339.6 bn)

A CE could add 1.1 percentage points to the Asia Pacific region's 2022 GDP growth of 3.9% (equivalent to US$339.8 billion).[15]

Net employment increase of
1.0% (15m new jobs)

A CE could add 1.0 percentage point to the region's 2.0% employment growth reported between 2019 and 2022.[16] This is equivalent to creating 15 million full-time equivalent (FTE) jobs and includes transitioning people in new jobs from informal work into formal employment.

(Please note that while this growth reflects formal job creation, some positions may already exist in the informal sector and are not currently counted in government employment statistics. Formalising workers, if managed appropriately, can help to establish decent work conditions and living wages.)

Net emissions reduction of
7.2% (1.7 gigatonnes CO2e)

This is in comparison to actual CO2e increase of 1.2% in 2022.[17]

As mentioned in the earlier section, UNEP projects a

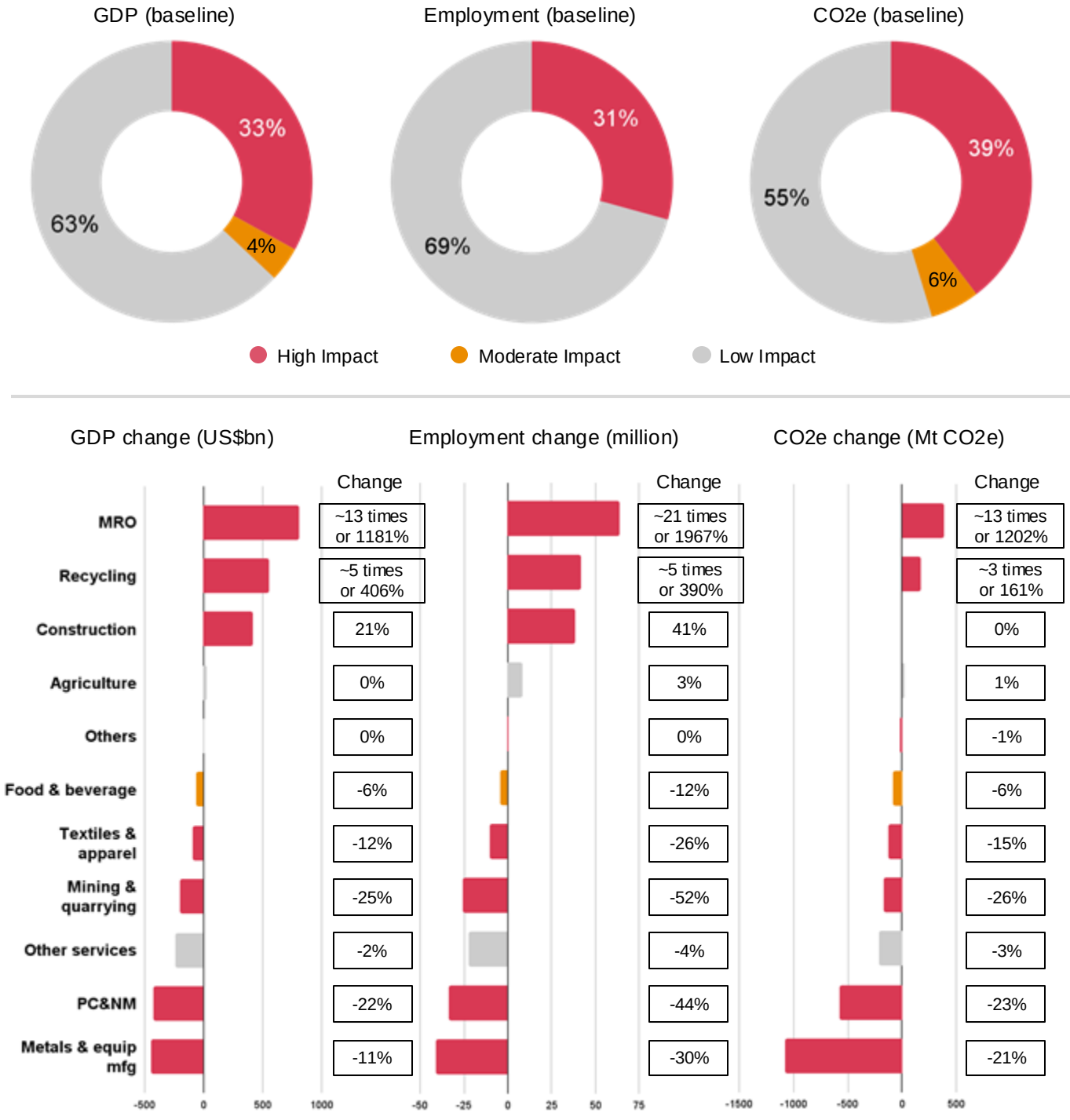
19%

decrease in emissions from circularity by 2050, aligning with the Intergovernmental Panel on Climate Change (IPCC) scenario analysis.[18]

* The results presented are a snapshot of the potential impacts if CE were applied today, reflecting the outcomes over a one-year period. The modelling uses 2022 economic data for each of the 14 Asia Pacific territories selected and applies changes to material inputs, resulting in a CE scenario model. We have not specified a timeline for therealisation of this scenario, as the transition to a CE is occurring at varying rates across different sectors, making precise date predictions challenging.

Circular economy sector interdependencies

Figure 4: Impact of a CE on Asia Pacific GDP, employment and emissions



Notes:

- High impact: More than 10%; and less than –10%
- Moderate impact: Between 5% and 10%; and between –5% and –10%
- Low impact: Between –5% and 5%
- Glossary: MRO - Maintenance, repair and operations; and PC&NM - Petrochemicals and non-metallic minerals
- The overall emission reductions in the CE scenario do not account for the transition to renewable energy within the energy sector. The model results focus solely on emissions driven by improved resource utilisation, highlighting the substantial impact of a circular materials transition in isolation. However, to achieve net zero goals, both the circular economy and energy transition must be implemented in tandem.

Source: PwC analysis

A CE transition could significantly impact more than one-third of the Asia Pacific economy. In particular, under the CE scenario, there is substantial economic potential in the maintenance, repair and operations (MRO), recycling and construction sectors:

- **MRO sector:** GDP is expected to expand around 13 times compared to the baseline level, growing more than twice as fast as the recycling sector. This highlights the significant growth potential in reuse, repair, refurbishing, remanufacturing and repurposing, which surpasses that of recycling and recovery.
- **Recycling sector:** GDP is expected to expand 5 times compared to the baseline level. This growth is driven by the increased use and demand for recycled materials in manufacturing inputs instead of virgin inputs.
- **Construction sector:** GDP is expected to expand by 21% compared to the baseline level, driven by infrastructure expansion to support rising MRO and recycling activities.

Concurrently, there is an increase in emissions and employment for the MRO and recycling sectors due to increased economic activities. Despite the rise in CO2 emissions in the MRO and recycling sectors, their carbon intensity is 50% to 70% lower than that of the manufacturing sector. In contrast, the construction sector sees nearly zero emissions growth, driven by a strong focus on waste reduction and material reuse.

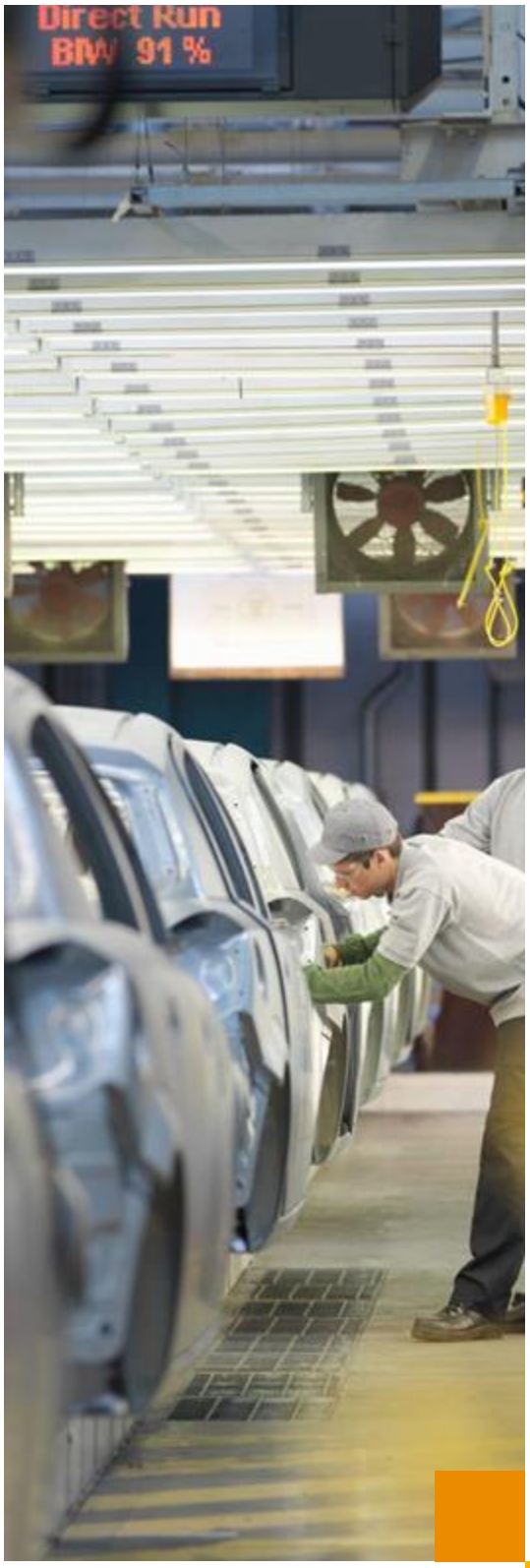
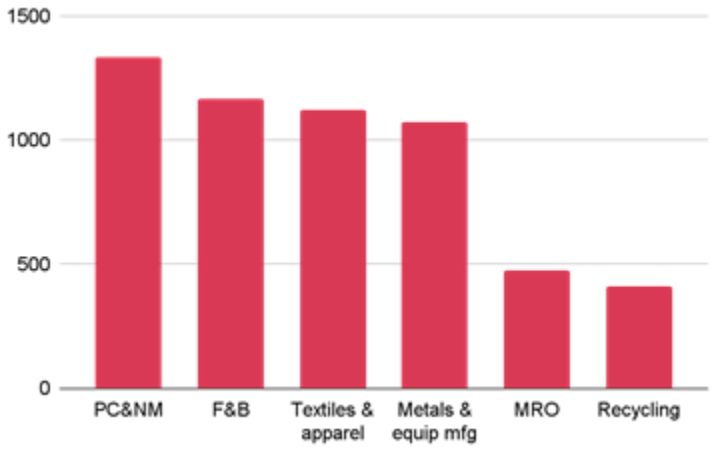


Figure 5: Carbon intensity in Asia Pacific's manufacturing, MRO and recycling sectors in CE scenario (tCO2e/GDP)



Note:

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Source: PwC analysis

The sectors disrupted by the CE transition are:

Mining and quarrying

Petrochemicals and non-metallic minerals (PC&NM)

Metals and equipment manufacturing

Together, these sectors contribute nearly 40% of the total baseline carbon emissions in Asia Pacific. In our CE scenario model, these sectors show the most significant declines in emissions in terms of percentage:

Mining and quarrying:

26%
reduction
equivalent to 172 Mt CO_2e

PC&NM:

23%
reduction
or 577 Mt CO_2e

Metals and equipment manufacturing:

21%
reduction
or 1,085 Mt CO_2e

However, these sectors are also expected to face substantial declines in GDP and employment, given that they account for 23% of the region's baseline GDP and 18% of its baseline employment:

Mining and quarrying:

25% drop in GDP | **52%** fall in jobs

PC&NM:

22% drop in GDP | **44%** fall in jobs

Metals and equipment manufacturing:

11% drop in GDP | **30%** fall in jobs

These figures underscore the significant economic and employment challenges posed by the transition to a CE.

To mitigate these losses, it is crucial for these sectors to transition their business models to ones which are compatible with a CE future. This shift offers a win-win approach to both decarbonisation and economic outcomes.

For instance, integrating MRO and recycling activities within existing extractive and manufacturing industries can help mitigate job and GDP losses as low-carbon pathways that can help these sectors transition towards a net-zero economy.

Spotlight on steel

Certain traditional industries have already implemented a circular economy. Steel is now one of the most recycled materials in the world. South Korea reached a 40% ratio of scrap steel usage in crude steel production in 2021.[19]

While the shift to a CE would be a big step forward, we know it could also cause some major disruptions, especially in certain sectors where jobs are heavily impacted. That's why it's so important for us to establish a 'just transition' for workers, including the 1.4 billion people working in the informal economy across the Asia Pacific region — that's about 68% of the employed population.[20]

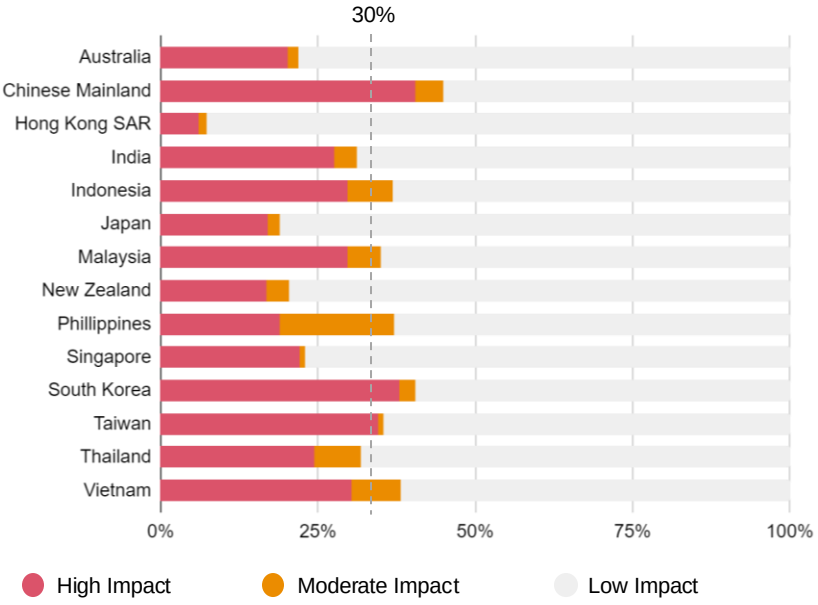
Though some recycling and MRO activities could take place in the incumbent manufacturing sectors (as discussed in the modelling assumptions, and below), workers may still need to develop new skills for the CE transition.

More information on how a CE would impact different sectors, can be found in Appendix II.

Economic impact of a circular economy across territories

The chart below illustrates the proportion of each Asia Pacific territory's GDP that will be highly, moderately or minimally impacted by the CE transition, based on the economic make-up of each territory.

Figure 6: Economic impact of transitioning to a CE across the Asia Pacific region



Notes:

- High impact sectors: Metals and equipment manufacturing, PC&NM, mining and quarrying, textiles and apparel, construction, recycling and MRO
- Medium impact sectors: Food and beverage
- Low impact sectors: Agriculture, other services and others

Source: PwC analysis

Territories with less than 30% of GDP in highly impacted sectors

In Vietnam, Malaysia, Thailand, the Philippines, India and Indonesia, economies are largely dependent on extractive and manufacturing sectors, with underdeveloped MRO and recycling sectors. However, these territories are well-positioned to seize CE opportunities, which can fuel economic growth, create jobs, lower carbon emission and curb environmental degradation. To help achieve a successful transition, investments in infrastructure, workforce upskilling and formalisation of informal workers should be considered and evaluated to assess how to best capture CE opportunities.

Australia's large extractive sector will continue to supply critical materials but can expand on material recovery and processing to tap into secondary resource markets. Japan benefits from its already advanced recycling and manufacturing sectors, along with its lower dependence on extractive industries and larger services sector. Meanwhile, New Zealand's smaller extractive and manufacturing base positions it for lower impacts. Both territories can focus on data analysis, innovation and transforming business models to unlock new circular opportunities.

Singapore's manufacturing and extractive sectors will be affected though these are relatively smaller in size, the large services and financial sectors will be less affected by the CE transition.

In Hong Kong SAR, where the services sector dominates, the CE transition will have lower disruption to this sector. However, integrating secondary materials remains a challenge due to limited domestic recycling capacities.

Territories with over 30% of GDP in highly impacted sectors

Chinese Mainland, South Korea and Taiwan's substantial manufacturing and recycling industries will face significant changes. Chinese Mainland's extractive sector will also be affected. To navigate these changes, these economies should continue to innovate and transform linear businesses to capitalise on opportunities to provide circular goods and services.

Overall, the CE transition will affect each Asia Pacific territory uniquely, depending on its economic structure and sector maturity. Adapting strategies to these specific contexts is essential for identifying opportunities, mitigating risks, and unlocking the full potential of CE business models for long-term growth and sustainability. The implementation of these models is key to driving transformation, offering a clear pathway for unlocking economic and corporate value, as explored in the next section.

3

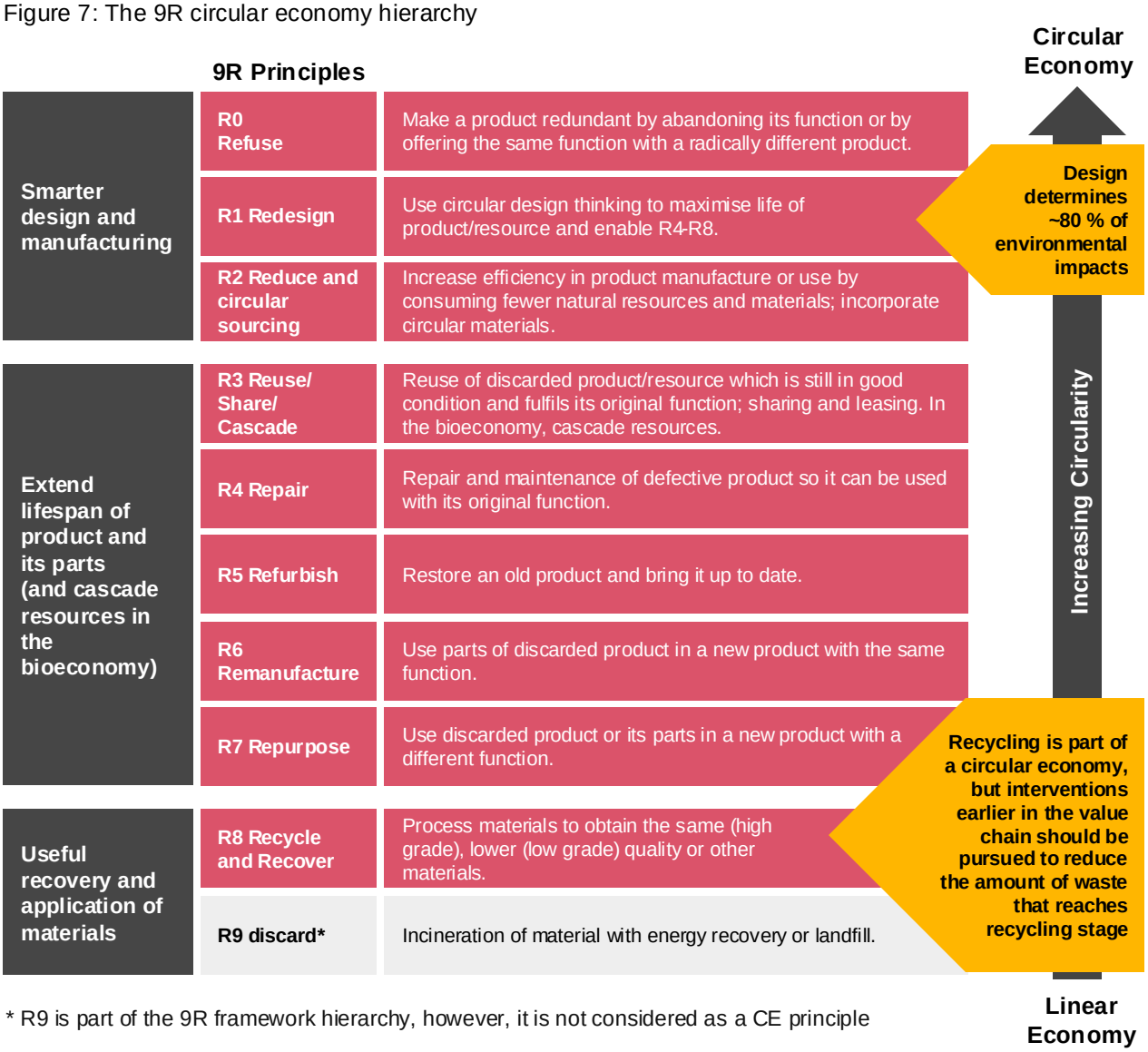
Unlocking corporate value - your guide to success

3. Unlocking corporate value - your guide to success

The 9R circular economy framework

The '9R Framework for the Circular Economy' is the recognised blueprint for implementing circular models. This framework, ranging from R0 (refuse) to R9 (discard), provides an extensive set of interventions across the product and material value chain. Implementing these principles enables businesses to capture and create value, fostering innovation, resilience and sustainability in their operations.

Figure 7: The 9R circular economy hierarchy



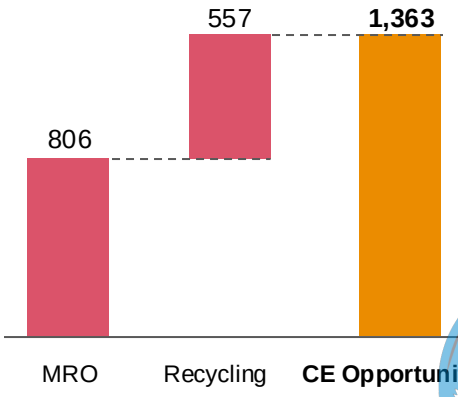
* R9 is part of the 9R framework hierarchy, however, it is not considered as a CE principle

Source: Adapted from PBL Netherlands Assessment Agency[21]

The 9R framework can be further categorised into five circular business models — circular supplies, resource recovery, product life extension, sharing and product-as-a-service. These offer strategies and opportunities for businesses to change revenue model, enhance competitiveness and foster innovation, while contributing to sustainability. Their adoption depends on the sector relevance, impact and feasibility.

These models include the MRO and recycling sectors, which together have the potential to add US$1.36 trillion to the economy (GDP) under the CE scenario. Importantly, MRO and recycling can be vertically integrated into the existing sector supply chain. For example, manufacturers can incorporate MRO, and the extractive industry can engage in recycling, thereby preserving value without reducing the production of new goods or the extraction of virgin materials.

Figure 8: GDP increases for MRO and recycling sectors in a CE scenario (US$bn)



Source: PwC analysis

Shifting from traditional to circular business models

Here's a closer look at how traditional business models can shift to a circular model, some successful case study examples and the opportunities gained.

Figure 9: Transitioning to the five circular business models

	Circular supplies	Resource recovery	Product life extension	Sharing	Product-as-a-service
Traditional model:	Products are made from virgin raw materials.	Businesses dispose of waste materials or by-products.	Products are designed with a limited lifespan, leading to frequent replacements.	Businesses focus on individual ownership of products.	Businesses sell products directly to consumers, and the ownership is transferred to the buyer.
Circular model:	Companies use renewable, recycled, or biodegradable materials as inputs to reduce reliance on finite resources and minimise waste.	Companies identify waste streams and find ways to recover and reuse materials, turning waste into valuable inputs for the same or other processes.	Companies design products that are durable, repairable, and upgradable, extending their useful life and reducing the need for new production.	The sharing economy emphasises access over ownership, where multiple users share access to a product or service. This reduces the need for each individual to own the product, thereby decreasing overall production and resource use.	Companies retain ownership of the product and offer it as a service. Customers pay for the usage rather than ownership (e.g., leasing or subscription models). This promotes the return of products to the company for repair, refurbishment, or recycling, extending their life cycle and reducing waste.
Case study:	Dole Sunshine Company, the Philippines	Contemporary Amperex Technology Co. Limited (CATL), Chinese Mainland	Renault Group, France	A Distributed District Cooling (DDC) network, Chinese Mainland	nornnorn (Circularity Co., Ltd), Thailand
Opportunity:	New markets for agricultural waste	Electric vehicle (EV) battery recycling	Repair and remanufacture of car parts to reduce waste and costs	Lowers cooling and heating costs, CO2 emissions and capital outlay	Pay-as-you-use subscription service for mattresses creating recurring income

Five circular economy business models and case studies

1. Circular supplies

Case study:

Dole Sunshine Company (Dole), a global food and beverage company, has partnered with Philippines-based social enterprise, Musa Fabric. They have turned extracted banana waste fibre from Dole's Philippines plantations into yarn, creating over US$50 million in fashion products. They also train local communities in banana fibre extraction, weaving and designing, creating livelihoods. The initiative aims to reduce 258,720 tonnes of CO2e emissions.[22]

In a separate study, turning banana waste into fabric has increased Indian farmers' income by up to 300%.[23] This success highlights the potential of converting other types of agricultural waste into fibres, offering similar economic benefits to communities.

2. Resource recovery

Case study:

Chinese Mainland battery producer, Contemporary Amperex Technology Co., Limited (CATL), through its subsidiary Brunp, handled 100,000 tonnes of used batteries (about 250,000 EV batteries), recovering up to 99.6% of nickel, cobalt and manganese and 91% of lithium from its products in 2023.[24]

CATL estimates that only about 5% of EV batteries globally are currently recycled, with lithium extraction from spent cells particularly challenging and costly.[25] To improve this Brunp has developed or revised 369 battery materials and recycling standards, filed 4,527 patents and invested US$4.5 billion in a Hubei recycling project, which is expecting to recycle up to 500,000 tonnes of spent battery materials.[26] A similar project in Guangdong could see investments reaching US$3.3 billion.[27]

3. Product life extension

Case study:

Carmakers such as Renault Group, are renovating, repairing and reusing used vehicles, batteries and parts. Through its Refactory ecosystem, the company creates new value by closing the loop of a vehicle's life cycle, creating economic, environmental and social value. Its Flins Refactory site, near Paris, undertakes:

- Re-trofit: reconditioning of used vehicles
- Re-energy: repairing and developing applications for batteries in second life such as energy storage
- Re-cycle: for recycling, resource management and the manufacture of its E-Tech smart gearbox – a highly efficient hybrid gearbox
- Re-start: a training and Research and Development centre dedicated to the CE.[28]

Based at the Flins Refactory, Renault Group launched The Remakers in May 2024 as a new European leader in automotive parts refurbishment, with a goal to achieve 50% business growth by 2030.[29]

The Remakers offers an expanded range of 9 families of automotive components, which are on average 30% more economical for the customer and more environmentally friendly.[30] Given the substantial growth potential of the European replacement parts market — valued at approximately €6.8 billion in 2022 and projected to expand to €8.2 billion by 2030 — the launch of The Remakers aligns with a promising and expanding industry.[31]

Five circular economy business models and case studies (cont'd)

4. Sharing

Case study:

A Distributed District Cooling (DDC) network provides cooling to multiple buildings through a centralised chiller plant, reducing the need for individual plants. This lowers energy consumption, carbon emissions and costs, as heating, ventilation and air conditioning (HVAC) systems account for 40-60% of building energy use or 15% of global energy consumption.[32]

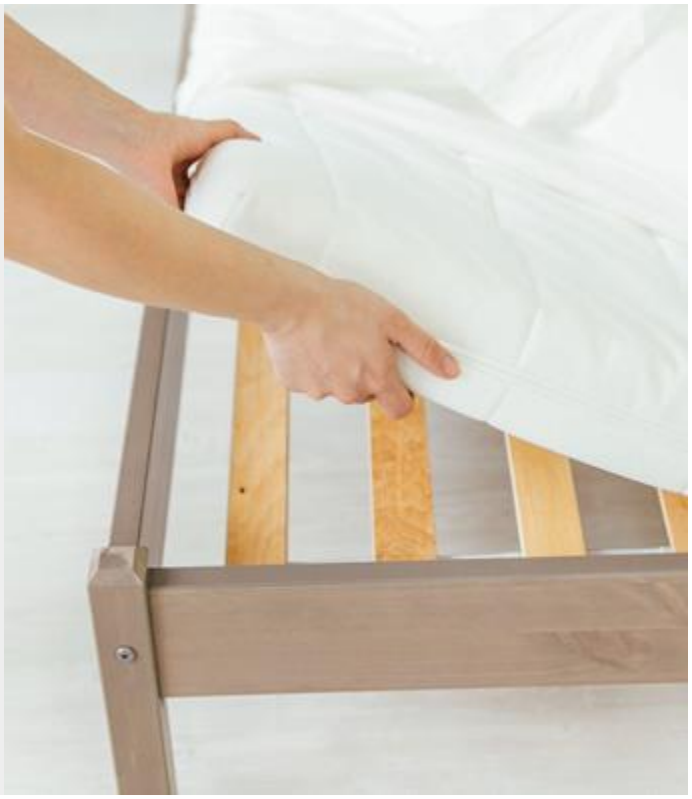
Singapore's SP Group is to invest over US$27.6 million in a district cooling and heating system for a sports park in Chengdu, Chinese Mainland. Operational in 2025, it will improve energy efficiency by over 30% for cooling and 50% for heating, saving 2,900 megawatt hours (MWh) of electricity and reducing carbon emissions by 1,700 metric tonnes annually.[33]

5. Product-as-a-service

Case study:

nornnorn (Circularity Co., Ltd), a Bangkok-based, Singapore-incorporated start-up, is pioneering a pay-as-you-use subscription service for premium quality recyclable mattresses. It makes mattresses more financially viable for hospitality businesses, related industries and individual consumers, while minimising waste generation and reducing emissions by collecting and recycling used mattresses.

The company aims to serve 367,000 B2C and 41,000 B2B subscriptions by the end of 2029. It expects to recover at least 2.3 million mattresses, or around 73,000 tonnes of materials and prevent at least 70,000 tonnes of GHG emissions. It plans to extend its service to other durable consumer goods, such as electronics, solar cells and batteries, further contributing to sustainable consumption patterns.[34]



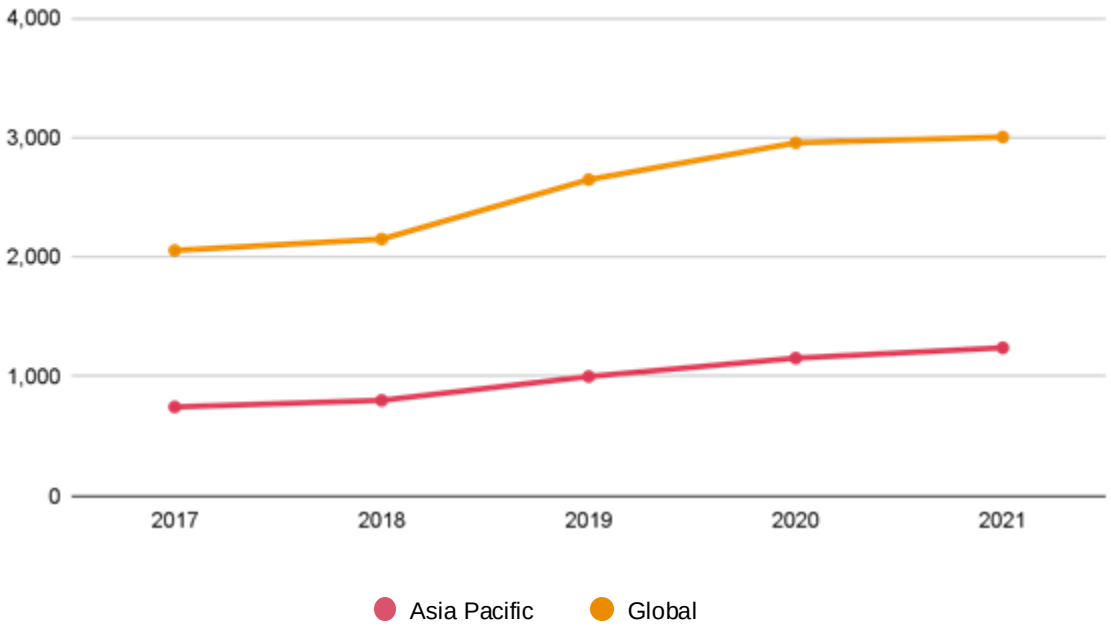
How a circular economy creates value for organisations

1. New markets' opportunities

Businesses can position themselves to capture new market opportunities that cater to the growing customer demand for sustainability, resource efficiency and innovation.

Among the growth areas is waste management technology. Patents for the technology — including material recovery, recycling and reuse — have increased by 46% globally from 2017 to 2021, reaching a total of 3,004 patents. The growth in Asia Pacific has been even more remarkable, surging by 67% over the same period and accounting for 41% of the total patents in this category.[36]

Figure 10: Growth in patents for waste management technologies



Source: Organisation for Economic Co-operation and Development (OECD)[37]

2. Cost savings

A CE can help businesses save costs by capturing and utilising waste and optimising logistics.

For example, in the fast-moving consumer goods sector, a CE could lead to net material cost savings of roughly up to US$700 billion per annum globally. These material savings would represent about 20% of the materials input costs incurred by the consumer goods industry.[38.] Digital technologies and data analytics can further optimise CE business models and improve operational efficiency.

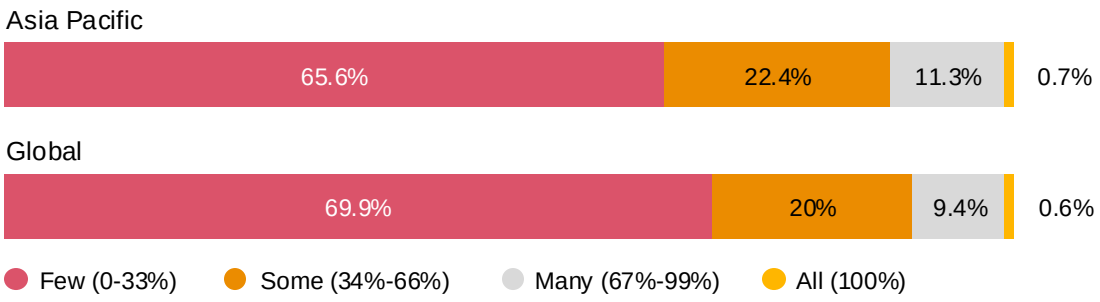
3. Reduced climate impact

In terms of global GHG emissions, over the long-term (2050) a CE can reduce 19% of Asia Pacific emissions, complementing energy transition efforts at reducing the 75% of emissions which come from fossil fuels.[39]

The adoption of CE models is also crucial for enhancing supply chain resilience, particularly for critical minerals and components essential to the energy transition and EVs.

In Asia Pacific, a minority of companies have credible climate transition plans. This makes a CE a critical component for building a net zero strategy — and a market differentiator.

Figure 11: Disclosure of climate transition plan indicators by disclosure tier, 2023



Source: CDP[40]

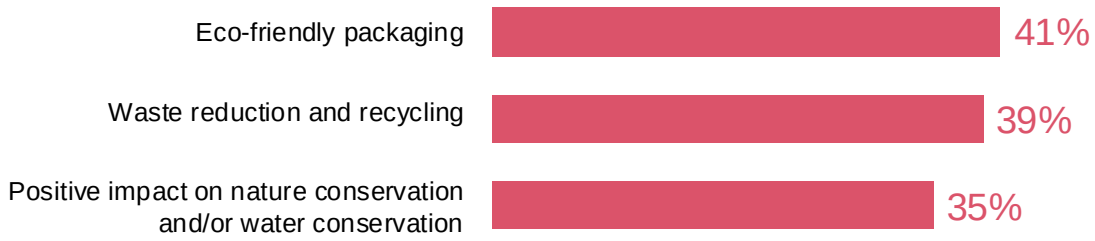
4. Improved market pricing and positioning

Efforts to reduce climate and environmental impact through a CE can enhance companies' pricing and market strategies.

According to PwC's Voice of the Consumer 2024, half of Asia Pacific buyers are already purchasing more sustainable products, with over 40% being more mindful of their consumption. They are willing to pay nearly 11% above the average price for sustainable products, surpassing the global average of 9.7%.

The survey also highlights the top three sustainability factors influencing consumer purchases: sustainable packaging, waste reduction and recycling, and nature preservation. A CE can address these.

Figure 12: Brand sustainability metrics that influence consumer purchase likelihood



Source: PwC Voice of the Consumer Survey 2024: Asia Pacific

While consumers prioritise sustainability, they also face significant cost-of-living pressures. From the same survey, nearly two-thirds (61%) of Asia Pacific consumers identified inflation as the greatest threat to their consumption habits in the coming year. CE's potential to reduce costs and pass on these savings to consumers can become compelling selling points for products.

Companies with better ESG ratings have shown an average annual return of 12.9%, compared to 8.6% for those with lower ratings.[41]

5. Mitigating climate-related regulatory risks

Managing compliance risks is crucial as new regulations take effect, with a raft of CE related regulations coming from the European Union (EU), United States and Asia Pacific territories. These regulations compel companies to comply to avoid fines, reputational risk and higher taxes. They cover reporting, Extended Producer Responsibility (EPR), design and packaging standards and carbon taxes, among others.

Companies supplying to EU and international markets will need to adhere to the EU's Corporate Sustainability Reporting Directive (CSRD) if they have a large EU-based subsidiary or are listed on the EU market. Additionally, they must comply with the Ecodesign for Sustainable Products Regulation (ESPR), which will apply to all manufactured goods placed on the EU market.

We are also seeing a rise in CE policy adoptions globally, with 75 national CE roadmaps and strategies launched, and more than 520 CE-related policies worldwide.[42] As regulatory and consumer pressures intensify, circularity assessments will increasingly influence investment decisions.

Not adopting CE principals poses risks to business viability. According to PwC's 27th Annual CEO Survey, 63% of Asia Pacific CEOs remain uncertain about their company's viability beyond a decade without change. Companies that fail to reinvent their business models, as in the case of CE, risk falling behind competitors and becoming obsolete.

CSRD criteria

Asia Pacific businesses in the following categories should expect to be impacted at a legal entity and/or a consolidated level:

- Single entities listed by debt or equity on an EU-regulated market
- Large single EU-based entities that meet two of three of the following criteria over two consecutive financial years:
  - More than > 250 employees
  - More than > EUR€25 million assets
  - More than > EUR€50 million net turnover
- Non-EU companies with an EU subsidiary or EU branch fulfilling certain criteria, and net turnover of more than > EUR€150 million in the EU in each of the last two consecutive financial years

4

Challenges and enablers

4.Challenges and enablers

Transitioning to a circular economy presents challenges, but there are ways to ease the process. While shifting from the traditional linear model requires overcoming perception, economic, technological and operational hurdles, it also offers numerous opportunities for innovation and value creation.

Figure 13: Circular economy challenges and enablers

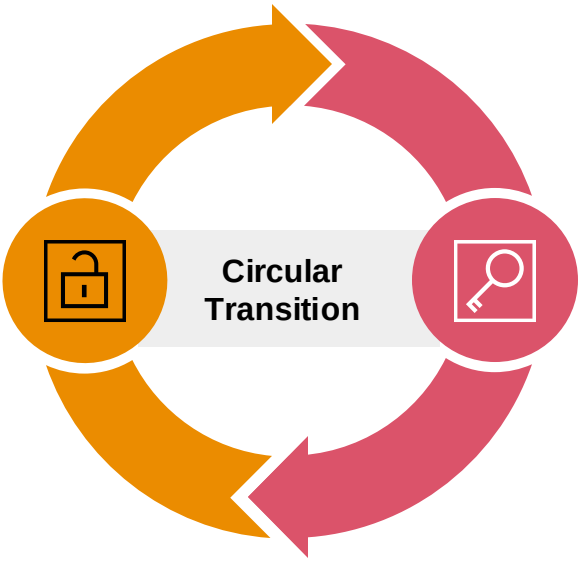
Challenges

Changing mindset and perception

Scaling-up

Economic and labour displacement vs. just transition

Costs of circular materials



Enablers

Building awareness and communication

Standards, incentives and sustainable financing

Designing and using technology and data

Collaboration, ecosystem thinking and integration

Developing capabilities and supporting a just transition

Challenges adopting a circular economy

1. Changing mindset and perception

A significant challenge in transitioning to a CE is changing the mindset and perception of all stakeholders, including boards, C-suites, suppliers, consumers and policymakers. They need to understand that a CE goes beyond waste management and recycling, encompassing five innovative business models and the 9R principles.

A lack of understanding of existing regulations, reporting requirements and circular metrics can exacerbate these challenges and present risk.

There is no one-size-fits-all approach to changing perceptions on CE across the region. Different territories are at varying stages of economic development, income levels, awareness and practice of a CE. Awareness and communication strategies must be tailored to the specific context of each territory.

Challenges adopting a circular economy (cont'd)

2. Scaling-up

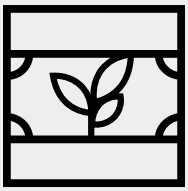
The global circularity rate has actually declined from 9.1% in 2018 to 7.2% in 2023.[43] This indicates increased consumption of virgin materials despite heightened climate awareness. Accelerating CE growth is urgent as the current linear consumption model is unsustainable.

Several challenges hinder the scaling of the circular economy, including difficulties in financing due to the novelty of CE investment models and metrics, as well as the lack of historical data. Supply chain activation poses another challenge, requiring significant changes, particularly in reverse logistics for material return and recycling. Additionally, businesses need to develop technical knowledge and capabilities to comply with regulations and achieve scale. The underdeveloped infrastructure in the region, including limited waste management and recycling facilities, further hampers progress.

3. Economic and labour displacement vs. just transition

The transition to a CE is an economic transformation. This presents challenges across industries and the labour market, as highlighted in the CE modelling scenario in Section 2. The model also shows that the impact on employment tends to be more pronounced than on GDP. In other words, fluctuations in GDP often result in more significant changes in employment levels.

If not managed properly, this transition can lead to the displacement of economic sectors, industries, small and medium enterprises (SMEs) and labour, leading to increased social inequality. Government and industry stakeholders need to work together to develop tailored solutions on addressing these challenges with a focus on skills uplift and social impact. This includes taking into account the informal workforce and how these workers may be included in the transition.



4. Costs of circular materials

Factors such as supply and demand, commodity market volatility and low economies of scale of CE materials contribute to the current higher costs of some recycled materials. This has led to varied recycling rates among different materials. For example, steel has a recycling rate of 80%, while plastic sits at only 9%. The cost of using recycled plastic can fluctuate significantly, depending on oil prices, demand and supply. The price disparity between renewable and virgin materials can deter businesses from adopting CE practices due to the substantial initial financial outlay.

Although initial CE production costs may be higher in the short term, they can present significant cost-saving opportunities in the medium to long term. As technologies advance and economies of scale improve, the efficiency of CE processes will increase, reducing production costs. This transition period, while challenging, offers potential substantial economic benefits by improving our ability to anticipate and respond to future market demand.

Enablers of a circular transition

Successfully transitioning to a CE requires strategies and capabilities to tackle its challenges. This involves changes in communication, policy, technology, collaboration and developing capabilities to support a just transition.

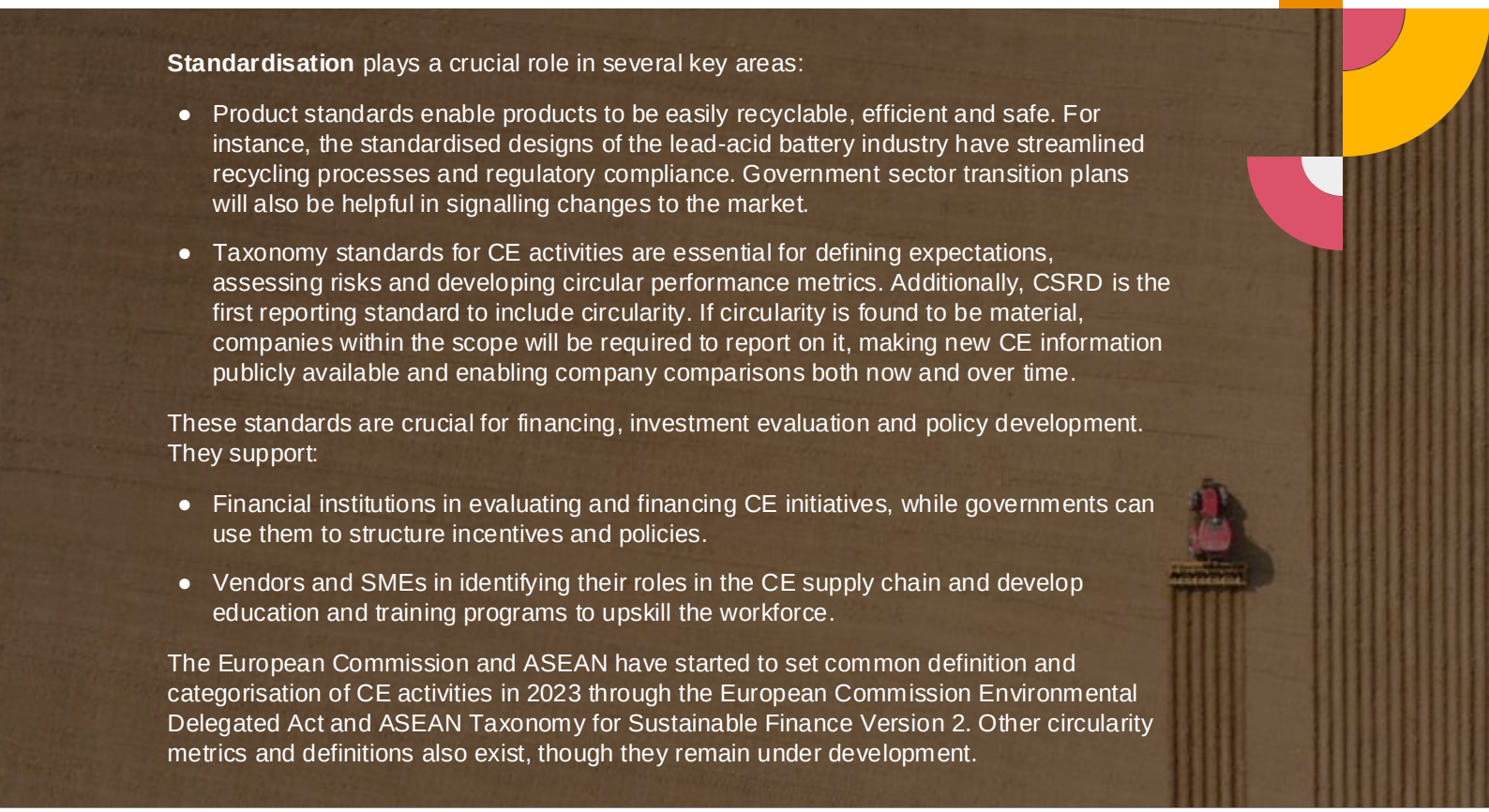
1 Building awareness and communication

It is crucial to help boards, C-suites and suppliers recognise the significant impact of climate and biodiversity on corporate value, positioning a CE as a strategic imperative. This will provide the necessary buy-in from the top.

By educating others — consumers, policymakers, financial institutions and investors — about CE benefits and regulatory landscapes, organisations can build support and obtain funding to accelerate the transition. Simultaneously, this will drive market demand and promote sustainable growth. As CE adoption remains in its early stages, continuous feedback and open communication channels are vital to refine operational processes and sell CE products and services effectively.

2 Standards, incentives and sustainable financing

The transition to a CE requires a thorough ecosystem shift, necessitating common standards, policy support and sustainable financing to drive adoption of new CE business models. Organisations, along with policymakers and financial institutions, play a crucial role in setting these frameworks and providing the necessary support for a successful transition.



Standardisation plays a crucial role in several key areas:

- Product standards enable products to be easily recyclable, efficient and safe. For instance, the standardised designs of the lead-acid battery industry have streamlined recycling processes and regulatory compliance. Government sector transition plans will also be helpful in signalling changes to the market.
- Taxonomy standards for CE activities are essential for defining expectations, assessing risks and developing circular performance metrics. Additionally, CSRD is the first reporting standard to include circularity. If circularity is found to be material, companies within the scope will be required to report on it, making new CE information publicly available and enabling company comparisons both now and over time.

These standards are crucial for financing, investment evaluation and policy development. They support:

- Financial institutions in evaluating and financing CE initiatives, while governments can use them to structure incentives and policies.
- Vendors and SMEs in identifying their roles in the CE supply chain and develop education and training programs to upskill the workforce.

The European Commission and ASEAN have started to set common definition and categorisation of CE activities in 2023 through the European Commission Environmental Delegated Act and ASEAN Taxonomy for Sustainable Finance Version 2. Other circularity metrics and definitions also exist, though they remain under development.

Similarly, **government incentives** will need to be updated to drive and scale-up CE activities. They include:

- Refreshing the taxation system to offer incentives for the CE transition, such as tax breaks or credits for CE-related investments and clarifying customs valuation rules to accommodate the circular movement of goods. This can stimulate investment, foster behavioural change, promote innovation and collaboration, and enhance knowledge.
- Developing CE policies to build the necessary infrastructure, enable resource recovery, promote the use of secondary resources and integrate eco-design into manufacturing and supply chains.

Sustainable financing is another key enabler in scaling-up the CE transition, providing the necessary capital to support innovative business models and infrastructure. Effective policies are essential to support sustainable financing by helping to establish a viable underlying CE market, with strong opportunities and incentives for investment.

Aligning tax and a circular economy

Corporate tax:

- Tax incentives and grants for investments in circular technologies and activities can encourage the transition to a CE.
- Tax considerations for business model shifts, like product-as-a-service, are essential to support CE adoption.

Customs and trade tax:

- Surcharges on non-circular goods to discourage their use.
- Fair valuation of refurbished goods for customs purposes to promote equitable trade.

Transfer pricing (TP):

- Implement TP strategies that align with CE practices to facilitate compliance and efficiency.

Indirect Tax:

- Lower or exempted VAT/GST for recycled and refurbished goods to incentivise their use.

Role of the public sector in driving a circular economy

Policymakers are essential in creating an environment conducive to the CE. They shape a sustainable future by integrating CE principles into the economy through:

- Robust policy, regulatory frameworks and incentives, which drive CE adoption and foster innovation and collaboration.
- Providing stability and predictability, policymakers enable businesses to invest confidently in circular initiatives and financial institutions to finance them.
- Collaboration with industry stakeholders facilitates well-informed policies that effectively address CE challenges and opportunities.

Policymakers' role spans across all five CE enablers, making their involvement crucial for a successful transition. For more insights, see 'The Role of the Public Sector in Driving a Circular Economy.'

3 Designing and using technology and data

Designing products with CE principles begins with circular design thinking, aiming to maximise product and resource lifecycles. Technology, including artificial intelligence (AI), plays a pivotal role in enhancing circularity through several key methods:

- Innovation in products and materials: It can analyse vast amounts of data to develop optimal design and materials permutations that meet the 9R parameters and extend product lifecycle.
- Automation: It can drive automation in recycling, repair and maintenance processes. For example, Tetra Pak provided technical expertise and financial support to Luhai Pro-environment — a waste management company specialising in beverage carton and lightweight packaging recycling — to establish the Chinese Mainland's first automated sorting centre for low-value recyclables in Xiamen. The plant uses innovative technologies, such as AI and near-infrared sensors, to achieve unprecedented efficiency, with a capacity four times greater than traditional manual sorting methods.[44]
- Market efficiency: Digital platforms and AI analytics enhance market efficiency by matching supply with demand in the CE marketplace, reducing discovery cost.

Spotlight on Japan

Japanese manufacturers are leveraging technology, robotics and AI to automate the recycling process of household appliances like washers, dryers, TVs and air conditioners. This includes the separation of materials such as iron, copper, aluminium, glass and plastics, as well as the recovery of harmful substances.[45]

This technology-driven approach enhances both efficiency and safety. In addition, manufacturers are proactively designing products with recycling in mind, emphasising the easy and safe separation of components and materials.

Such initiatives have helped increase the recycling rate of household appliances in Japan to between 72% and 92% in 2021.[46]

The indispensable nature of data

- Data helps organisations monitor and track the complex life cycle of materials from extraction and processing to manufacturing, use, reuse, disposal and recycling in a CE ecosystem. This information enables the assessment of CE impact and opportunities, allowing for informed decisions to develop and refine designs, strategies and controls for circularity.
- It helps reveal unintended consequences, socio-economic impacts, net impacts and net emissions reductions. This is essential for explaining the CE pathway to citizens and businesses, fostering transparency and understanding.
- Increasing the reporting of CE data, rather than viewing it as a burden, can provide valuable information to support new growth, create jobs, and drive economic development.

4 Collaboration, ecosystem thinking and integration

Collaboration among the multiple stakeholders is vital due to the complex interdependencies involved. This fosters innovation, best practices and synergies across sectors and organisations. To succeed in a CE, understanding your role, value proposition and collaboration strategies is essential.

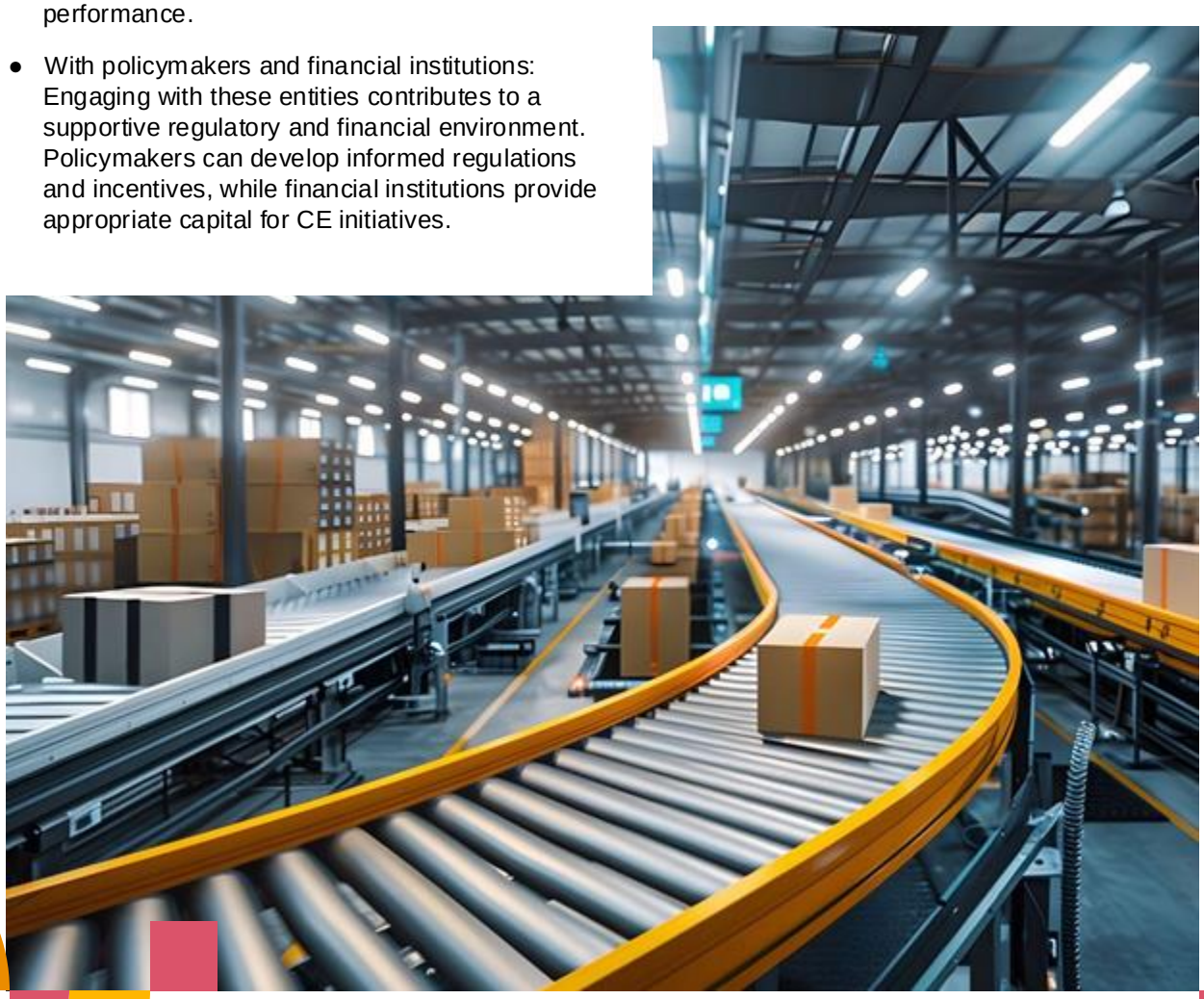
There are several levels of collaboration to consider:

- Within the organisation: Collaboration across departments like product strategy or design, sourcing, procurement, IT, finance and training is crucial, bringing diverse expertise and driving innovation in CE practices.
- With start-ups and technology providers: Partnering with these entities provides access to and enables the utilisation of new technological advancements, such as Dole's collaboration to transform agricultural waste into yarn and fashion products.
- With vendors, suppliers and the broader industry: Building strong relationships enables a consistent supply of sustainable materials and creates closed-loop supply chains, enhancing CE performance.
- With policymakers and financial institutions: Engaging with these entities contributes to a supportive regulatory and financial environment. Policymakers can develop informed regulations and incentives, while financial institutions provide appropriate capital for CE initiatives.

Ecosystem thinking and integration encourages collaboration across the entire value chain – from raw material producers to end customers and the reverse logistics required under a circular model.

Whether responding to evolving regulatory demands, meeting tracing and tracking requirements, or building resilient and efficient supply chains, ecosystem integration facilitates the alignment of players in their efforts.

Ultimately, integrating ecosystem thinking into CE strategies helps stakeholders across the value chain not only navigate challenges but also create opportunities for innovation, shared value and long-term sustainability.



5 Developing capabilities and supporting a just transition

The transition to a CE is expected to have an uneven impact on sectors and jobs across Asia Pacific. As the modelling in Section 2 shows, an estimated 9.5% of the region's workforce or 138 million jobs are at risk, particularly in extractive and manufacturing areas. However, this shift also brings new opportunities, with 10.5% of the region's workforce or 153 million jobs projected to emerge in MRO, recycling and related activities. (Note that this includes a projected transition of already existing informal waste pickers into formal recycling and MRO activities).

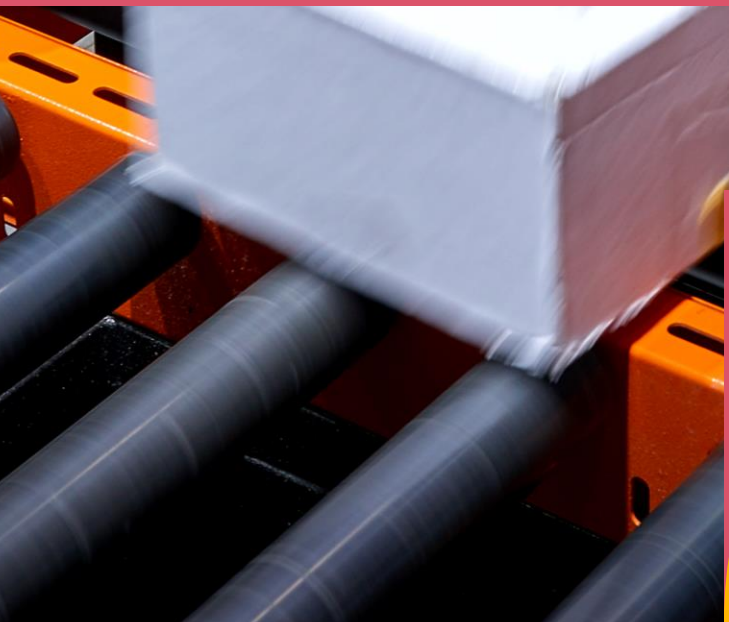
To minimise disruptions and maximise the benefits of a CE, it is crucial to equip workers — especially those from affected areas — with the necessary skills through training, reskilling and retooling.

It is also essential for governments, industry players and local communities to collaborate in supporting vulnerable groups. The expected disruption would extend beyond the workforce to include low-income communities, informal and unskilled workers, and micro, small and medium enterprises (MSMEs) that support the broader industry supply chain.

These groups often lack the resources and capital to adapt to a CE marketplace. Support needs to help them transition successfully and share in the growth and benefits that the CE offers. This is also an opportunity to provide decent jobs, with appropriate safety protections and living wages, to workers already engaged in informal waste management.

5

Five-step approach to accelerate your circular economy transition



5. Five-step approach to accelerate your circular economy transition

While technology enablers, ecosystem thinking and standards are all helpful, they take significant time and investment to achieve.

Businesses, especially nowadays, are grappling with a crowded ESG landscape full of continuously emerging compliance requirements, while needing to maintain their commercial operations and value. Often, it can seem daunting to add another consideration to the table, particularly when it is an ambitious one like achieving circularity.

The following step by step approach guides businesses from compliance, to efficiency, to value creation. There is an approach that suits businesses just starting in their journey, to those further in their journey but are still looking for new ways to create value and adapt to the changing environment.

For businesses

Early in their CE journey:

1 

Understand compliance obligations

Work with experts to fully understand regulatory requirements and compliance obligations related to sustainability, including reporting, climate, nature, labour rights, and extended producer responsibility.

2 

Assess current state and benchmark

Evaluate your current sustainability performance against existing targets and stated ambitions. Benchmark your performance against industry peers and competitors. This process will help pinpoint priority hotspots for change, such as waste generation or packaging.

3 

Examine cost-benefit analysis

Evaluate options through a cost and efficiency lens. Though compliance may seem to be a cost burden, transitioning to a CE can improve efficiency and save money. For instance, packaging redesign can cut material use and costs, while waste reduction can lower waste management expenses.

4 

Integrate with sustainability strategy

Integrate potential actions with the broader sustainability strategy, ensuring alignment between CE initiatives and overall sustainability goals and plans.

5 

Develop an implementation plan

Create a robust implementation plan with a clear, achievable timeline. Outline necessary enablers such as capability building, forming alliances, and engaging suppliers to facilitate successful execution.

Focus on: compliance, efficiency and cost savings from circularity

For businesses

Further in their CE journey:

1 

Understand compliance obligations

This is still important as regulations are continuously emerging.

2 

Identify competitive differentiation opportunities

Benchmark against peers and competitors and assess market sentiment to re-set your circular vision for the future.

3 

Advanced changes to products

Identify the competitive edge gained through more advanced changes to products and product delivery, including by looking at the value chain, considering supplier relationships and tax.

4 

Activate investments and partnerships

Activate strategic investments and partnerships with upstream and downstream ecosystem stakeholders.

5

Embed circular actions into business strategies

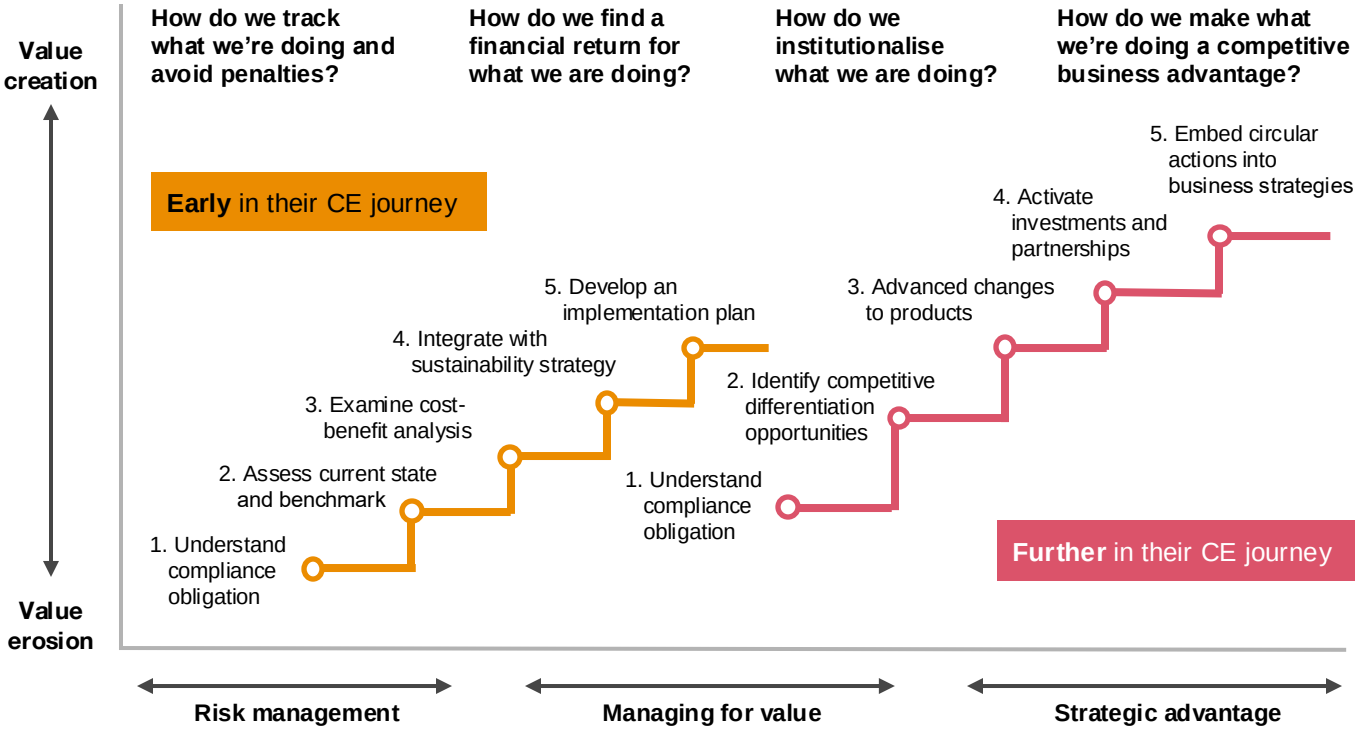
Embed CE initatives beyond the sustainability strategy and into business strategy. This involves going beyond applying circularity to single products or sustainability KPIs, to embedding (and measuring) a circular model as a value creation opportunity for the business.

Focus on: Continued compliance and efficiency, value creation opportunities from circularity

Path to sustainable business reinvention

Achieving a mature CE is undoubtedly complex. However, this challenge can be approached incrementally, starting with compliance and advancing to efficiency. Ultimately, businesses can create value through sustainable reinvention. This approach not only fosters a positive impact on the environment and society but also contributes to healthy economic performance. Leveraging different skillsets within the organisation, from procurement and sustainability to corporate strategy, can facilitate this transition effectively.

Figure 14: CE maturity from compliance to value



Adopting a CE is not a matter of choice but a necessity. The shift is inevitable and the urgency is clear with the escalating triple planetary crisis (climate, pollution/waste and biodiversity loss). Embracing a circular mindset will not only promote sustainability but also drive growth and enhance resilience, helping to mitigate these looming crises.

Each incremental step plays a crucial role in the broader reinvention journey. By examining your data, evaluating your current state and exploring new initiatives, you pave the way for unforeseen opportunities and advancements.

The time to act decisively and reimagine a sustainable future is now. By embracing a CE, the Asia Pacific region can maintain its position as the world's fastest-growing economy while significantly reducing its environmental footprint. Creating a circular world will promote long-term prosperity and environmental sustainability for generations to come.

Appendices

Appendix

Appendix I: Our modelling approach

The circular economy modelling analysis uses input-output (IO) methods to examine changes in production inputs from Asia Pacific territories between baseline and CE scenarios.

The CE scenario uses 2022 economic data for each of the 14 Asia Pacific countries and regions selected and applies changes to material inputs, resulting in a CE scenario model. We have not specified a timeline for the realisation of this scenario, as the transition to a CE is occurring at varying rates across different sectors, making precise date predictions challenging.

The baseline reflects the current linear economy of 14 selected Asia Pacific countries and regions, they are: Australia, Chinese Mainland, Hong Kong SAR, India, Indonesia, Japan, Malaysia, New Zealand, Philippines, South Korea, Singapore, Taiwan, Thailand and Vietnam.

The CE scenario reflects the following:

- Reduction of virgin material inputs: 20% to 60%, depending on the industry, with some renewable resources replacing more emissions-intensive ones.
- Lower demand for products and materials: Reduced by 10% to 75%, varying by industry, due to repairing, refurbishing, remanufacturing and smart design.
- Incorporation of the informal sector: This analysis notably assumes that 50% of informal waste pickers (undocumented workforce) will transition into organised circular waste and recycling.

The CE scenario covers a total of 26 sectors, which we have grouped into the following categories:

- Agriculture
- Construction
- Food and beverage
- Metals and equipment manufacturing includes: metal product; electrical and machinery; and transport equipment sectors
- Mining and quarrying
- Maintenance, repair and operations (MRO)
- Petroleum, chemical and non-metallic mineral products (PC&NM)
- Recycling
- Textiles and apparel
- Other services includes: education, health and other services; electricity, gas and water; financial intermediation and business activities; hotels and restaurants; post and telecommunications; public administration; retail trade; transport; and wholesale trade sectors
- Others includes: private households, re-export and re-import; wood and paper and other sectors

Limitations of CE modelling:

- The economic model dataset is sourced from Eora. While Eora offers a way to measure a territory's global value chain competitiveness and sector performance accurately, there are limitations. No single data source is perfect, particularly when attempting to cover global data thoroughly. Some territories may have incomplete or missing data, that, where possible and available, has been adjusted against national databases and other publicly available sources.
- Recycling and MRO: In the CE model, recycling and MRO activities are categorised as separate sectors. However, in reality, these activities can be integrated into incumbent manufacturing sectors. Such integration can affect sectoral GDP, employment, and emission estimates, improving the picture in incumbent manufacturing sectors under a CE scenario.
- The overall emission reductions in the CE scenario do not account for the transition to renewable energy within the energy sector, i.e. non-renewable energy transition (RTE). The model results focus solely on emissions driven by improved resource utilisation, highlighting the substantial impact of a circular materials transition in isolation. However, to achieve net zero goals, both the circular economy and RET must be implemented in tandem.
- Exports: The CE model assumes a closed-loop system within the economy for each territory and does not account for exports amongst territories in Asia Pacific or to territories beyond. In reality, exports constitute a significant part of the economy, especially in Asia Pacific, which is a global manufacturing hub.

Appendix

Appendix II: CE impact on Asia Pacific sectors

Note: Ranked by percentage change in GDP, from positive to negative.

Maintenance, repair and operations (MRO)

Changes in CE model (against baseline)

GDP	CO2e	FTE
1181.5%	1202.0%	1966.9%
US$bn	Mt CO2e	m
805.4	383.7	63.8

Overview

The sector is expected to grow significantly, supporting the longevity of products across various industries and reducing the need for new production. This results in sizable increases in the economy, employment and emissions.

This sector shows the highest growth across all Asia Pacific territories ranging from 2x to 44x. This is driven by:

- Low current MRO sector contribution to GDP.
- Increased demand for refurbished, repaired, and remanufactured goods and services to extend useful life of high-quality products.

Recycling

Changes in CE model (against baseline)

GDP	CO2e	FTE
406.2%	161.4%	389.7%
US$bn	Mt CO2e	m
557.6	175.0	41.5

Overview

Projected to expand significantly, receiving more input from manufacturing and modernising to handle increased volumes efficiently. This expansion contributes to growth across GDP, FTE and emissions.

The scale of GDP growth varies by territory, influenced by the maturity of the existing recycling sector and the composition of the labour force within the sector. For example:

- Territories with large informal sector workforce in recycling show an increase of 1.5x to 9x.
- Territories with a significant existing formal recycling sector projected to grow between 1.5x and 2x, e.g. India and Thailand.
- Territories with less mature existing recycling sectors to grow between 3x and 9x, e.g. Vietnam, Malaysia, Indonesia and the Philippines.
- Territories with hi-tech recycling sectors such as Chinese Mainland, Japan and South Korea also experience significant increases of 3x to 9x.

Appendix

Appendix II: CE impact on Asia Pacific sectors

Construction

GDP	CO2e	FTE
21.3%	-0.2%	41.4%
US$bn	Mt CO2e	m
415.7	-3.2	38.5

Overview

The construction sector will incorporate recycled materials, modular design and smart building practices to reduce raw material use and waste.

Sector GDP increases across 14 territories covered in Asia Pacific, ranging from 2.4% to 42.0% driven by infrastructure expansion in support of a CE transition.

Agriculture

GDP	CO2e	FTE
1.6%	1.3%	3.1%
US$bn	Mt CO2e	m
28.9	18.4	8.7

Overview

Agriculture will transition to organic fertilisers and bio-gas digesters, reducing dependency on petrochemical inputs and external energy sources.

Expected growth in the agriculture sector is driven by demand for:

- Agricultural byproducts in organic fertilisers due to the switch from chemical fertilisers produced by the petrochemical industry.
- Organic fibres from agriculture will be used as renewable inputs in the textile sector, replacing synthetic textiles produced by the petrochemical industry.

Sector GDP increases across the majority of Asia Pacific territories covered, ranging from 0.2% to 9.0% (excluding New Zealand).

Appendix

Appendix II: CE impact on Asia Pacific sectors

Food and beverage (F&B)

GDP	CO2e	FTE
-5.8%	-6.0%	-12.4%
US$bn	Mt CO2e	m
-66.5	-79.9	-4.3

Overview

The F&B industry will see a significant reduction in waste and resource consumption through reducing food waste and increasing recycling, upcycling and sustainable practices. The focus will be on creating closed-loop systems where waste is minimised, and resources are continuously reused.

Overall, at an aggregate level in Asia Pacific, F&B sector GDP decreases by 5.8% driven by decrease in final demand for food products as households decrease food waste.

Metals and equipment manufacturing

GDP	CO2e	FTE
-10.5%	-21.1%	-30.3%
US$bn	Mt CO2e	m
-446.3	-1084.5	-40.9

Overview

The metals and equipment manufacturing sector is a combined sector covering metal product, electrical and machinery, and transport equipment sectors.

The industry will remain vibrant, continuing to meet our needs through urbanisation, infrastructure projects and technological advancements. However, a CE transition will mean we can achieve this with secondary materials.

Some companies have already begun implementing various strategies, for example: material recovery, design for longevity, and remanufacturing and refurbishment.

At an overall aggregate level, the sector's GDP decreases by 11% driven by:

- Increase in repair, refurbishment and remanufacture activity which decreases the demand for new metal products.
- Increase in use of recycled metal to produce new metal products

However, it is important to note that the value creation from equipment repair, refurbish and remanufacture, and recycled metal is shown in the MRO and recycling sectors due the set-up of the model, though some growth may actually occur in the metals and equipment manufacturing sector.

Appendix

Appendix II: CE impact on Asia Pacific sectors

Textiles and apparel

GDP	CO2e	FTE
-12.4%	-14.6%	-26.4%
US$bn	Mt CO2e	m
-94.0	-128.3	-10.7

Overview

The textiles and apparel sector will become more circular by using recycled and organic materials, and extending the lifespan of clothing, reducing new textile demand.

This shift includes apparel service and repair models, which represent a new frontier for growth for the sector in a CE scenario.

While the sector shows a decrease in GDP, it has the potential to capture some of the value from recycled textiles — currently attributed to the recycling sector due to the model limitation — by pursuing vertical integration within its supply chain.

Sector GDP decrease for most Asia Pacific territories covered, ranging from -3.3% to -29.4%.

Petroleum, chemical, non-metallic mineral (PC&NM)

GDP	CO2e	FTE
-22.5%	-22.8%	-43.8%
US$bn	Mt CO2e	m
-424.5	-577.1	-33.7

Overview

The PC&NM sector will see reduced demand as industries shift towards bio-based and recycled materials and decrease reliance on fossil fuels. This includes reduced demand for key products such as chemical fertilisers, plastics and synthetic textiles.

Sector GDP decreases for all 14 Asia Pacific territories ranging from -1.5% to -26.7%.

Appendix

Appendix II: CE impact on Asia Pacific sectors

Mining and quarrying		
GDP	CO2e	FTE
-25.2%	-26.1%	-51.9%
US$bn	Mt CO2e	m
-196.2	-172.4	-26.0

Overview

In an optimal CE state, demand for mining will decrease due to increased recycling, use of secondary raw materials, and extended product life cycle from MRO, refurbished and remanufactured products.

Mining companies are already starting to leverage technologies to extract resources from their own waste. Companies can continue to do this as well as invest in mineral recycling outside of their operational boundaries to offset GDP losses from traditional business models.

Sector GDP decreases for all 14 Asia Pacific territories ranging from 9.7% to 30.2%.

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Contact details

Ivy Kuo
Asia Pacific Sustainability Leader,
Partner, PwC China
ivy.ws.kuo@cn.pwc.com

Melissa MacEwen
Circular Economy Lead,
PwC Global Sustainability Impact Centre and Asia Pacific Sustainability, Director, PwC New Zealand
melissa.c.macewen@pwc.com

Ronit Sinha
Global Sustainability Impact Centre and Asia Pacific Sustainability, Circular Economy Manager,
PwC Australia
ronit.sinha@au.pwc.com

Lead author
Melissa MacEwen (PwC New Zealand)

Co-authors
Chris Crow (PwC New Zealand)
Khar Keong Ong (PwC Malaysia)
Ronit Sinha (PwC Australia)
Kinaryossy Ametishya (PwC Indonesia)

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