https://uncrd.un.org/content/12th-3r-ce-forum

Circular Economy: waste-derived economic growth and resilience

Professor Seeram Ramakrishna
https://www.linkedin.com/in/seeram-ramakrishna/

Mount Taranaki, a 2,500m-high dormant volcano, is a popular spot for tourism, hiking and snow sports. PHOTO: PIXABAY

Mountain on NZ's North Island now legally considered a person

Rhea Yasmine

A mountain in New Zealand – seen as an ancestor by the country's indigenous Maori people – is now legally considered a person.

Mount Taranaki, now known by its Maori name Taranaki Maunga, was granted personhood by Parliament's 123 lawmakers, who unanimously affirmed the Taranaki Maunga Collective Redress Bill on Jan 30.

The Bill gives local tribes more say in maintaining the mountain's well-being, including the conservation of wildlife in the area, reported CNN. Public access to the mountain will remain.

The 2,500m-high dormant volcano on the country's North Island is a popular spot for tourism, hiking and snow sports. While hunting and sports groups were able to influence the management of the mountain, the Maori people were not, reported Sky News.

But with the passing of the Bill, four people from the local Maori tribes and four others selected by New Zealand's conservation minister will form an entity to act as "the face and voice" of the mountain.

"The mountain has long been an honoured ancestor, a source of physical, cultural and spiritual sustenance, and a final resting place," Mr Paul Goldsmith, the lawmaker who is responsible for the settlements between the government and Maori tribes, was quoted by CNN as telling Parliament.

According to The New Zealand Herald, the passing of the Bill on Jan 30 came after almost a decade of settlement negotiations.

The Bill also acknowledges that the mountain was taken from the Taranaki region's Maori tribes by British colonisers.

The Treaty of Waitangi – New Zealand's founding document that was signed in 1840 – promised that the Maori would still have rights over their land and resources. But in 1865, sections of land, including the mountain, were taken from the Maori to punish them for rebelling against the British, reported CNN.

"Today, Taranaki... our maunga tupuna (ancestral mountain), is released from the shackles, the shackles of injustice, of ignorance, of hate," Ms Debbie Ngarewa-Packer, a co-leader of political party Te Pati Maori and a descendant of the Taranaki tribes, reportedly said.

"We grew up knowing there was nothing anyone could do to make us any less connected."

The mountain is the third natural feature in New Zealand to be conferred personhood.

In 2014, a law was passed recognising the Te Urewera forest on the North Island as a person. It was the first time in the world that a natural feature was legally recognised as a person.

In 2017, the Whanganui River, also on the North Island, was recognised as human.

The recognition of Mount Taranaki's personhood comes after thousands marched in New Zealand's capital in November 2024 to protest against a conservative push to redefine the Treaty of Waitangi, which many critics see as an attempt to strip long-agreed rights from the country's 900,000 Maori population.

ryasmine@sph.com.sg

THE STRAITS TIMES
Saturday, February 08, 2025

Countries committed to climate plans despite US exiting Paris pact: UN official

He encourages them to submit stronger plans in 2025 to reap 'massive rewards'

BRASILIA – Countries are staying committed to their national climate plans and looking to lead the clean energy transition as the US plans to exit the Paris climate agreement, the UN's top climate official said in his first speech of the year on Feb 6.

Mr Simon Stiell, executive secretary of the UN Framework Convention on Climate Change (UNFCCC), laid out priorities ahead of annual climate talks in November, and encouraged countries to prepare stronger national climate plans in 2025, even after US President Donald Trump said he will remove the world's second-biggest greenhouse gas emitter from the Paris Agreement.

"A country may step back, but others are already stepping into their place to seize the opportunity, and to reap the massive rewards: stronger economic growth, more jobs, less pollution and far lower health costs, more secure and affordable energy," Mr Stiell said in a speech in Brazil's capital Brasilia, alongside COP30 president Andre Correa do Lago.

Asked about which countries are stepping up, Mr Stiell says this will be known at the end of the year, as the countries deliver a new round of nationally determined contributions (NDCs).

"The call is for greater ambition, for these plans to be economy-wide. These will be the most comprehensive climate plans ever developed, the third generation of NDCs. We'll be able to give better commentary as we synthesise that towards the end of the year," he said.

"But in terms of actions being taken, just looking at what is happening within the markets, region by region, country by country, it's very clear, as I said, those that are pushing forward, regardless of whatever rhetoric there is about those who wish to step back," he argued, citing, for example, what China, Brazil and India are doing on reducing emissions.

Mr Stiell said that in the 10 years since the Paris Agreement was adopted, the world has become more divided but the climate negotiation process has "managed to buck the trend".

Some governments have faced political backlash to climate policies. Green candidates in Europe are losing support and the US elected Mr Trump, who campaigned against the Biden administration's climate-centred agenda.

Even so, Mr Stiell said the world has mobilised around US$2 trillion (S$2.7 trillion) in climate finance, money to support poorer countries' efforts to reduce emissions and adapt to climate impacts, from "nearly nothing" over the last decade. He called on countries to increase the amount of climate finance they agreed to target at the climate summit in 2024 of US$300 billion annually by 2035.

Mr Stiell said the Paris Agreement provides all the mechanisms to drive countries to reduce emissions, but recognises it "lacks enforceability".

"And at the end of the day, it is for countries to nationally enforce and manage. And what we're seeing there is that gap between what needs to be done and what is being done," he said.

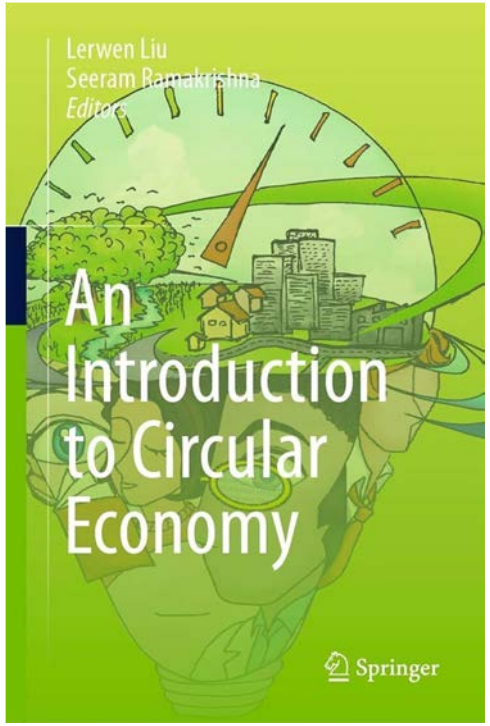
Mr Stiell said also that he expects the vast majority of countries to submit new national climate plans under the Paris Agreement in 2025. The UNFCCC has a Feb 10 deadline for submissions of those plans but many countries said they would submit them later in the year. REUTERS

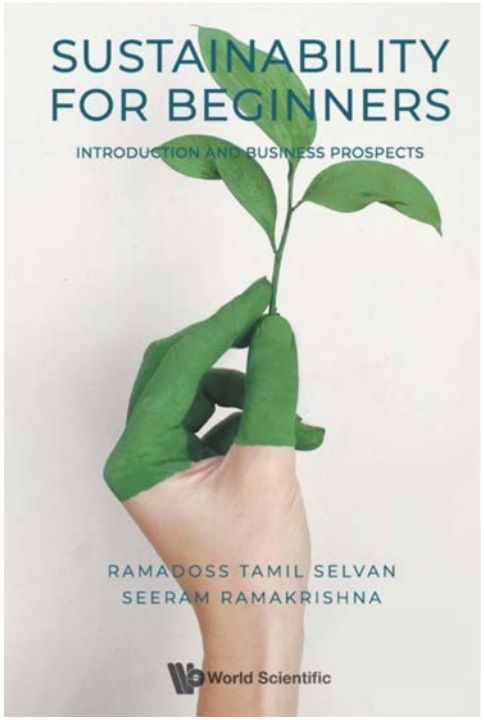
Top UN climate official Simon Stiell says that in the 10 years since the adoption of the Paris Agreement, the world has become more divided but climate talks have "managed to buck the trend". PHOTO: REUTERS

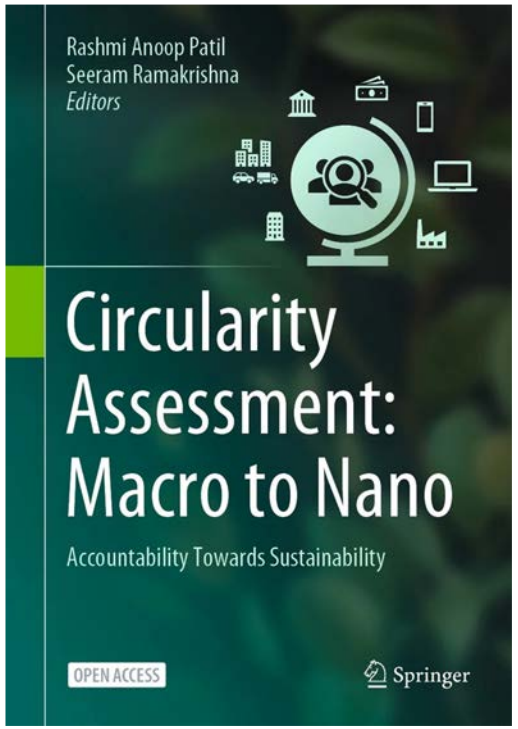
FILLING THE VOID

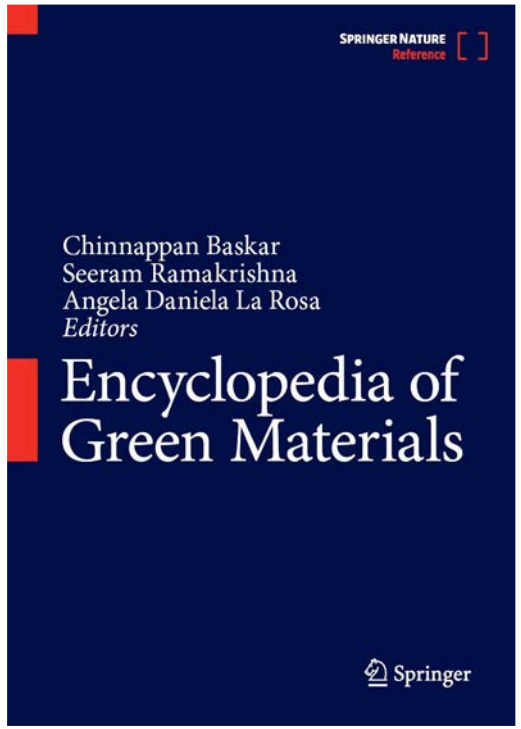
A country may step back, but others are already stepping into their place to seize the opportunity, and to reap the massive rewards: stronger economic growth, more jobs, less pollution and far lower health costs, more secure and affordable energy.

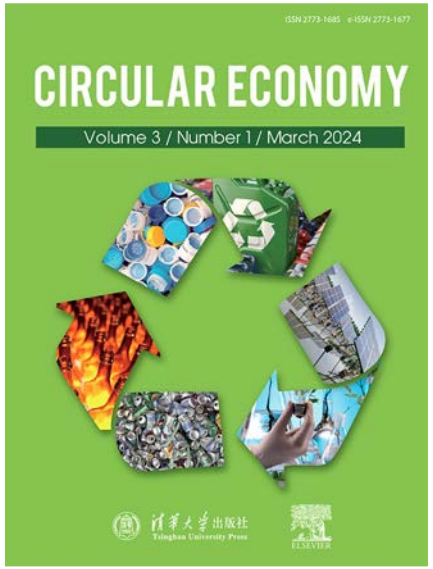
MR SIMON STIELL, executive secretary of the UN Framework Convention on Climate Change, on the US' withdrawal from the Paris Agreement.

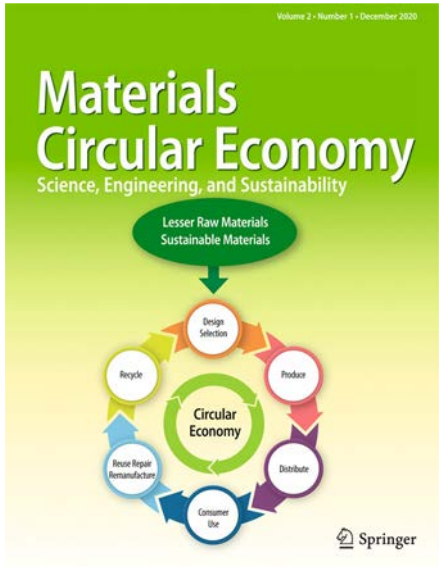


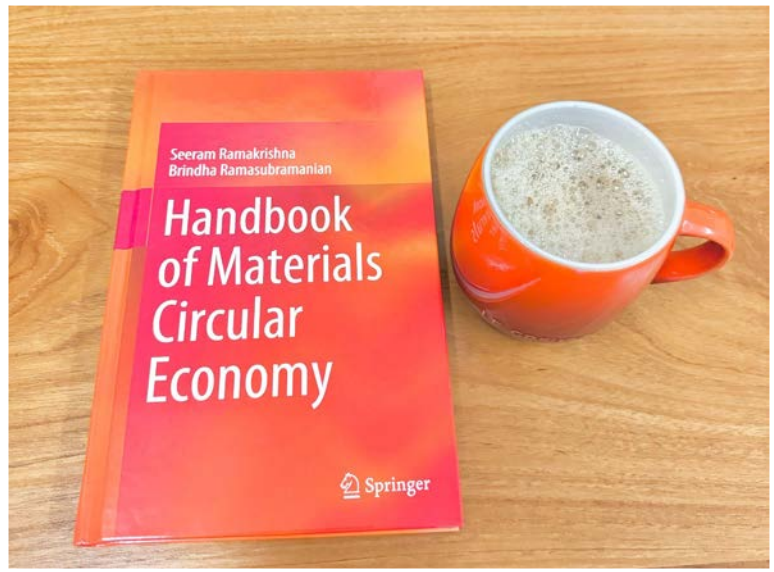






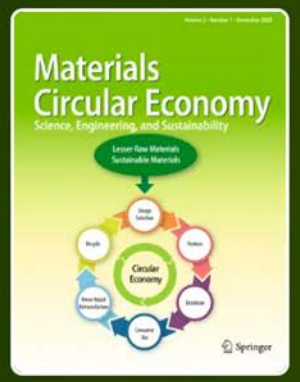






https://honourinternational.sg/speakers/

https://doi.org/10.1007/978-981-97-4618-7



Materials Circular Economy

Science, Engineering, and Sustainability

Publishing model

Hybrid

Submit your manuscript →

Editorial board | Aims and scope | Journal updates

Overview

Materials Circular Economy provides a platform for research related to the science, engineering and technologies of sustainable materials, 6Rs (reuse, recycle, redesign, remanufacture, reduce, recover), lifecycle engineering and life cycle assessment of materials with or without the use of artificial intelligence and data science.

Main Editor

Seeram Ramakrishna, Jose Rajan

Materials Circular Economy

Publishing model: **Hybrid**

← Back to overview

Supporting the Sustainable Developmental Goals

SPRINGER NATURE GROUP
SDG Programme

supporting the Sustainable Development Goals

We are proud to acknowledge that over 50% of the articles published in *Materials Circular Economy* in 2023 were related to one or more of the 17 Sustainable Development Goals (SDGs). Springer Nature supports the SDGs through a dedicated SDG Programme and is a signatory of the SDG Publishers Compact.

https://link.springer.com/journal/42824

UNESCO Report: Transforming Higher-Education for Global Sustainability

Access the report:

UNESCO EGU2030- Global Independent Expert Group on the Universities & the 2030 Agenda

https://unesdoc.unesco.org/ark:/48223/pf0000380519

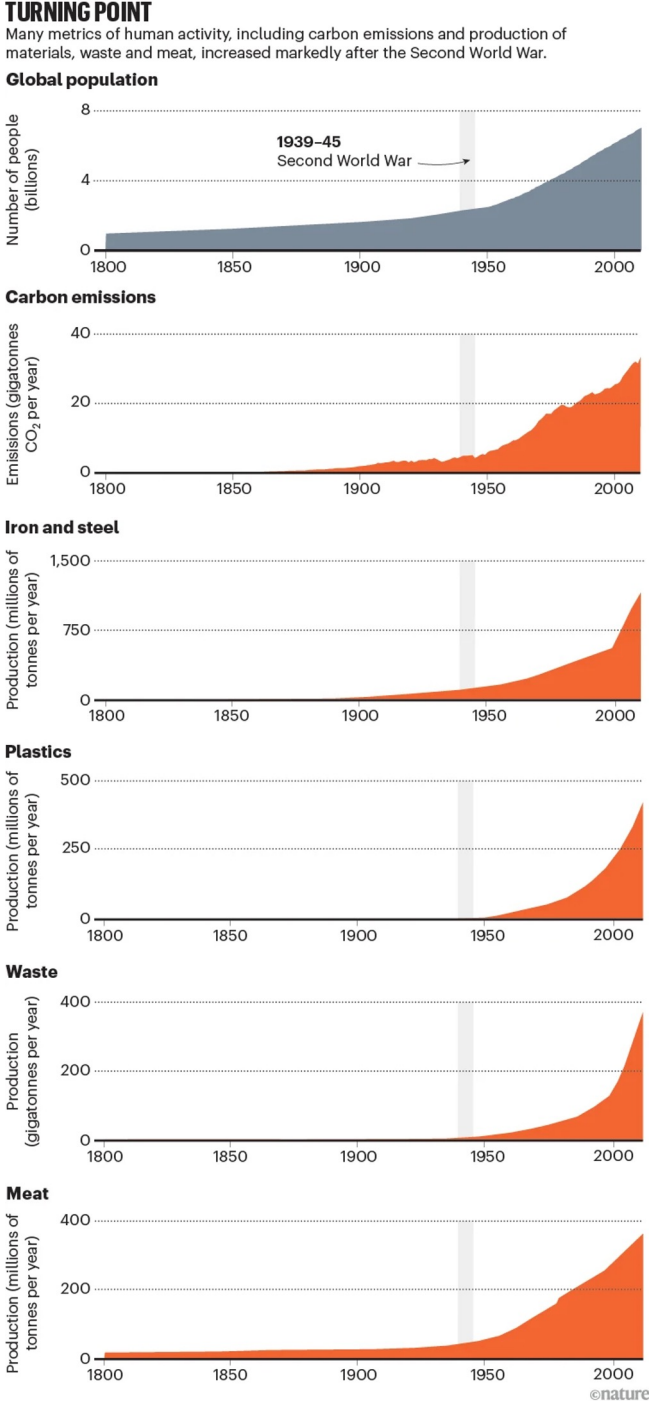
https://www.uib.no/en/sdgbergen/141236/members-unesco-expert-group

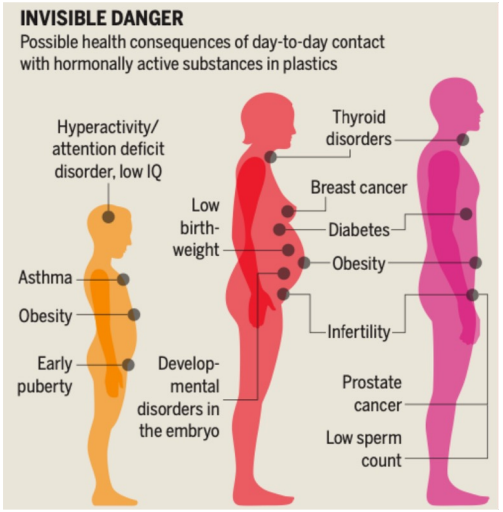
The universities we need for the future we want

https://unesdoc.unesco.org/ark:/48223/pf0000380519

https://www.uib.no/en/sdgbergen/141236/members-unesco-expert-group

Planet and life once upon a time!





3,600 chemicals used in food packaging have been detected in human bodies. 100 of them are of "high concern" to human health.

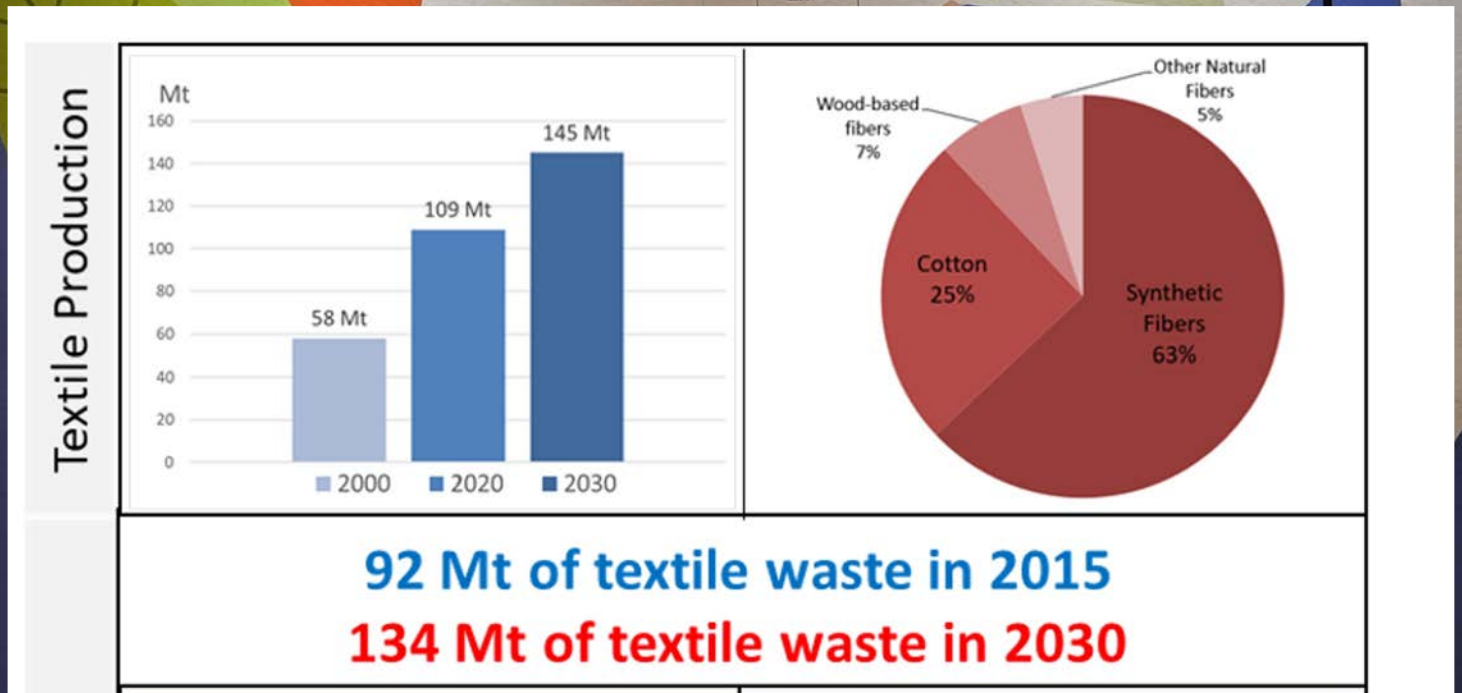
(2) Human Health Effects ☹

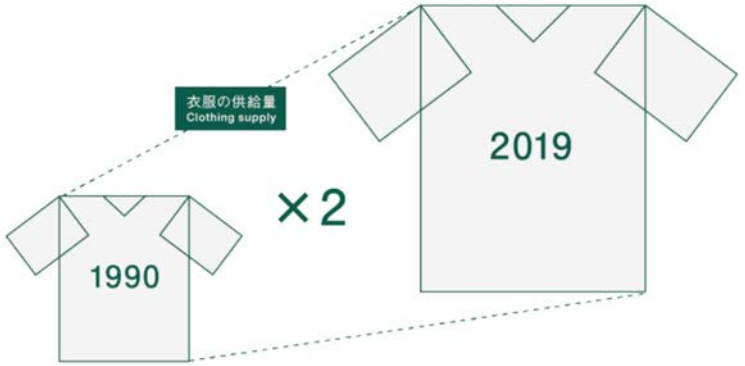
Ills of Linear Economy in vogue

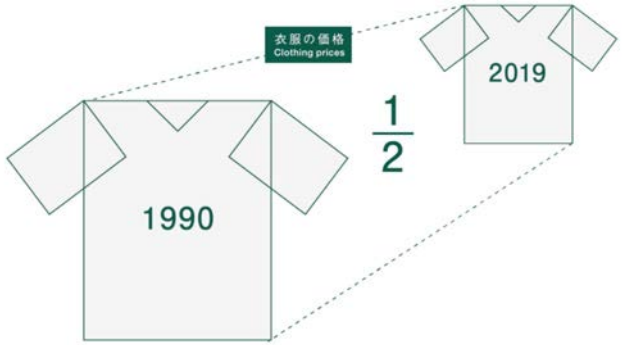
An excavator loading copper ore onto a truck at a mine near Karaganda, central Kazakhstan, in March. The world's transition to renewable energy, including electric cars, requires huge amounts of copper in addition to nickel, lithium and other so-called critical minerals, and Kazakhstan has many of them.

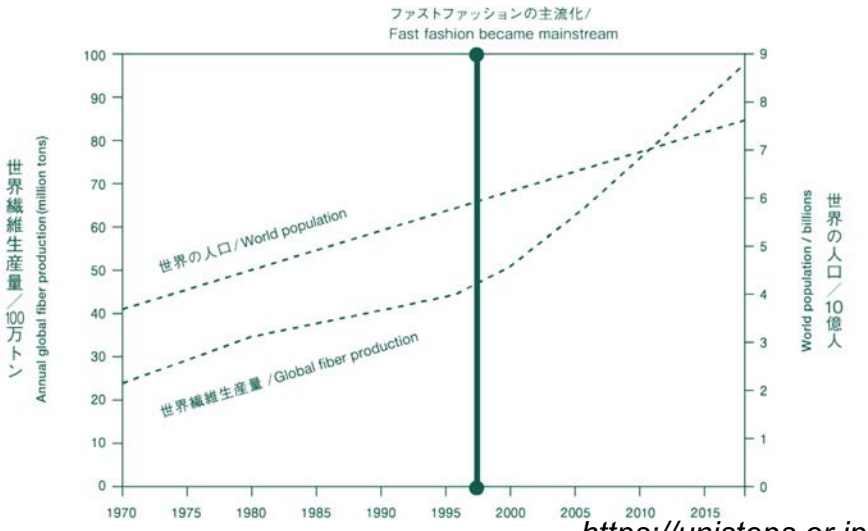
(1) Planned Obsolescence and Resources Crunch ☹

https://doi.org/10.1038/d41586-024-02712-y; https://www.offgridnigeria.com/floating-littered-plastic-waste/









https://unisteps.or.jp

THE STRAITS TIMES
Wednesday, February 12, 2025

Trump signs order that takes aim at paper straws

WASHINGTON – US President Donald Trump signed an executive order on Feb 10 pushing for a return to plastic drinking straws, saying their impact on marine life was limited and that paper ones favoured by environmentalists "explode".

The Republican's order reverses a target set by his Democratic predecessor Joe Biden to eliminate single-use plastic utensils like straws across US government agencies by 2035.

"We're going back to plastic straws," Mr Trump said.

He said of paper straws: "These things don't work, I've had them many times, and on occasion, they break, they explode. If something's hot, they don't last very long, like a matter of minutes, sometimes a matter of seconds. It's a ridiculous situation."

Environmentalists have long campaigned for an end to the use of plastic straws and other utensils, saying they pollute marine environments in particular.

But Mr Trump rejected their concerns. "I don't think that plastic is going to affect a shark as they're eating, as they're munching their way through the ocean."

Presenting the document for Mr Trump to sign, White House staff secretary Will Scharf said the environmental impact was "entirely debatable" and that American consumers were "wildly dissatisfied with their straws".

Mr Trump, who has called climate change a "scam", has issued a series of orders on the environment since returning to the White House for a second term.

BUSINESS INSIDER

SCIENCE

Researchers found a spoon's worth of nanoplastics in human brains — the latest evidence that plastic is accumulating in our bodies

Jenny McGrath and Jessica Orwig
Feb 4, 2025, 4:48 AM SGT

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https://www.businessinsider.com/microplastics-human-brains-high-levels-2025-1

Earth Day 2024 : 22 April 2024

Advisory: PG

Directed by: Jessica Cheam and Fraser Morton

Cast: Jessica Cheam, Prof Seeram Ramakrishna, Dr. Martin A. Blake, Annupa Mattu Ahi, Prashant Singh, Ng Wai Mun, Robin Hicks, Liang Lei

Year: 2023

Language: English

Subtitles: English

Date: Mon 22 Apr, 7pm

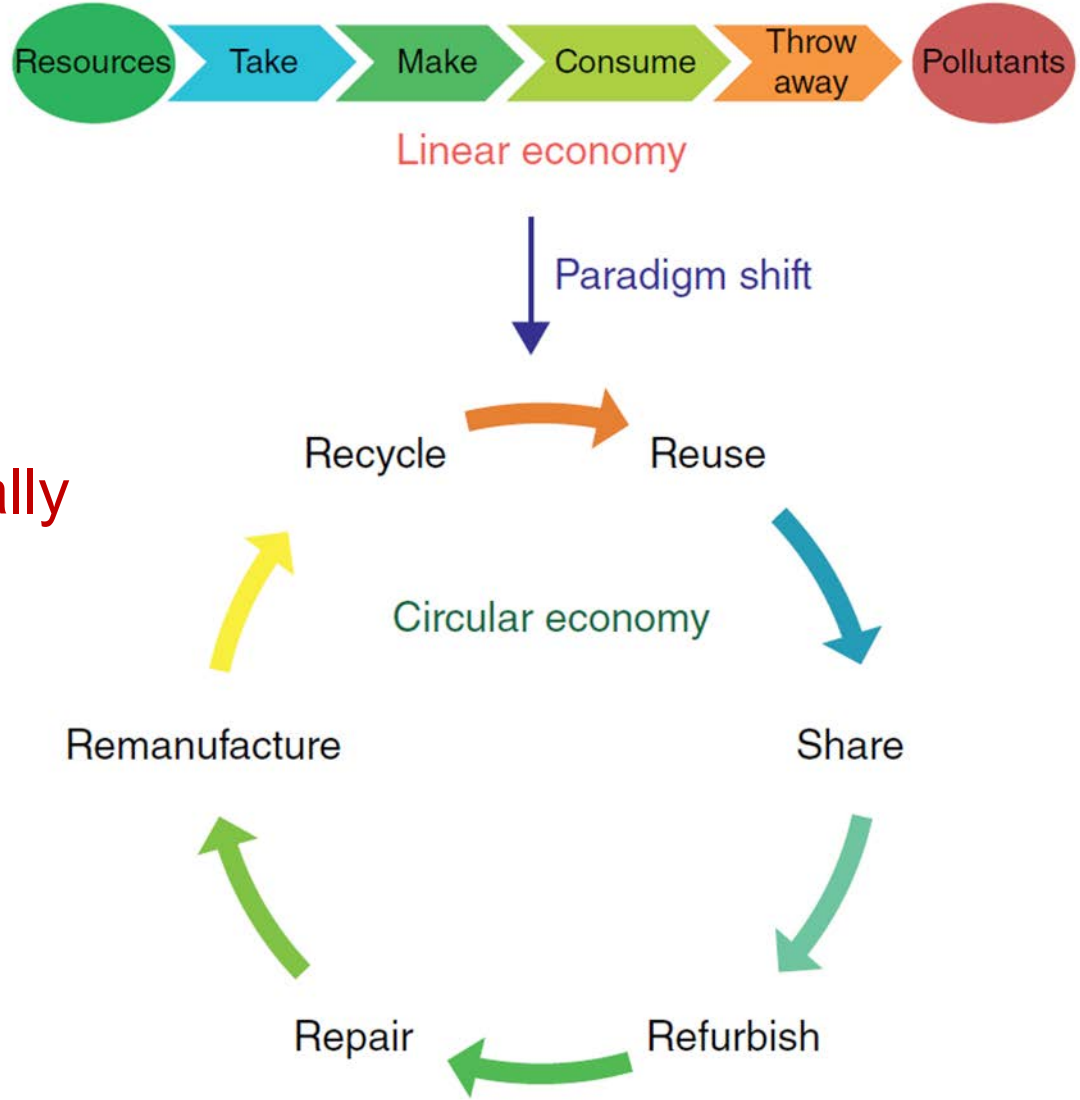
The Projector, Cineleisure

This is the story of waste.

https://www.linkedin.com/posts/seeram-ramakrishna_waste-earthday-activity-7188061671267950592-sw7f?utm_source=share&utm_medium=member_desktop

Circular Economy?

uses a systemic approach to maintain a circular flow of resources, by recovering, retaining or adding to their value, while contributing to sustainable development (ISO59004:2024).



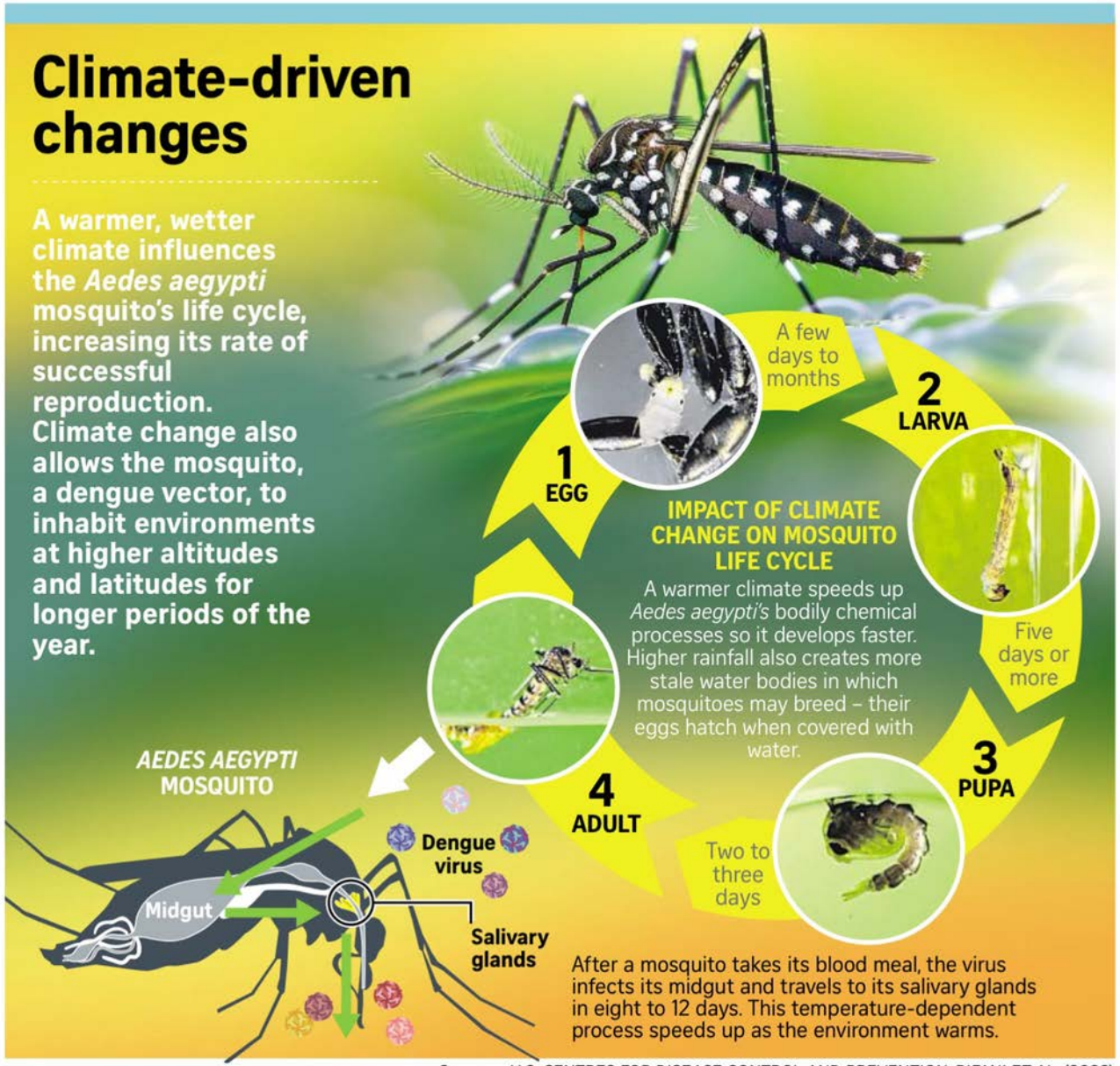
Circular economy has the potential to substantially reduce GHG emissions and particulates

Resources (fossil fuels, minerals, and biomass) extraction and processing contribute to

https://www.unep.org/resources/Global-Resource-Outlook-2024; ISBN: 978-1-119-81768-0 ; @Shutterstock

THE STRAITS TIMES

Saturday, January 18, 2025



Sources: U.S. CENTRES FOR DISEASE CONTROL AND PREVENTION, BIFANI ET AL (2022)
PHOTOS: ADOBE ST... TIMES

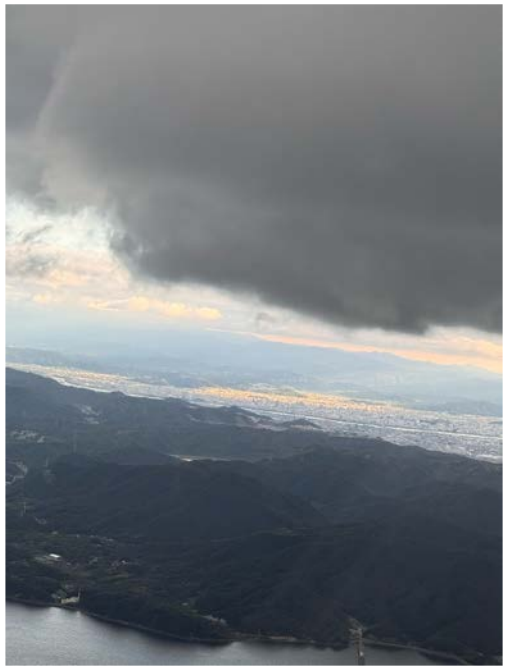
MAMMALS

One of the universal adaptation responses to climate change in mammals is that they get smaller as temperature rises. Jonathan Bloch (University of Florida, 2017) reported that the earliest ancestors of horses were about the size of a dog, with body size inversely correlated with temperature: the hotter it got, the smaller the horses.

Fig. 9. Modern horses were much smaller during the PETM.

Alexander Severinsky (2022) The desertification of crop lands, 116 pages, LAP LAMBERT Academic Publishing. ISBN-13 : 978-6204744193

Net-Zero emissions pledges (target year) by t



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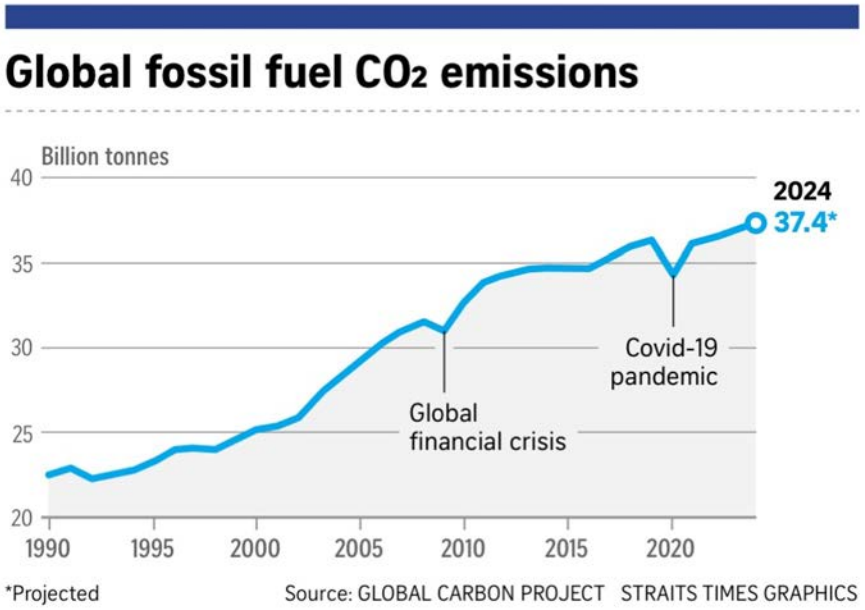
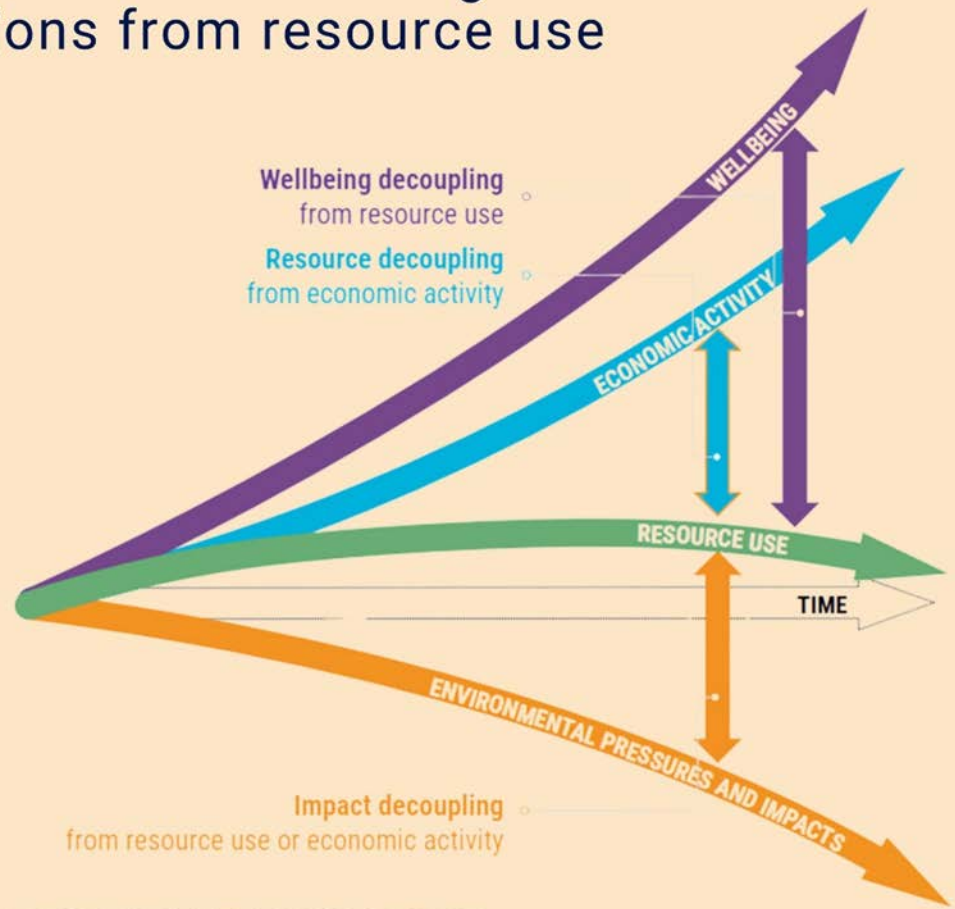


Journal of Energy Chemistry 59 (2021) 688–705, https://doi.org/10.1016/j.jechem.2020.12.005

International Resource Panel

Delivering on the SDGs for all requires decoupling, so that the environmental impacts of resource use fall while the well-being contributions from resource use increase



UN environment programme GLOBAL RESOURCES OUTLOOK 2024 REPORT

Increasing resource use is the main driver of the triple planetary crisis.

Extraction and processing of material resources (fossil fuels, minerals, non-metallic minerals and biomass) account for over 55 per cent of greenhouse gas emissions (GHG) and 40 per cent of particulate matter health related impacts. If land use change is considered, climate impacts grow to more than 60 per cent, with biomass contributing the most (28 per cent) followed by fossil fuels (18 per cent) and then non-metallic minerals and metals (together 17 per cent). Biomass (agricultural crops and forestry) also account for over 90 per cent of the total land use related biodiversity loss and water stress. All environmental impacts are on the rise.

UNEP Global Resources Outlook 2024 - Bend the trend: Pathways to a Liveable Planet as Resource Use Spikes. https://wedocs.unep.org/20.500.11822/44901)

Top 20 Asia-Pacific cities

The 2025 Asia-Pacific Best Cities Report ranked more than 140 cities on how liveable, lovable and prosperous they are.

Rank	City	Rank	City
1	**Singapore**	11	Osaka
2	Tokyo	12	Delhi
3	Seoul	13	Mumbai
4	Hong Kong	14	Bangalore
5	Beijing	15	Auckland
6	Bangkok	16	Taipei
7	Sydney	17	Guangzhou
8	Shanghai	18	Shenzhen
9	Melbourne	19	Brisbane
10	Kuala Lumpur	20	Perth

Source: RESONANCE CONSULTANCY ST PHOTO: GAVIN FOO STRAITS TIMES GRAPHICS

WORLD ENGINEERING DAY

FEATURING

THE CHARLES RUDD

DISTINGUISHED GLOBAL LECTURES 2025

Towards A Sustainable World: Engineering The Way Forward

CIRCULAR ECONOMY I RESILIENT FUTURE

11 FEBRUARY 2025 | 9AM - 12PM (SGT)

SP CONVENTION CENTRE & ZOOM (For International Participants)

PDUS FOR PE/CENG | STU (STRUCTURAL) [TO BE CONFIRMED]
2 PDUS FOR SCEM [CONFIRMED]

PANEL DISCUSSION

**NAVIGATING THE FUTURE:
CIRCULAR ECONOMY AND BUILDING RESILIENCE**

This panel explores how the circular economy, driven by engineering, innovation, and education, can eliminate waste, tackle climate challenges, and achieve net-zero goals. Learn how to build resilience, develop sustainable solutions, and equip future engineers for a greener, more sustainable future.

MODERATOR

Professor Seeram Ramakrishna
Chair of Sustainability Cluster, The Institution of Engineers, Singapore
Professor of Mechanical Engineering, National University of Singapore

Ms Kate Drews
Regional Head, Australia & New Zealand
Surbana Jurong Group

Ms Karina Cady
Chief Executive Officer
Nandina REM

Mr Loh Yew Chiong
Deputy Principal (Academic)
Singapore Polytechnic

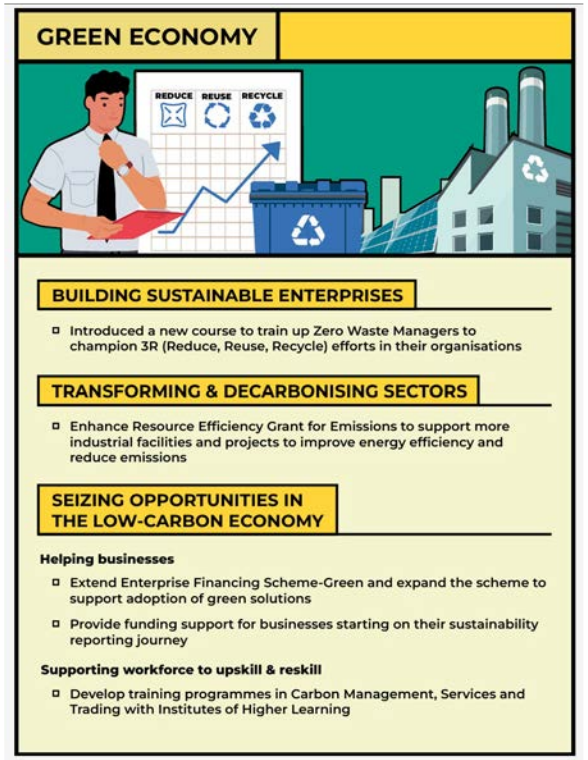
Ms Suzy Goulding
Head of Sustainability, APMEA, MSL / Publicis Groupe; Asia Lead, Salterbaxter
Vice-President and Co-Chair Marketing and Communications Business Committee, British Chamber of Commerce Singapore

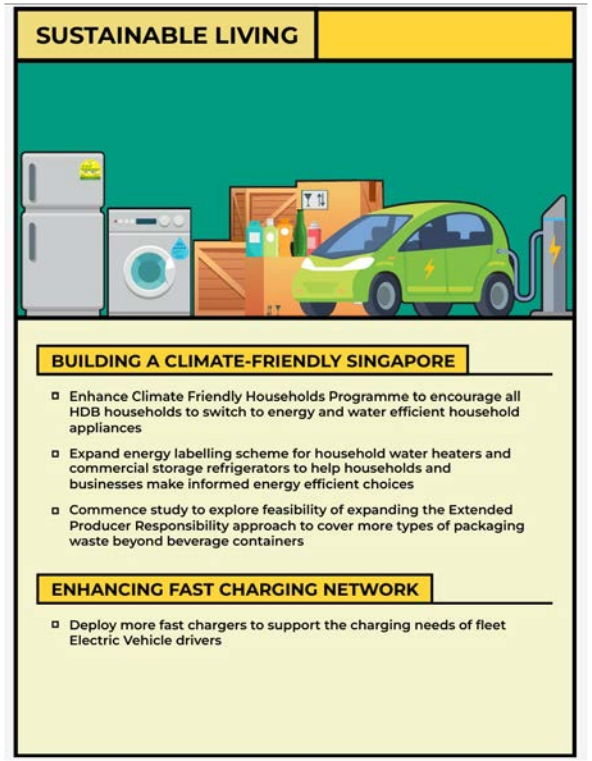
Ms Violet Chen
Director, Energy Capabilities Development Department
Energy Market Authority

https://charlesrudd.com/charles-rudd-2025/panellists/

https://charlesrudd.com/charles-rudd-2025/panellists/

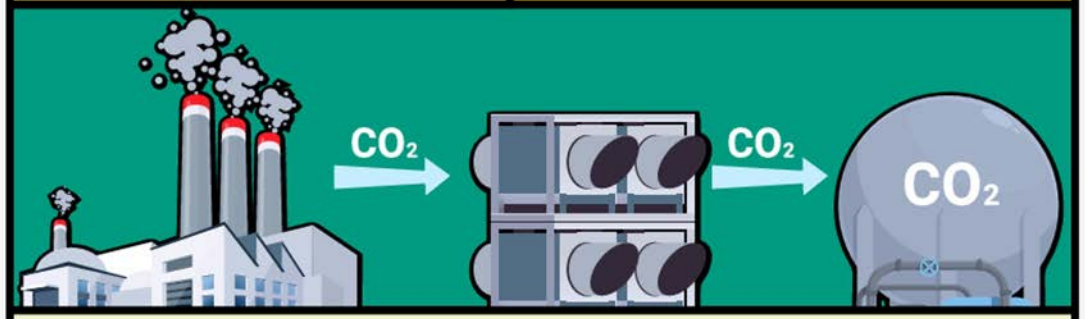
SG Green Plan 2030: Singapore's commitment towards the UN Sustainable Development Goals (SDGs).





https://www.greenplan.gov.sg/infographics/

GREEN ECONOMY



DEVELOPING CARBON CAPTURE & STORAGE AS A DECARBONISATION PATHWAY

- Work with an industry consortium to study the viability of developing a cross-border Carbon Storage project capturing emissions from Singapore

SUPPORTING BUSINESSES TO PURSUE SUSTAINABILITY COLLABORATIONS

- Introduce Environmental Sustainability Business Collaboration Guidance Note

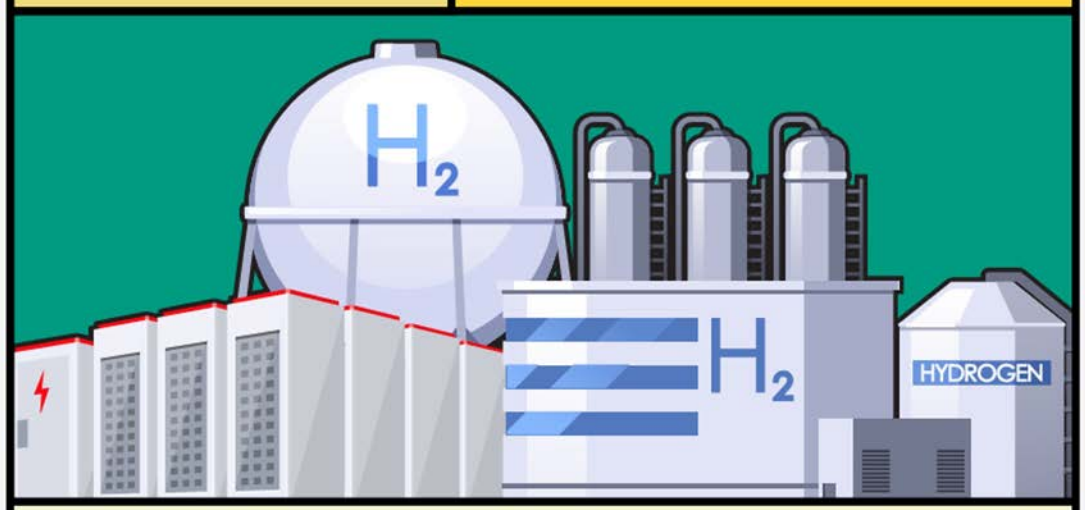
ENCOURAGING BUSINESSES TO INVEST IN ENERGY EFFICIENT EQUIPMENT

- Expand Energy Efficiency Grant to support adoption of energy efficient equipment in more sectors

SUPPORTING MARITIME BUSINESSES TO TAP ON NEW GROWTH OPPORTUNITIES

- Establish a new pillar under the Maritime Cluster Fund to catalyse first mover adoption of pre-approved sustainability solutions in targeted new areas

ENERGY RESET



ADOPTING BEST-IN-CLASS POWER GENERATION TECHNOLOGY

- Awarded YTL PowerSeraya the right to build, own and operate a new hydrogen-ready Combined-Cycle Gas Turbine (CCGT) power plant
- Commencement of operations by end 2027, making it the third hydrogen-ready CCGT power plant in Singapore

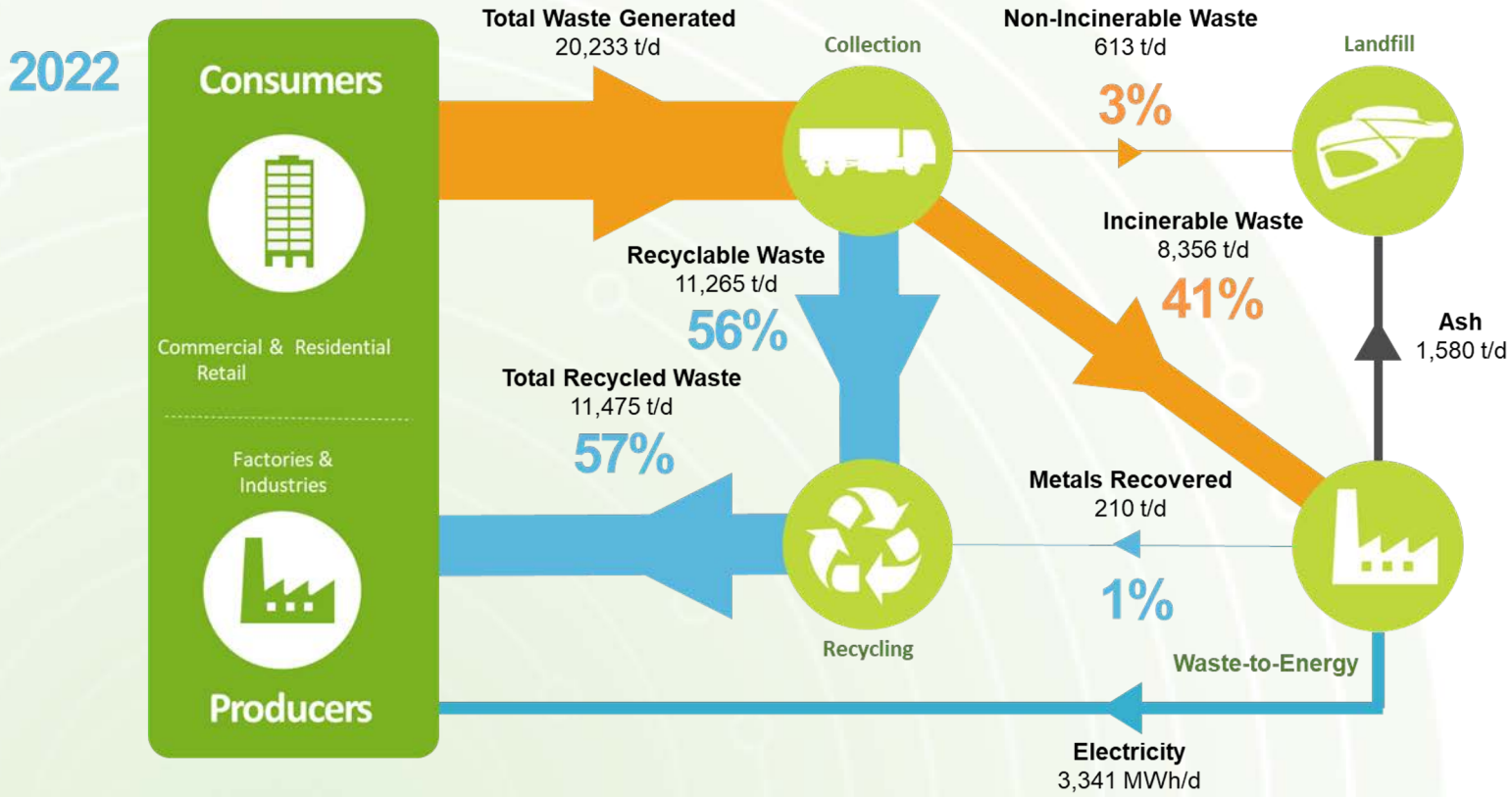
ADVANCING EFFORTS IN EXPLORING LOW-CARBON ALTERNATIVES

- Launched request for proposals for low/zero carbon ammonia solutions for power generation and bunkering
- Committed $53 million to 16 Low-Carbon Energy Research projects to improve technical and commercial viability of low-carbon energy technologies such as hydrogen

https://www.greenplan.gov.sg/infographics/

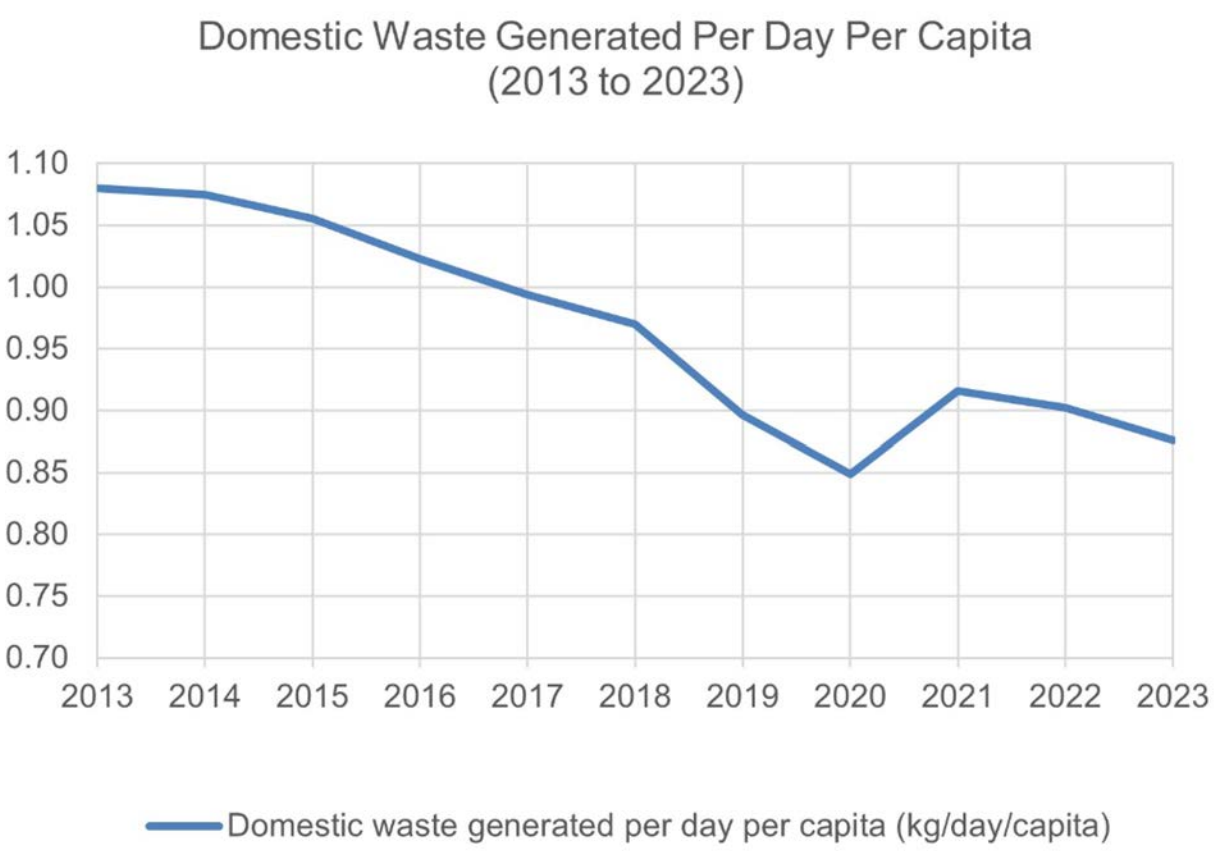
Singapore Green Plan 2030 (*https://www.greenplan.gov.sg*)

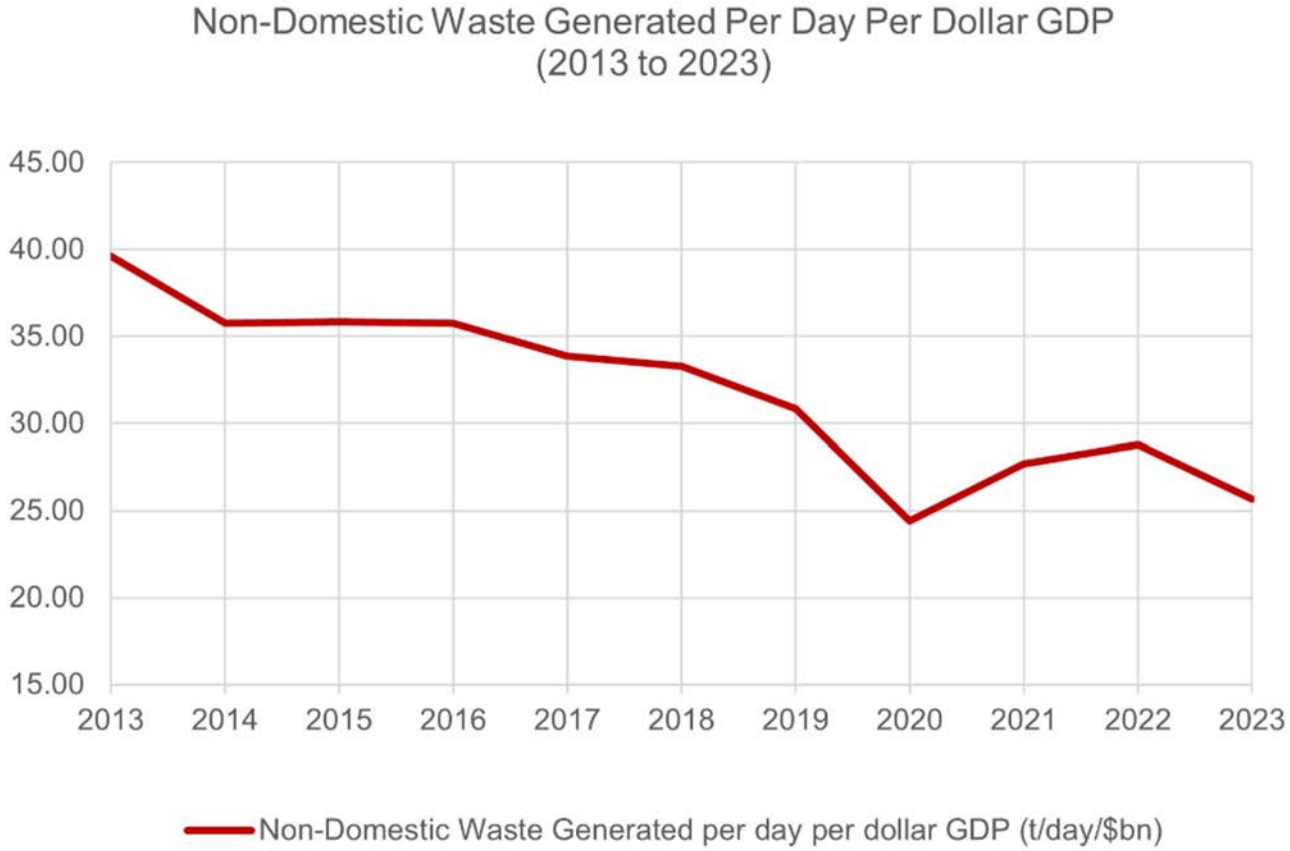
Singapore Green Plan 2030 | Zero Waste Masterplan are aimed to a) reduce the amount of waste sent to the landfill each day by 30% by 2030, and b) develop a circular economy. This will complement Singapore's climate actions.



In 2022, Singapore generated 20,000 tons of waste per day – 57% Recycled and 41% Turned into Energy

Singapore Waste Statistics (2023)





https://www.nea.gov.sg/our-services/waste-management/waste-statistics-and-overall-recycling

THE STRAITS TIMES

Monday, January 27, 2025

Global food waste by the numbers

Food waste is a major source of greenhouse gas emissions, a key driver of deforestation and a headache for waste management firms. Yet it is also a key resource that can be recycled and repurposed into valuable products and energy.

KEY FIGURES

US$1 trillion

Value of food thrown away every year, according to the United Nations Environment Programme (UNEP), based on 2022 figures.

132kg

The average amount of food waste each person produces a year, 79kg of which is trashed at home.

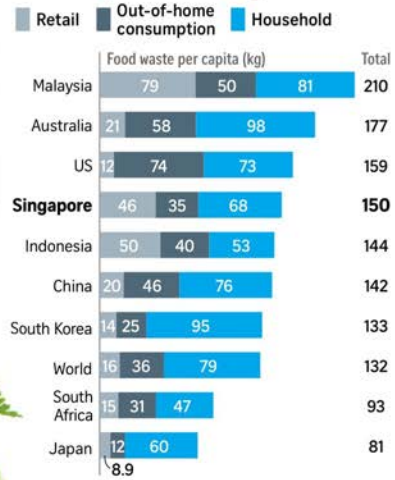
1.05 billion tonnes

The amount of wasted food from the retail, food service and household sectors.

8-10%

The proportion of global greenhouse gas emissions generated by food waste.

GLOBAL FOOD WASTE PER CAPITA IN 2022 (based on UNEP data)



Per-capita waste for Singapore*

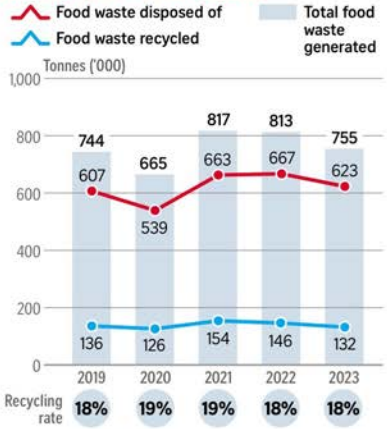
2022 About 144kg

2023 About 128kg

*Based on data from the National Environment Agency and population figures

NOTE: Total figures may not add up due to rounding.

SINGAPORE FOOD WASTE



Sources: UNITED NATIONS ENVIRONMENT PROGRAMME, OUR WORLD IN DATA, NATIONAL ENVIRONMENT AGENCY

PHOTOS: ADOBE STOCK STRAITS TIMES GRAPHICS

Waste-to-energy plants aren't perfect but likely have less climate impact than landfills.

A youth searching through a landfill for recyclable material in Basrah in southern Iraq in 2023. When biodegradable stuff decays above ground or in compost piles, bacteria digest it using oxygen, which produces carbon dioxide. But when your food scraps find themselves under 80 tonnes of other waste, bacteria resort to a different, oxygen-free (anaerobic) process that produces lots of methane. PHOTO: AFP

That landfill you are ignoring oozes methane

Dumping our garbage – especially our food waste – into the ground is bad for the earth's atmosphere.

F.D. Flam

Every year, Americans dump over 250 million tonnes of garbage into landfills, where it seems to magically disappear from our lives. In reality, our rubbish either gets fossilised or digested by vast populations of methane-emitting bacteria.

Over a 20-year horizon, every pound (454g) of methane emitted has 80 times the heat-trapping power of the same amount of carbon dioxide (CO_2 lasts much longer in the atmosphere). And America's 1,200 landfills are producing more methane than we realised, according to a group of scientists who recently used an aerial remote sensing system to fly over 200 of them. They measured methane emissions 1.4 times what had been officially recognised by the US Environmental Protection Agency (EPA). The journal Science published their findings in March.

These revelations underscore that fighting climate change will require reducing or phasing out landfills. That would not only make a huge cut in greenhouse gas emissions but also save tracts of land from getting gobbled up by the growing landfill industry.

The new measurements confirm recent estimates his group has made, said Columbia University professor Nickolas J. Themelis. By his estimate, US landfills emit about 10 million tonnes of methane a year – which over the next 20 years have the greenhouse gas equivalent to 800 million tonnes of CO_2. That is an amount comparable to what is produced by the aviation industry, he said.

While oil and gas production and agriculture are the biggest sources of methane pollution, landfills place a close third, said the Science study's lead author Dan Cusworth, a climate scientist at the University of Arizona and the project scientist for the non-profit organisation, Carbon Mapper.

Until recently, the only direct methane measurements scientists could perform on a landfill involved sending some brave soul walking around on top of it, he said. This was far from systematic.

"Landfills are very complex, dynamic environments," he said. There are hills and even cliffs. "You can imagine the area where trash is being actively dumped – it's too dangerous for someone to walk there." Most prior research on landfill emissions thus relied on mathematical models – which, it turned out, were underestimating the problem. With a technique called airborne imaging spectroscopy, Dr Cusworth's group could better measure emissions from each landfill.

Although Dr Cusworth's research reveals the true scale of the problem, people have known for decades that landfills create methane, said Dr Sally Brown, a professor at the University of Washington and one of the world's experts on the secret lives of landfills and their contribution to climate change.

When biodegradable stuff decays above ground or in compost piles, bacteria digest it using oxygen, which produces carbon dioxide. But when your food scraps find themselves under 80 tonnes of other waste, bacteria resort to a different, oxygen-free (anaerobic) process that produces lots of methane.

In the past, when rubbish went to an ordinary dump, these emissions could create a fire hazard. Concerns about public safety led the EPA to require that town dumps be replaced by "sanitary landfills" which involve a honeycomb structure of cells lined with clay.

"They had to start collecting gas," she said, "so that it doesn't go to Joe Schmo's basement and blow him up when he has a cigar."

Today, concerns about climate change should spur a similar rethink of landfills. Pipes leading out of the cells could divert some methane, Prof Brown said, where it could be used for energy or burned.

Then there's waste-to-energy plants. While uncontrolled incineration is a major source of air pollution, a well-designed, modern waste-to-energy plant captures most of the heavy metals, dioxins, particulates and other impurities. In China in 2006, Beijing found itself surrounded by 500 landfills, Columbia's Prof Themlis said, and since then they've started putting most of their garbage into waste-to-energy plants.

The plants do still emit carbon dioxide and some people have protested against their construction in their neighbourhoods, but Denmark and Japan are already using them to phase out landfills – along with strategies like generating less waste and getting better at recycling.

"You know, I see Elon Musk talking about spending money to populate Mars," Prof Themelis said. "It's so absurd... when at the same time, every year, we're transforming a large patch of green Earth to landfills."

There are also small things each of us can do to reduce the problem. Most of the methane from landfills comes from food waste, Prof Brown said, and in the US, much of that is made up of edible food. By some estimates, as much as 30 per cent of the food we produce goes into landfills rather than to our tables.

That's easy to remedy – already, Seattle has cut way down on food waste with better public awareness and systems for getting still-edible food to food banks. Prof Brown said Alameda County, California, has another good system for keeping food waste out of landfills.

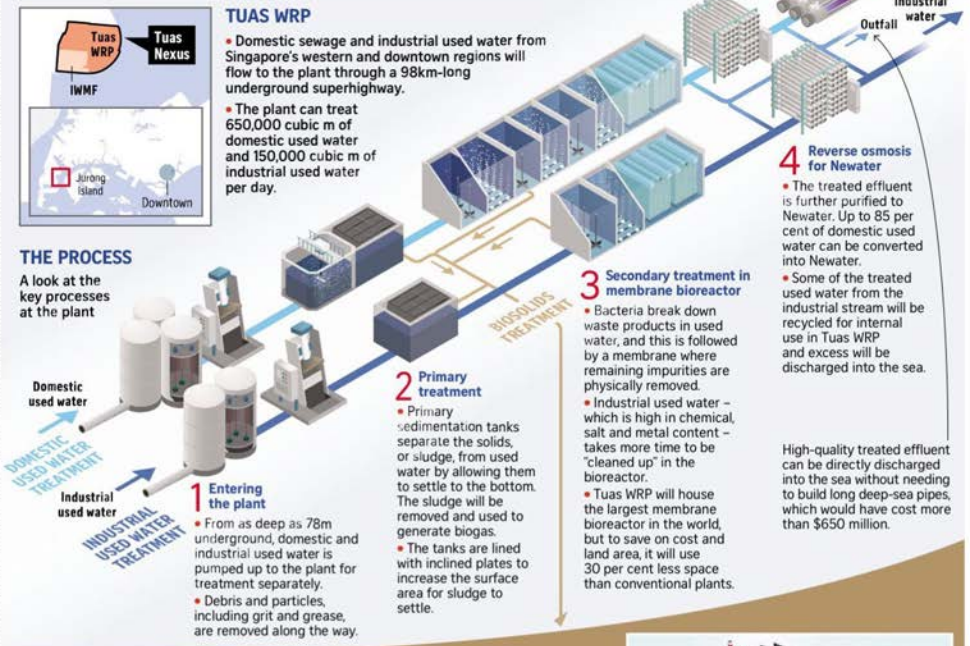
Another way to get rid of food waste is to turn it into animal feed. Over our Zoom link, Prof Brown showed me a gadget she has in her home that dries out food waste and turns it into chicken feed. "We give it to our neighbour," she said. In return, the neighbour shares the eggs. Near Las Vegas, there's a programme that diverts food waste to feed pigs.

For whatever waste is left, we'll have to make smart decisions. Waste-to-energy plants aren't perfect but likely have less climate impact than landfills. After all, garbage doesn't just vanish.

BLOOMBERG

https://www.straitstimes.com/opinion/that-landfill-you-are-ignoring-oozes-

Construction of the more than $3 billion Tuas Water Reclamation Plant (WRP) is one-third complete and set to start operations by 2026.
Shabana Begum and **Lim Yong** outline how the plant will treat used water.



SOURCE, PHOTOS AND ARTIST'S IMPRESSIONS: PUB

Water-energy-waste nexus allows food waste and used water sludge to be co-digested to generate up to three times more biogas than conventional sludge treatment processes. The biogas generated will boost electricity production. The Tuas Nexus facility is expected

Resource Sustainability Act (RSA) was enacted in October 2019 to give legislative effect to the regulatory measures targeting the three priority solid waste streams of e-waste, food waste and packaging waste, including plastics.

REPUBLIC OF SINGAPORE

GOVERNMENT GAZETTE

ACTS SUPPLEMENT

Published by Authority

NO. 36] FRIDAY, OCTOBER 4 [2019

The following Act was passed by Parliament on 4 September 2019 and assented to by the President on 23 September 2019:—

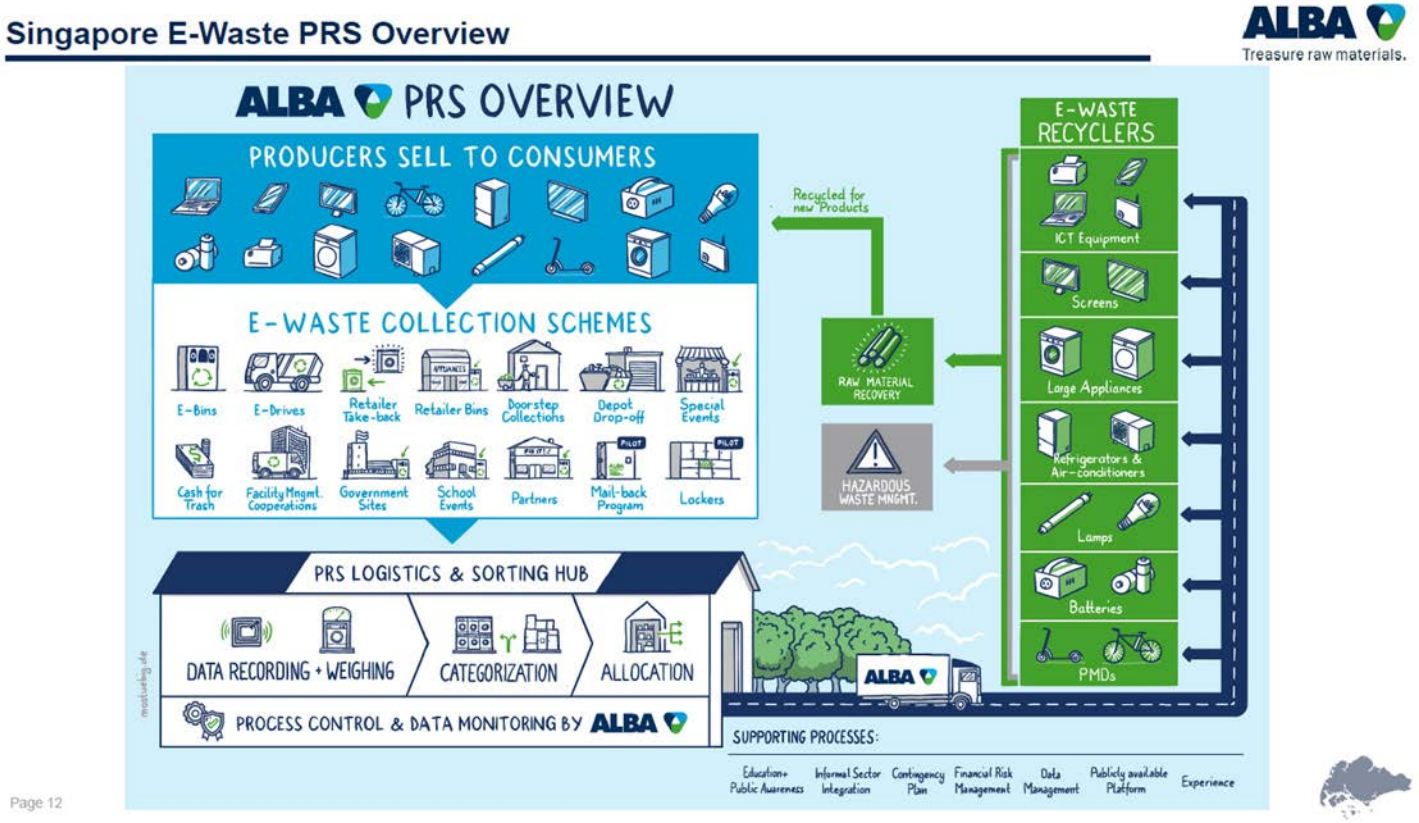
RESOURCE SUSTAINABILITY ACT 2019

(No. 29 of 2019)

https://www.mse.gov.sg/resource-room/category/2020-07-30-resource-sustainability-act/

A RENEW e-waste collection bin located within an electronics store in Singapore (Source: Koh Mui Fong/TODAY https://www.todayonline.com/singapore/more-800-kg-e-waste-collected-electronic-retailers-under-expanded-starhub-programme)

Under the **Extended Producer Responsibility (EPR) framework,** producers of regulated electrical and electronic products are made responsible for the collection and proper treatment of their e-waste. These producers are companies that manufacture or import regulated products for supply on the local market. All e-waste collected will have to be channelled to licensed e-waste recyclers for proper treatment. Singapore National Environmental Agency, NEA awarded the licence to operate a Producer Responsibility Scheme (PRS) to ALBA Group plc & Co. KG. ALBA is responsible for the e-waste collection targets set by NEA. Producers of consumer products will be required to join the PRS and finance the collection and recycling of the e-waste.



Tamil Selvan and Seeram Ramakrishna, Sustainability for Beginners, World Scientific Publishers

Recycling a refrigerator from start to finish

A recycling facility is now able to handle the recycling of large household appliances such as refrigerators and washing machines from start to finish and, with automation, is able to do so more efficiently. This is what happens to a refrigerator after it is sent to EWR2 in Tuas.

1 The refrigerator is sent to EWR2, where it is dismantled.

2 Some parts, such as the motor, will be taken to specialised machinery such as a compressor and a motor cutter, where the copper coil is extracted and then recycled.

The refrigerant, which contains harmful gases, is also properly extracted. Other parts of the refrigerator, such as its plastic shelves and compartments, will also be removed and set aside.

3 The refrigerator, now just a frame, will be placed inside the large household appliance recycling machine, where it is crushed into small pieces.The debris is then sorted into materials such as plastic, foam and metals, which are then sold off.

4 The circuit board of the fridge is sent to a chemical plant, where a robotic arm dips it into acids that are used to extract precious metals such as palladium. The used acid is then treated so it can be used again.

5 An oven is then used to press the precious metals into blocks which are sold off. These precious metals can be used in various ways, such as to make new electrical appliances.

6

Meanwhile, the other materials from the refrigerator such as plastic, foam and glass will also be sold to recyclers that deal with these materials.

Source: EWR2 PHOTOS: ADELINE TAN, CHIA TI YAN STRAITS TIMES GRAPHICS

THE STRAITS TIMES

Third plant adds 30% to battery recycling capacity

KGS has invested around $2 million to set up the plant, which has the potential to process around seven tonnes of batteries per day "if it is run 24 hours". Right now, its battery feedstock is primarily from information and communications technology equipment. ST PHOTO: DESMOND FOO

KGS aims to capitalise as electric vehicle adoption picks up in S'pore and regionally

Christopher Tan
Senior Transport Correspondent

In anticipation of a boom in the battery recycling business when electric vehicle (EV) adoption gains traction, three young men have set up a 20,000 sq ft facility in Tuas to plug into the nascent sector.

Mr T. Max, 33, a businessman; Mr Jasper Tan, 33, previously in the IT industry; and Mr Andrew Tay, 35, who worked at a paper recycling company, got together in 2016 to form KGS to recycle electronic waste (e-waste).

In 2023, KGS branched into battery recycling, with an eye to capitalise on the electrification drive accelerating in Singapore, the region and around the world.

Mr Max said KGS has invested around $2 million to set up the plant, which has the potential to process around seven tonnes of batteries per day "if it is run 24 hours".

"EV batteries make up none of the feedstock now, but we expect this to change," Mr Max said. "We are also looking to source for feedstock from the region."

Currently, battery feedstock at KGS is primarily from information and communications technology (ICT) equipment, although batteries from hybrid vehicles and e-scooters are beginning to show up.

KGS' plant in Tuas South Lane is the third battery recycling plant here. The first two are TES Singapore and Se-cure Waste Management, which are in Tuas and Jurong, respectively.

Dr Amy Khor, Senior Minister of State for Sustainability and the Environment, who officiated at the opening of the battery recycling plant on Tuesday, said KGS will boost Singapore's battery recycling capacity by 30 per cent to 11,000 tonnes per year.

She said this was "important", given the "rising volume of EV batteries... as well as lithium-ion batteries from ICT equipment that we expect from wider digitalisation".

She added that battery and e-waste recycling was key to Singapore's goal of reducing its landfill waste by 30 per cent by 2030.

At KGS' plant, batteries are first submerged in containers of saltwater to discharge whatever power they still hold.

They are then fed into shredders which break them into tiny bits, which are then sorted into three main groups – plastics; metals, such as copper and aluminium; and black mass, a powdery substance which has to be chemically broken down further to extract reusable materials such as graphite, cobalt hydroxide and lithium carbonate.

Mr Max said the KGS plant currently does not have the means to undertake the latter portion of this recycling process, but plans are afoot to include this "some time in the third quarter of 2024".

He added that there are also plans to extract battery cells that are still in relatively good health to be used in energy storage systems. This extends the usefulness of EV batteries, which in their "second life" could augment a building's power needs, for instance.

In reality, however, industry observers reckon demand from battery makers for recycled materials which they can use to make new batteries – said to be far more cost-effective than mining the earth for fresh materials – will render second-life batteries less commercially viable.

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Singapore aims to roll out a **beverage container return scheme** (Deposit Refund Scheme) to encourage people to recycle drink containers such as plastic bottles and aluminum cans.

THE STRAITS TIMES

Thursday, August 01, 2024

Under the scheme, consumers will pay an extra 10 cents for bottled and canned drinks, and upon returning the empty containers, they will get a refund of the deposit. ST FILE PHOTO

10-cent beverage container return scheme to kick off on April 1, 2026

Natalie Tan

Consumers will have to pay a refundable 10-cent deposit for bottled and canned drinks from April 1, 2026, a year later than originally announced.

The request for the delay was made by beverage producers, who required more time to adjust to the changes, said the National Environment Agency (NEA) in an update on July 31.

The beverage container return scheme was first announced in September 2022. Under the scheme, consumers will pay an extra 10 cents for bottled and canned drinks but will receive a full refund of the deposit when they return the empty beverage containers at designated return points.

Applied to all plastic bottles and metal cans ranging from 150ml to 3 litres, the scheme will run for seven years, from April 1, 2026 to March 31, 2033, in line with the licensing validity period.

More than 1,000 return points will be located at supermarkets and other communal areas to increase convenience and facilitate a higher rate of return to boost recycling.

NEA aims to reach its target return rate of 80 per cent from 2029, the third year of the scheme. This means that out of an estimated one billion beverage containers released into the market annually, around 800 million will be returned for recycling.

"We hope that it will also help to foster a culture of recycling among the public, divert these actually very valuable recyclable materials away from the incineration plant and our landfills," said Dr Amy Khor, Senior Minister of State for Sustainability and the Environment, during a fireside chat at the Singapore Institute of Directors' inaugural Climate Governance Singapore Forum on July 31.

Beverage Container Return Scheme Ltd (BCRS Ltd), a not-for-profit company formed by a consortium of beverage producers comprising Coca-Cola Singapore Beverages, F&N Foods and Pokka, will oversee the process.

BCRS Ltd, which received its licence to operate from NEA on July 29, will be involved in collecting, sorting and recycling beverage containers, setting up return points, and ensuring that stakeholder fees are fair and transparent. It will also provide the start-up capital to initiate the scheme's operations, and maintain sufficient reserves to cover its operations.

At least two BCRS Ltd board members will be appointed to represent the interest of smaller beverage producers, as required by law. BCRS Ltd will act on behalf of all participating beverage producers in Singapore.

The launch was delayed to provide beverage producers and retailers more time to design and run the scheme smoothly. The consortium also took more time than anticipated to submit their proposal, contributing to the delay.

While the scheme will take effect on April 1, 2026, there will be a transition period until June 30, 2026, to allow the beverage and retail industry to clear older stocks, which are ineligible for refunds.

By July 1, 2026, all beverage containers must be labelled with the deposit mark and carry a 10-cent deposit.

To raise awareness of the scheme, NEA and BCRS Ltd will organise outreach programmes and launch a website with information about return point locations and educational events.

"Our climate action efforts include promoting low-carbon solutions, reducing our waste generation through initiatives such as the disposable carrier bag charge," Dr Khor, who is also Senior Minister of State for Transport, wrote in a Facebook post on July 31.

"Every effort counts when it comes to climate action. So let's do our part to continue building a clean and sustainable home for generations to come."

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TR 109:2023
(ICS 13.020.20; 55.040)

ERSC set up the Technical Committee on Circularity of Materials to oversee the preparation of this document. The Technical Committee consists of the following members:

		Name	Representation
Chair	:	Mr Dalson Chung	*Individual Capacity*
Deputy Chair	:	Ms Melissa Tan	*Individual Capacity*
Secretary	:	Mr Samuel Yeo	*Standards Development Organisation @ Singapore Chemical Industry Council*
Members	:	Mr Marc Allen	*Individual Capacity*
		Ms Chan Vun Ching	*Building and Construction Authority*
		Mr Thomas Chhoa	*Alliance to End Plastic Waste*
		Ms Mia Sara Choo	*A*Star, Urban Green Tech Horizontal Technology Programme Office*
		Mr Paul Fong	*Singapore Chemical Industry Council*
		Mr Colin Goh	*National Environment Agency*
		Mr Jidesh Kambil	*Singapore Green Building Council*
		Dr Adrian Kuah	*Individual Capacity*
		Mr Walter Leong	*Singapore Environment Council*
		Asst Prof Grzegorz Lisak	*Nanyang Technological University, Singapore*
		Ms Jade Loh	*Plaspulp Union Pte Ltd*
		Mr Jasbir Nanda	*Unilever Asia Ltd*
		Mr Ong Chong Ren	*National Parks Board*
		Prof Seeram Ramakrishna	*National University of Singapore*
		Mr Matt Stanelos	*Individual Capacity*
		Mr Sean Tay	*Zenith Engineering*
		Mr Teoh Soon Kay*	*National Environment Agency*
		Mr Venkatesha Murthy	*Vans Chemistry Pte Ltd*
		Mr William Wong^	*Singapore Environment Council*

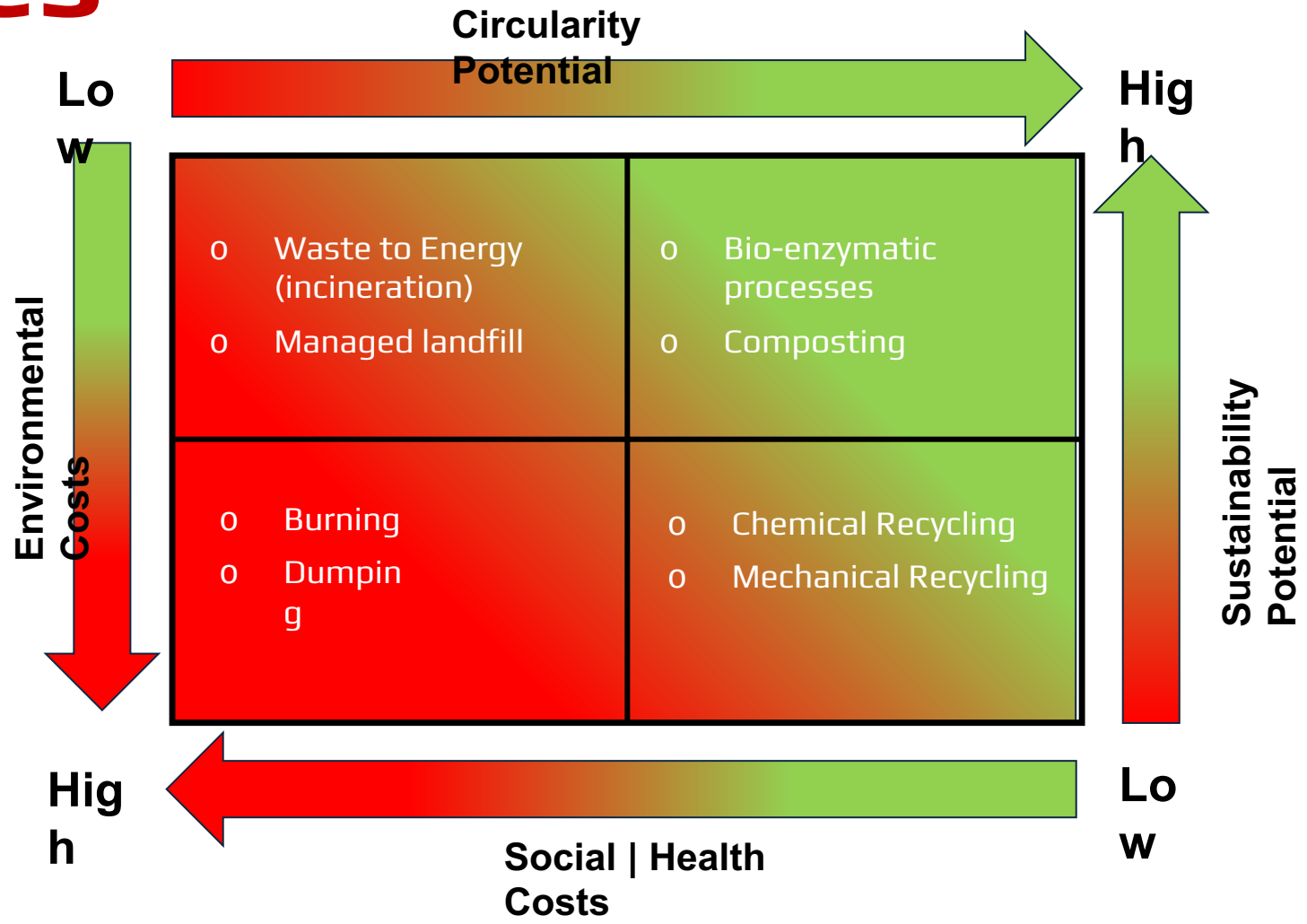
TECHNICAL REFERENCE

Sustainable packaging guiding framework and practices

Singapore Standards Council

https://www.nea.gov.sg/media/news/news/index/new-technical-reference-to-guide-companies-on-sustainable-packaging-practices

Plastic waste management strategies



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THE STRAITS TIMES

Saturday, February 11, 2023

LTA trying out asphalt containing plastic waste

Tests being done to measure factors such as noise reduction, heat absorption, durability

Kok Yufeng
Transport Correspondent

Sections of the West Coast Highway, the Pan-Island Expressway and Jalan Buroh in Boon Lay have been paved with asphalt that incorporates recycled plastic waste.

This is part of trials that the Land Transport Authority (LTA) is conducting to assess the feasibility of greener road surfacing materials and improve their durability.

Various field tests are being carried out until the first quarter of 2024 to measure factors such as noise reduction, heat absorption and road roughness.

In a Facebook post on Friday, Senior Minister of State for Transport Amy Khor said the new road mixes may be used on selected expressways and roads if they are found to be acceptable. "I'm heartened that we are taking on more of these green initiatives in our drive for transport sustainability," she wrote.

In response to queries, LTA said it is testing out two asphalt mixes that have plastic waste in them and are targeted at different road applications.

The trial in Jalan Buroh uses readily available clean plastic waste as an additive to enhance the performance of road segments that have heavy loads, such as industrial roads with slow-moving heavy vehicles.

Earlier tests of this mix, which is based on existing technology, showed a 30 per cent improvement in performance over the existing asphalt mixes, LTA said.

This project is a collaboration between LTA, the National Environment Agency, Singapore Polytechnic and local construction company Samwoh.

Meanwhile, the trial at the West Coast Highway and Pan-Island Expressway uses a new plastic-bituminous composite asphalt mix that LTA developed in collaboration with the National University of Singapore.

LTA said this new road mix is meant for general application, and it involved a complete redesign of how asphalt mix is produced.

This new material is also expected to help reduce road noise and improve urban cooling without compromising performance.

The idea of using recycled materials for road construction is not new. LTA changed road construction specifications in 2010 to allow the use of recycled waste materials. This came after it had conducted a trial the year before on a 200m stretch of Tampines Road made using processed construction waste material recycled from the milling of defective portions of road and processed incinerated waste from landfills.

Since June 2020, the authorities have also been testing NewSand, a material created from repurposed municipal solid waste, for the layer of material directly below the asphalt in a stretch of Tanah Merah Coast Road.

Asphalt mixes that incorporate recycled plastic waste have been in use overseas since the early 2000s, in countries such as India, Indonesia and Britain.

On Friday, LTA said it is in early discussions with Magorium on its proposal to trial its new product, NewBitumen, on public roads. The local start-up was founded in 2019 to turn plastic waste into road construction material, and NewBitumen has been used to pave five private roads here, including driveways at the DBS Newton Green building and a condominium in Marymount.

Separately, LTA has said that it will use a low-noise asphalt mix that uses materials such as latex and rubber when resurfacing some sections of expressways here. There are plans to use this low-noise mix in 2025 for a stretch of Tampines Expressway that intersects Sengkang and Punggol.

"Besides doing our part for the environment, we also hope to find better-performing road surfacing materials," it added.

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A stretch of West Coast Highway that has been paved with a new plastic-bituminous composite asphalt mix. Senior Minister of State for Transport Amy Khor said the new road mixes may be used on selected expressways and roads if they are found to be acceptable. PHOTO: AMY KHOR/FACEBOOK

Circular Economy Example – Jurong Island

Shell plant to turn plastic waste into useful feedstock chemical

Ovais Subhani
Senior Correspondent

Shell broke ground yesterday on a new plant on Pulau Bukom that will turn hard-to-recycle plastic waste into a feedstock chemical that can be used to make everyday products, from tyres to mattresses.

Slated to start production in 2023, Shell's pyrolysis oil upgrader unit is the first project in step with the plan for the sector that includes a sustainable energy and chemicals park on Jurong Island, and will also be the first such plant globally for the Dutch oil major.

It will also be the largest plant of its kind in Asia, with a capacity to produce 50,000 tonnes of pyrolysis oil a year.

The groundbreaking ceremony was officiated by Minister for Trade and Industry Gan Kim Yong.

Mr Gan said climate change has been identified as the single biggest threat to humanity, while consumers and investors are also increasingly placing emphasis on sustainability. That has put the energy and chemicals sector under the spotlight, because of its high carbon footprint.

"But the good news is that the sector is not standing still. It has recognised the existential impact of climate change on its future and has started to respond proactively," he said.

Ms Aw Kah Peng, chairman of Shell Companies in Singapore, said Shell's energy and chemicals park in Singapore is "a key driver in our strategy to transform our business, reduce our own emissions and those of our customers, as we move to a low-carbon economy".

"The transformation that we are embarking on is unprecedented for the industry here," she added.

Shell will use pyrolysis oil to produce circular chemicals that are used to make foams used in bedding, furniture and cars, and which can be recycled back into their liquid form, ready to be used for another cycle.

It has already signed its first circular chemicals agreement in Asia with Asahi Kasei, a multinational Japanese chemical company.

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Green targets for Jurong Island

BY 2030

Increase the output of sustainable products by **1.5 times** from 2019 levels.

Ensure that the refineries and crackers are in the **top quartile of the world** in terms of energy efficiency.

Realise at least **2 million tonnes** of carbon capture.

BY 2050

Increase the output of sustainable products by **4 times** from 2019 levels.

Achieve more than **6 million tonnes** of carbon abatement per annum from low-carbon solutions.

Source: EDB STRAITS TIMES GRAPHICS

Trade and Industry Minister Gan Kim Yong said the energy and chemical sector here is in the midst of a transition towards lower-carbon fuels, renewables and sustainable chemicals, and the sustainable park initiative will build on these ongoing efforts.

Nasreen, S.A.A.N., Sundarrajan, S., Nizar, S.A.S. et al. Pyrolysis, Microwave, Chemical and Biodegradation Methodology in Recycling of Plastic Waste: a Circular Economy Concept. Circ.Econ.Sust. (2021). https://doi.org/10.1007/s43615-021-00109-x

https://www.jtc.gov.sg/about-jtc/news-and-stories/press-releases/51-companies-jointly-support-industry-first-circular-economy-study-by-jtc-to-optimise-resource-use

THE STRAITS TIMES

Monday, January 20, 2025

CO2 carrier offers glimpse into future of carbon capture in region

A purple and turquoise vessel that docked at Tanjong Pagar Terminal on Jan 16 and 17 drew attention not just for its unique colours.

Deep in the belly of the 130m-long Northern Pathfinder are two tanks that can hold about 8,000 tonnes in total of planet-warming liquid carbon dioxide (CO2).

Built in a China shipyard, the vessel is on its maiden voyage to Norway, where an interim storage facility is waiting to receive the CO2 before the liquid is sent to a vault kilometres beneath the North Sea seabed.

The Northern Pathfinder, powered by liquefied natural gas and which had been refuelled in Singapore, is part of the world's first cross-border carbon capture and storage (CCS) project, called Northern Lights.

The project – jointly formed by energy and oil and gas giants Shell, TotalEnergies and Equinor – aims to contribute to a commercial CCS market in Europe.

Northern Pathfinder offers a glimpse of the infrastructure needed to shape CCS projects in Southeast Asia and the Asia-Pacific.

On Jan 17, the media, industry partners and representatives from Singapore agencies, among others, were invited to tour the ship.

Shell is the lead developer of the vessel – one of four ships that will form a fleet of CO2 carriers under the project.

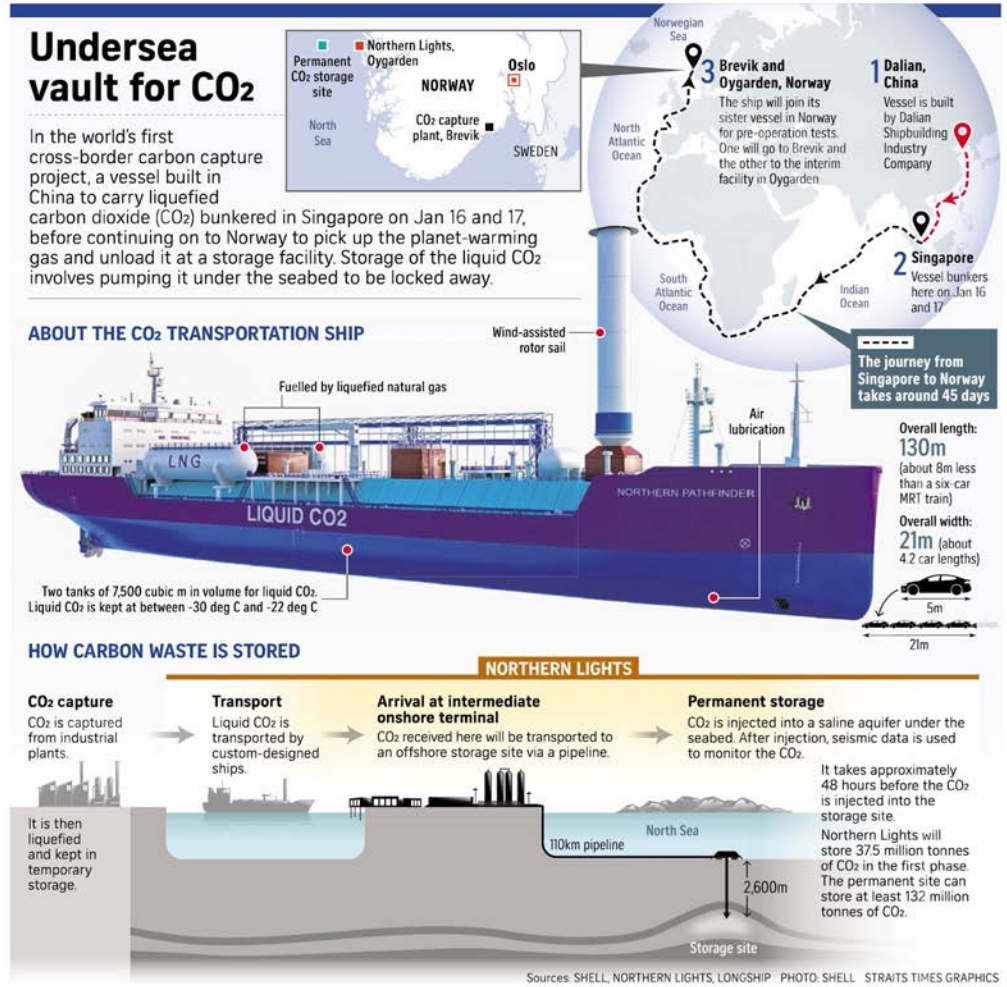
Northern Pathfinder's sister ship, Northern Pioneer, left China for Norway in November 2024.

Transporting captured CO2 from emitter countries to storage nations using ships is key for the region's CCS ambitions, said Ms Zharin Zhafrael Mohd, Shell's general manager of CCS for the Asia-Pacific.

"(The Asia-Pacific)... is largely archipelago, so shipping becomes absolutely imperative and important for us to realise carbon capture and storage, and reduce carbon emissions," she added at a media briefing on Jan 17.

Mr Lee Teng-Huar, Shell's general manager for maritime operations for the Asia-Pacific and Middle East, said: "Compared with a pipeline which is fixed between two parties, point to point, shipping allows you to be a lot more flexible.

"If the project grows a lot more scalable, it can always increase more ships to take on more volumes, versus a pipeline where, once it's built, capacity could be limited."



Shell, which has formed a consortium with ExxonMobil and is partnering the Singapore Government, has been evaluating the technical and economic feasibility of cross-border carbon capture projects here, since the Republic lacks suitable and sizeable geological storage sites.

The consortium plans to develop a CCS project that can permanently store 2,500 kilotonnes of CO2 a year by 2030, either in rock formations deep underground or under the seabed, given that the region has strong geological potential for CO2 storage.

On storage locations, Shell has been looking at places like Brunei, Malaysia, China and Australia.

The National Climate Change Secretariat has said that early CCS projects will target highly concentrated CO2 emissions from energy or chemical plants on Jurong Island.

Sectors such as chemicals produce CO2 as part of their production processes, and will require the use of CCS to avoid releasing new emissions into the atmosphere.

Singapore now levies a carbon tax of $25 per tonne, with a view of reaching $50 to $80 per tonne by 2030.

In early January, it was announced that Singapore and Malaysia will discuss cross-border CCS and work towards a legally binding agreement. They will also share best practices and information on the decarbonisation solution, and facilitate industry-led research projects.

Singapore is also looking to collaborate with Indonesia, which has passed a law to allow CCS operators to set aside storage capacity for international entities.

The Republic also aspires to become a hub for the trading of carbon credits.

In June 2024, delegates from Singapore, including Senior Minister of State for Sustainability and the Environment and Transport Amy Khor, visited the Northern Lights project's receiving terminal in Oygarden in western Norway.

The Northern Lights team, local consortium and government representatives have had multiple engagements centred on the technical risks and complexities of CCS, transboundary agreements and the commerciality of the solution, said Ms Zharin.

CCS is highly expensive because it is a nascent technology, and the cost for each project varies depending on the type of capture method, mode of transport and storage location.

A project like Northern Lights costs about US$1 billion (S$1.37 billion) or US$2 billion, added Ms Zharin. "So it's a very strong public-private partnership where the Norwegian government takes the lead, where the funding of about 80 per cent of the capital expenditure was supported."

The Northern Pathfinder is currently en route to Norway, with the trip expected to take more than 40 days. After joining its sister ship in Norway, it will undergo testing.

One ship will be in Oygarden and the other in Brevik, where the first operational customer, building materials giant Heidelberg Materials, is located.

The first phase of the CCS project, where 1.5 million tonnes of liquid CO2, equivalent to the emissions of 750,000 cars in one year, will be annually injected into an undersea reservoir 2.6km under the North Sea seabed, has been fully booked by customers.

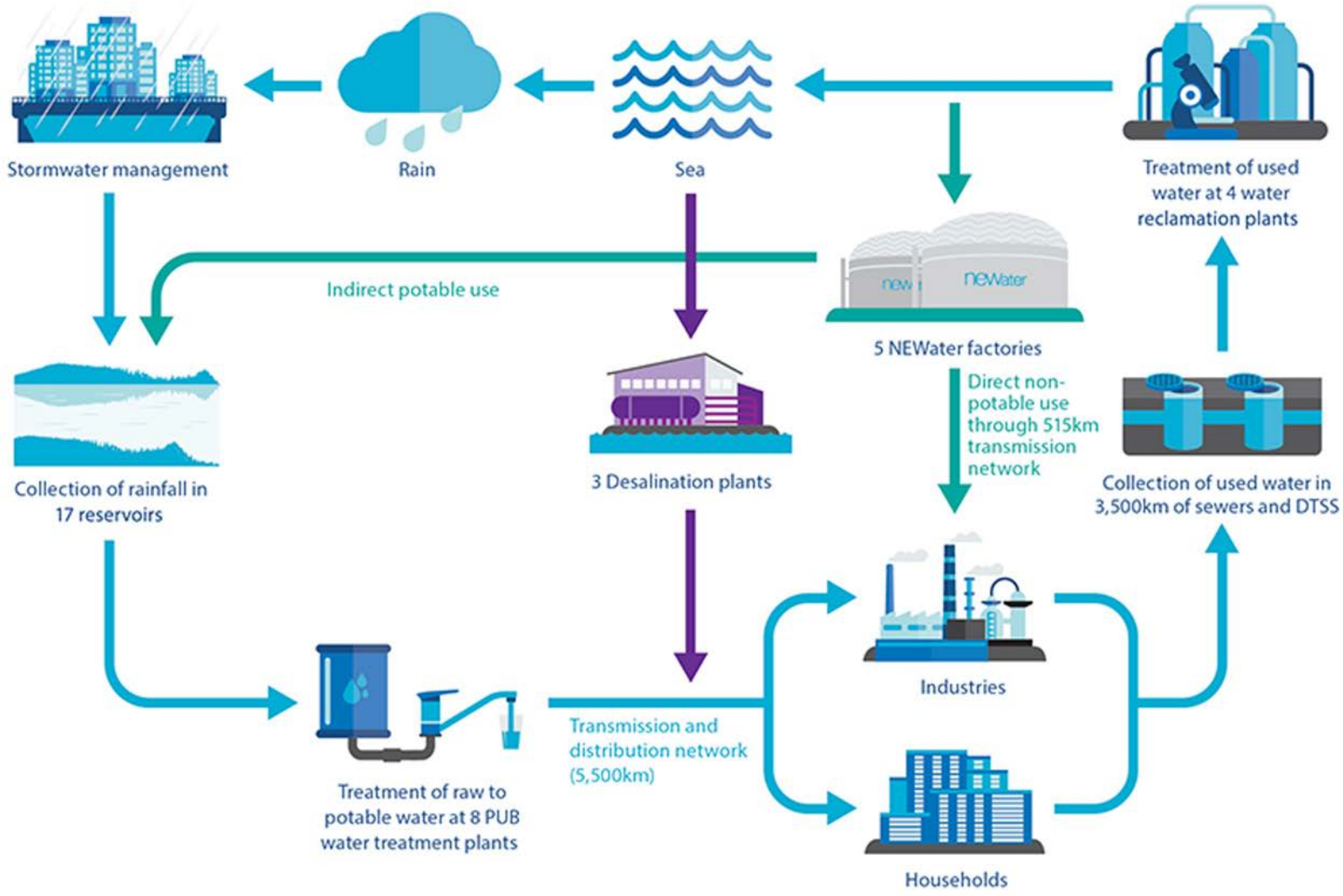
They include Heidelberg, an ammonia and fertiliser producer in the Netherlands, and a Danish energy company.

Northern Lights will transport and store 400,000 tonnes of CO2 from Heidelberg every year.

Operations are scheduled to start in 2025.

Shabana Begum

Singapore: Circular Water



https://www.towardszerowaste.gov.sg/zero-waste-masterplan/chapter2/circular-economy/

THE STRAITS TIMES

Sunday, August 18, 2024

S'pore tops global ranking in provision of safe drinking water

Christie Chiu

Singapore leads the world in the provision of safe and clean drinking water in the latest ranking of 180 countries by Yale University.

The United States-based university, in its 2024 Environmental Performance Index (EPI), ranked countries on their sanitation and water standards based on the likely health impact from exposure to unsafe sanitation and unsafe drinking water, particularly the risk of bacterial contamination leading to diarrhoeal diseases.

The report said: "Singapore not only has universal access to safe sanitation, but it is also a global leader in the treatment and reuse of wastewater. The Singaporean Government has integrated wastewater reuse into its socioeconomic development and water security."

For the ranking, the health risks associated with each country's water and sanitation were given a score based on a formula that calculates the loss of one year of full health, which the World Health Organisation calls disability-adjusted life years, adjusted for age.

A score of 100 means the country has among the lowest loss of health in the world, while a score of zero indicates the highest loss of health.

Singapore scored 99.9 in the EPI report, edging out Italy (98.2), the UK (98.2), Switzerland (98.0) and Germany (97.9). At the bottom end were mainly African countries like Madagascar (12.9), Niger (12.2), Lesotho (9.4), the Central African Republic (8.9) and Chad (4.3).

Clean drinking water refers to the accessibility, availability and quality of the water used by a given family for daily health and household needs, the report said.

"An adequate water source must be easily accessible and unlikely to be contaminated, particularly by faecal matter," it added.

Examples of adequate water sources include household water connections, public standpipes, boreholes, protected dug wells, protected springs and rainwater collection, it said.

The EPI said exposure to unsafe drinking water in a household is based on its primary water source and its treatment of drinking water to improve its quality before consumption, which includes boiling or filtering water.

Exposure to unsafe sanitation is determined by the type of toilet used by households. This ranges from "unimproved" facilities, such as open defecation, to "improved" ones like composting toilets, to flush toilets.

Apart from sanitation and water, the EPI also ranks each country's performance on 10 other environmental issues on their progress towards mitigating climate change, improving environmental health and protecting the vitality of its ecosystem.

Singapore ranked 44th in the overall report. It scored poorly – coming in at 129th – for marine habitat conservation, and was 96th in climate change mitigation, and 65th in ecosystem vitality.

In the 2022 EPI report, Singapore ranked 21st in sanitation and drinking water.

Published once every two years, the report used data from the Global Burden of Disease Study, published by the Seattle-based Institute for Health Metrics and Evaluation, which compiled data from 204 countries on household water sources and sanitation facilities from 1990 to 2021.

The EPI report said: "Singapore's national water agency PUB pioneered the automation of drinking water monitoring and early warning systems. The country now benefits from a robust monitoring system to test drinking water for potential chemical, microbiological and radiological contaminants.

"Yet, despite the top quality of their tap water, many Singaporeans boil tap water before drinking, further removing potential bacterial and chemical contamination."

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Yale's 2024 Environmental Performance Index

TOP 10

Country	Rank	Score
Singapore	**1**	**99.9**
Italy	2	98.2
United Kingdom	2	98.2
Switzerland	4	98
Germany	5	97.9
Norway	6	97.6
Montenegro	7	97.5
Sweden	8	97
United States	9	96.4
Finland	10	95.2

Source: 2024 ENVIRONMENTAL PERFORMANCE INDEX
SUNDAY TIMES GRAPHICS

ENSURING WATER SECURITY

Singapore not only has universal access to safe sanitation, but it is also a global leader in the treatment and reuse of wastewater. The Singaporean Government has integrated wastewater reuse into its socioeconomic development and water security.

YALE UNIVERSITY, in its Environmental Performance Index report.

Recycling a must for new projects using water intensively

PUB to mandate recycling requirements from 2024 amid rising consumption

Sludge from the used water treatment process is converted to biogas in egg-shaped digesters at the Jurong Water Reclamation Plant. A major source of water demand growth is expected to be the non-domestic sector, where it is projected to increase from 55 per cent of total consumption now to over 60 per cent. ST FILE PHOTO

Cheryl Tan

To help reduce water consumption in water-intensive industries, PUB will be mandating recycling requirements for new projects in these sectors from Jan 1, 2024.

These include projects in the wafer fabrication, electronics and biomedical industries, which account for about 17 per cent of non-domestic water demand, Minister for Sustainability and the Environment Grace Fu said on Thursday.

The national water agency said that with Singapore consuming about 440 million gallons of water per day and total water demand expected to almost double by 2065, recycling water can help companies by reducing their water bills and contributing to their long-term competitiveness.

PUB added that a major source of water demand growth is expected to come from the non-domestic sector, where it is projected to increase from 55 per cent of total consumption currently to more than 60 per cent.

"There is also high potential for water recycling in these industries, as their used water streams can be effectively recycled when segregated at source. In addition, some waste water streams from the electronics and biomedical plants are fairly clean, making it easier to recycle with minimal treatment required," it said.

Therefore, wafer fabrication plants involved in front-end semiconductor manufacturing, which consume at least 60,000 cubic meters of water annually, would have to recycle at least 50 per cent of their water consumption.

Likewise, electronic and biomedical plants which consume the same volume of water annually would be required to recycle their specified waste streams.

With these measures in place, PUB said, daily water savings could reach nine million gallons – equivalent to 15 Olympic-sized swimming pools – from 2035 onwards.

The agency has consulted companies from the affected industries, and said that the companies have found the new recycling requirements to be achievable for new projects.

The median water recycling rate among existing wafer fabrication plants stands at 43 per cent, PUB noted.

Companies looking to implement these water recycling projects can apply for financial support from PUB's Water Efficiency Fund and the Industrial Water Solutions Demonstration Fund within the next two years, until the end of 2025.

PUB is also reviewing its funding framework and looking into providing more incentives for companies to achieve a recycling rate beyond the mandated 50 per cent level.

Details will be made available in the next few months.

The Kranji Water Reclamation Plant (WRP) and the Kranji Newater Factory will also be redeveloped, said Ms Fu.

This comes amid major upcoming residential and industrial developments in the north, such as Tengah New Town and Sungei Kadut Eco-District, which will significantly increase the demand for used water to be collected and treated.

PUB will be using more advanced treatment technologies that have better treatment and land-use efficiencies, which also have a smaller carbon footprint.

The new Kranji WRP will be connected to the Deep Tunnel Sewerage System (DTSS) – a network of deep tunnels that form a superhighway for Singapore's used water – before reaching the water reclamation plants and the Newater factories.

The DTSS system would then have three nodes for water reclamation – the Kranji WRP in the north, the Changi WRP in the east and the Tuas WRP in the west. All three WRPs will be co-located with Newater factories.

"When completed, the DTSS will reduce by 50 per cent the amount of land that would otherwise have been needed for used water infrastructure, (which is) significant for land-scarce Singapore," said Ms Fu.

"We are making good progress on DTSS Phase 2 and expect tunnelling works to be completed by the second half of this year. This will connect the existing Changi WRP and the upcoming Tuas WRP in the west," she added.

The Tuas WRP will be completed by 2026, alongside the new Tuas Newater Factory, and the Kranji WRP and Newater Factory in the north will be the newest addition, with preliminary design to commence in 2023, said Ms Fu.

PUB said that to reduce domestic water consumption, Singapore had in 2018 set a target of 130 litres per capita per day (LPCD) by 2030 but the Covid-19 pandemic had increased consumption significantly, from 141 LPCD in 2019 to 154 LPCD in 2020 and 158 LPCD in 2021.

With the resumption of business activities and relaxation of safe management measures in April 2022, PUB said that household water consumption has decreased and reached 149 LPCD as at December 2022.

"PUB will continue to work towards the 130 LPCD target by 2030 and drive behavioural change among households to ensure a sustainable and resilient water supply for the future," said the agency.

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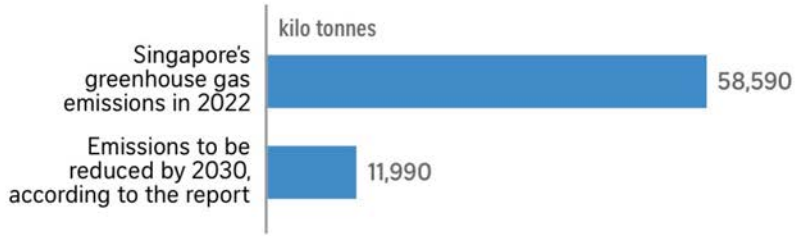
SIGNIFICANT REDUCTION

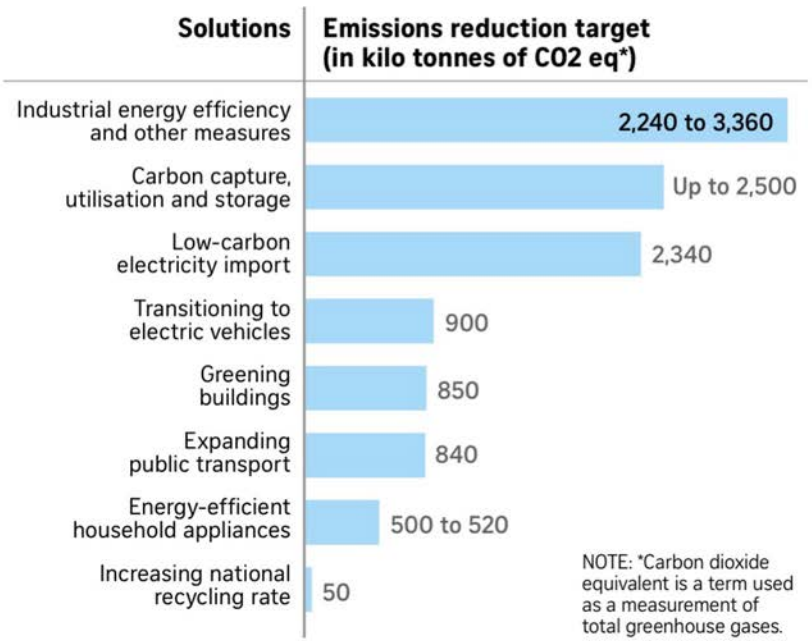
When completed, the DTSS will reduce by 50 per cent the amount of land that would otherwise have been needed for used water infrastructure, (which is) significant for land-scarce Singapore.

MINISTER FOR SUSTAINABILITY AND THE ENVIRONMENT GRACE FU, on the Deep Tunnel Sewerage System – a network of deep tunnels that form a superhighway for Singapore's used water.

Road to 2030: Cutting carbon emissions

Singapore is banking on carbon capture technologies, energy-efficient equipment and the import of green electricity to meet its 2030 climate change targets. The Straits Times highlights some of the strategies laid out in a recent climate report submitted to the UN.





NOTE: *Carbon dioxide equivalent is a term used as a measurement of total greenhouse gases.

Source: SINGAPORE'S FIRST BIENNIAL TRANSPARENCY REPORT 2024 STRAITS TIMES GRAPHICS

Monday, January 20, 2025

THE STRAITS TIMES

Singapore sets out plans to meet 2030 climate targets

In 2022, Singapore's greenhouse gas emissions measured about 58,590 kilo tonnes. The top contributors to the country's emissions are the power, industrial and transportation sectors. Singapore expects its planet-warming emissions to peak in 2028, before going down to about 60,000 kilo tonnes in 2030. ST FILE PHOTO

Energy efficiency, carbon capture, clean energy among key moves to cut emissions

Shabana Begum

For the first time, Singapore has publicly set out how it plans to cut emissions to meet its 2030 climate targets, with energy efficiency, carbon capture technology and clean energy imports expected to be among the most effective measures.

The various efforts to cut emissions, called mitigation measures, were detailed in a report the Republic submitted to the United Nations in November 2024. The biennial transparency report details a country's greenhouse gas inventory and progress made in reaching climate targets.

While the Republic has through its Singapore Green Plan 2030 – a sustainability road map – highlighted some of its plans to cut emissions, the latest report was the first to put a figure on the estimated amount of emissions that each measure could help reduce.

The report mentioned more than 10 mitigation measures, which include initiatives like electrifying vehicle fleets and greening buildings.

Of the various measures, three stood out for having the highest abatement potential, or potential to reduce Singapore's greenhouse gas emissions, by 2030.

They include energy-efficiency initiatives for industries, capturing carbon and importing green electricity.

In 2022, Singapore's greenhouse gas emissions measured about 58,590 kilo tonnes. The top contributors to the country's emissions are the power, industrial and transportation sectors.

Singapore expects its planet-warming emissions to peak in 2028, before going down to about 60,000 kilo tonnes in 2030.

The mitigation measures highlighted in the report can help Singapore to reduce its emissions by nearly 12,000 kilo tonnes by 2030. This is about 20 per cent of the island-state's total emissions in 2022.

Of the 12,000 kilo tonnes of emissions reductions, energy-efficiency initiatives could contribute up to 30 per cent.

The report estimated that such initiatives, including getting emissions-intensive industries like data centres or manufacturing plants to use more energy-saving machines, could reduce between 2,240 and 3,360 kilo tonnes of carbon dioxide equivalent (kt CO2 eq). CO2 eq is a measure of total greenhouse gases emitted.

Singapore has already been moving on this front. For example, minimum energy efficiency standards were introduced for industrial facilities in 2019 for chilled water coolers, the highest electricity-consuming system in the industry. Chilled water coolers help to keep buildings or industrial machines cool, preventing overheating.

The use of carbon capture, utilisation and storage technology is expected to contribute another 20 per cent or so to the total emissions reductions.

The report estimated that such technology, which sucks carbon dioxide from polluting sources and locks it away, can help to remove up to 2,500 kt CO2 eq by 2030.

Natural gas, a fossil fuel, is expected to continue to power more than 50 per cent of Singapore's energy needs by 2035.

The National Climate Change Secretariat, which is one of the agencies that prepared the report, told The Straits Times that Singapore must work with other countries on carbon capture storage, since it lacks suitable underground sites for this purpose.

The Government has been working with an industrial consortium to evaluate the technical and economic feasibility of cross-border carbon capture projects.

The consortium plans to develop a carbon capture and storage project that can permanently store 2,500 kilo tonnes of carbon a year by 2030, either in rock formations deep underground or under the seabed.

Among the countries Singapore is looking to collaborate with to lock up carbon or share best practices on the technology are Indonesia, Malaysia and Japan.

Importing renewable electricity could be another significant contributor to Singapore's emissions reductions, making up about 20 per cent of the expected total emissions reductions by 2030. The report had estimated its abatement potential to be about 2,340 kt CO2 eq.

Singapore had earlier announced plans to import low-carbon electricity from its neighbours, with such imports expected to make up around a third of the Republic's energy needs by 2035.

Singapore has inked deals with Indonesia, Cambodia and Vietnam to import 5.6 gigawatts of low-carbon electricity by 2035. Commercial operations under some of these import contracts could begin from 2028.

Mr Ho Hiang Kwee, an adjunct senior research fellow at the NUS Energy Studies Institute, said the report marks the first time that Singapore has detailed specific measures and their emissions reduction targets to meet its 2030 goals.

Many countries have set climate targets – particularly net-zero goals by the mid-century or so – but they often lack concrete pathways on how to get there.

While there are many ways for countries to cut their emissions to meet their climate change goals under the 2016 Paris Agreement, each nation will have to tailor its own toolbox.

For example, while some countries are able to deploy more renewable energy within their borders, space-constrained Singapore is unable to do so. This is why the Republic is ramping up efforts to enable it to import renewable-generated electricity from its neighbours.

However, Mr Ho noted that given Singapore's longer-term aspirations to reach net-zero emissions by 2050, the 2030 targets are not particularly ambitious. For example, he noted that while industrial energy efficiency appears to have the largest emissions-cutting potential in the report, the abatement target of up to 3,360 kilo tonnes is still less than 10 per cent of the roughly 38,000 kilo tonnes emitted by the sector in 2022.

Mr Ho said that Singapore, as a small, resource-constrained island state, faces many challenges in reducing its emissions, as the nation will need effective international cooperation and mature decarbonisation technologies to do so.

He added that there is also a need to accept that the costs of reducing emissions may be quite high, especially in the early years of installing new and complex solutions like electricity imports and carbon capture. Setting more ambitious climate targets hinges on scaling up decarbonisation technologies, among other factors.

By February 2025, countries have to submit new and more ambitious climate pledges to the UN, with those emission-reducing targets to be met by 2035.

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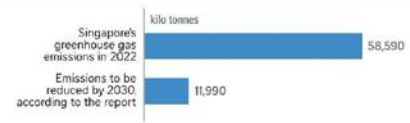
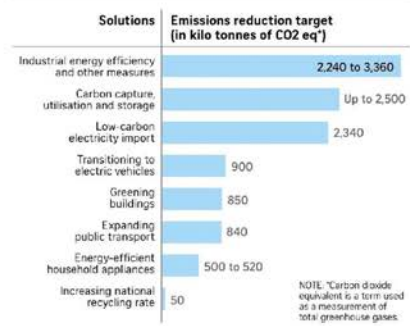
CO2 carrier offers glimpse into future of carbon capture in region

THE STRAITS TIMES

Road to 2030: Cutting carbon emissions

Singapore is banking on carbon capture technologies, energy-efficient equipment and the import of green electricity to meet its 2030 climate change targets. The Straits Times highlights some of the strategies laid out in a recent climate report submitted to the UN.





Source: SINGAPORE'S FIRST BIENNIAL TRANSPARENCY REPORT 2024 STRAITS TIMES GRAPHICS

Heat-reflective cool paint reduces the ambient temperature by up to 2 deg C!

Cooling HDB towns and making them more sustainable

A worker using cool paint, which can reduce surface heat absorption and emission, to paint the external walls of Block 848 Tampines Street 82 on Feb 3.

Cool coatings

- Additives in heat-reflective paint cause less heat to be absorbed by block's facade
- Less heat from the sun is emitted from the surface
- Initiative to be rolled out to all HDB estates by 2030

Smart electrical sub-meters

- Track energy consumption patterns and the performance of common services in each block
- Optimise town councils' maintenance cycles of common services and detect anomalies such as equipment faults to minimise downtime
- Enable comparison of energy usage across various HDB blocks
- To be installed in the consumer switch rooms of HDB blocks from the second quarter of 2025

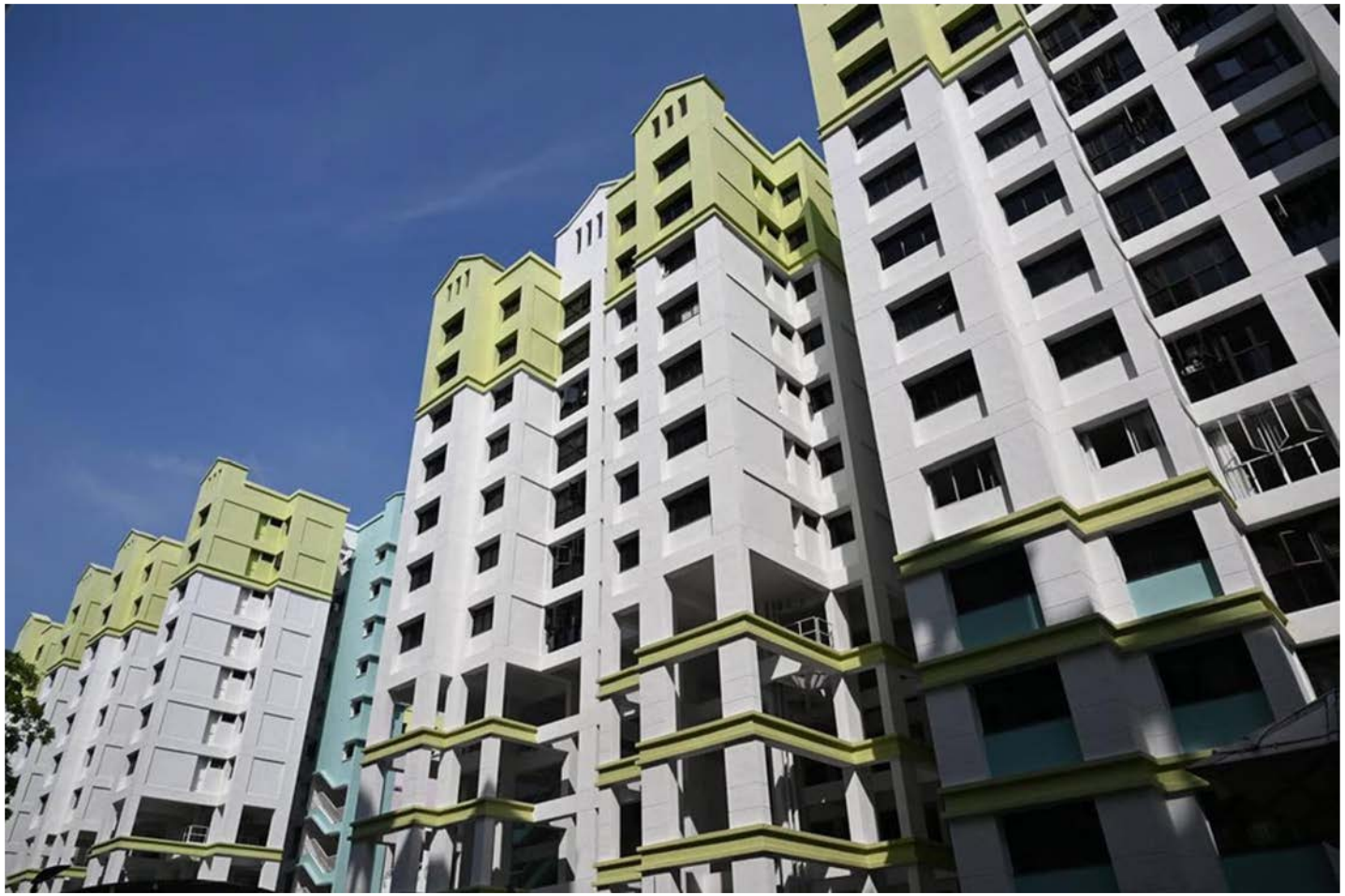
Beverage container return points

- More than 1,000 to be deployed islandwide, including at HDB-owned and town council spaces

HDB-managed complexes

- To be upgraded by 2030 to reduce their carbon footprint
- Solar panels to be installed on the rooftops
- More energy-efficient and water-efficient fittings
- Machines to turn food waste into compost

Source: HOUSING BOARD
ST PHOTOS: LIM YAOHUI, CHONG JUN LIANG, KUA CHEE SIONG
STRAITS TIMES GRAPHICS



https://www.straitstimes.com/singapore/housing/heat-reflective-paint-initiative-to-be-rolled-out-to-all-hdb-estates-by-2030

THE STRAITS TIMES

Friday, January 24, 2025

In total, the Government expects to commit more than $10 billion in fiscal spending for projects like the management of climate-related risks in the decade up to financial year 2030, under the Singapore Green Plan. ST PHOTO: BRIAN TEO

Govt to continue green budgeting approach and set aside funds for climate adaptation

Sue-Ann Tan
Business Correspondent

The Government will continue to take a green budgeting approach and ensure that it sets aside finances for climate mitigation and adaptation, said the Ministry of Finance (MOF) on Jan 23.

In total, it expects to commit over $10 billion in fiscal spending for projects such as the management of climate-related risks in the decade up to financial year 2030, under the Singapore Green Plan.

MOF detailed its plans to ensure that funds are set aside to secure a resilient future for Singapore, in a paper that outlined the Government's green budgeting approach.

"Green budgeting takes into account sustainability considerations in the management of our public finances and supports our commitment to climate action," MOF said.

Minister in the Prime Minister's Office and Second Minister for Finance Indranee Rajah said: "The Government has been adopting green budgeting practices to systematically incorporate environmental sustainability considerations in our financial policies while making sure that we are prudent and effective in our spending.

"We are putting resources behind our ambitious plans and ensuring our decisions continue to drive our efforts towards net zero."

Singapore has committed to achieve net-zero emissions by 2050. Initiatives that tap the green budget include Tuas Nexus, which is expected to be the world's first fully energy self-sufficient greenfield facility that integrates water treatment and solid waste management. The facility is estimated to cost about $6 billion.

The building of more cycling paths is also expected to cost about $1 billion, MOF said in its paper.

The ministry estimates that it has spent more than $2 billion on green initiatives in the 2021 to 2024 financial years.

To fund long-term green expenditure beyond 2030, the Government has also introduced measures such as a carbon tax to help fund decarbonisation efforts and support the transition to a green economy, MOF added.

The Government can also borrow money through green bonds to finance nationally significant green infrastructure projects. This will help to spread the costs across generations that will directly benefit from these projects.

As at January 2025, the Government has issued $9.2 billion of green bonds to finance the expansion of the electric MRT network, MOF noted.

Money has also been set aside for coastal protection measures to protect Singapore against rising sea levels. These are estimated to cost more than $100 billion over the next 100 years, and MOF said it has put an initial $5 billion into this fund.

The ministry has also put $5 billion into a fund to invest in critical infrastructure needed for energy transition, such as undersea cables to import low-carbon electricity and new hydrogen terminals and pipelines.

Regarding state investors, the Government expects them to take into account the impact of climate change on their investments, said MOF. It noted that GIC, the Monetary Authority of Singapore and investment firm Temasek have integrated sustainability considerations into their investment processes, although the Government does not direct their individual investment decisions or prescribe specific sustainability outcomes.

MOF said in its paper: "Climate change has significant interactions with public finances. Governments around the world need to facilitate the carbon transition and adapt nimbly to the effects of climate change, which require significant investments and fiscal resources.

"At the same time, climate change can cause severe disruptions to human and economic activities, but also holds the promise of creating new economic opportunities. These, in turn, affect public finances."

It noted that governments face the problem of balancing three things: the pace of decarbonisation, the impact on economic competitiveness, and ensuring fiscal sustainability.

"There is a need to balance these trade-offs while allocating finite resources to competing priorities," MOF said, adding that this problem is made worse by technological uncertainty and the high costs of decarbonisation pathways.

Hence, it said, it is important, now more than ever, for governments to incorporate sustainability considerations in the management of public finances. This ensures that budgets are aligned with national climate and sustainability strategies.

"Finance serves as a crucial lever to support governments' climate goals, and enable a whole-of-society transformation to achieve optimal sustainability outcomes. If done well, climate mitigation and adaptation can create economic and social benefits," MOF said.

On Jan 23, MOF also released its refreshed Singapore Green Bond Framework.

First published in 2022, the framework lays out the requirements around sovereign green bonds issued to finance green public sector projects. It ensures that the public sector upholds a high level of green standards in line with best practices in the industry.

"The addition of these science-based and robust thresholds ensures that the projects financed by public sector green bonds under the framework will contribute substantially to Singapore's climate ambition," MOF said.

The framework governs factors such as what the proceeds from the green bonds will be used for, what sort of projects will be funded, how the proceeds from the green bonds are tracked, and how the whole process is reported to investors.

The Singapore Government has planned to issue up to $35 billion in public sector green bonds by 2030 to support the growth of the sustainable finance market here.

These issuances will also help to attract green capital and investors, and anchor Singapore as a green finance hub in Asia, MOF said.

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THE STRAITS TIMES

Sunday, August 18, 2024

Yale's 2024 Environmental Performance Index

TOP 10

Country	Rank	Score
Singapore	**1**	**99.9**
Italy	2	98.2
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Norway	6	97.6
Montenegro	7	97.5
Sweden	8	97
United States	9	96.4
Finland	10	95.2

Source: 2024 ENVIRONMENTAL PERFORMANCE INDEX

SUNDAY TIMES GRAPHICS

Dialogue Session Information

In May 2024, the International Organization for Standardization (ISO), which is responsible worldwide for setting technical standards, published new international standards under the Technical Committee ISO/TC 323, aimed at ensuring transition to circular economy.

The three new ISO standards are Vocabulary, principles and guidance for implementation (ISO 59004), Guidance on the transition of business models and value networks (ISO 59010), and Measuring and assessing circularity performance (ISO 59020).

Under the Singapore Standardisation Programme, the Working Group (WG) on Circular economy would be adopting the three ISO standards as Singapore Standards. The draft standards would be available for public comments from 1 Nov 2024 to 2 Jan 2025. Click here to view.

This dialogue session aimed at gathering feedbacks from industry on the standards as well as clarity on its use.

Time	Topic
1.00pm – 1.30pm	**Registration**
1:30pm – 1:50pm	**Introduction to Technical Committee for Circularity of Materials and overview of ISO/TC 323** *Mr Dalson Chung* Chair, TC for Circularity of Materials Co-Convenor, WG on Circular Economy
1:50pm – 2.30pm	**Sharing of ISO 59004:2024 Circular economy – Vocabulary, principles and guidance for implementation** *Prof Adrian Kuah* Member, WG on Circular Economy
2:30pm – 3:00pm	**Sharing of ISO 59010:2024 Circular economy – Guidance on the transition of business models and value networks** *Ms Cui Mengmeng* Member, WG on Circular Economy
3:00pm – 3:20pm	**Sharing of ISO 59020:2024 Circular economy – Measuring and assessing circularity performance** *Prof Seeram Ramakrishna* Member, WG on Circular Economy
3:20pm – 4:00pm	**Feedback and queries on ISO 59004, ISO 59010 and ISO 59020** *Moderator: Mr Dalson Chung* Panelists: Prof Adrian Kuah, Ms Cui Mengmeng, Prof Seeram
4:00pm – 4:30pm	**Refreshments**

Singapore Standards Council

Dialogue session on ISO Circular Economy Standards

ISO 59004:2024 – Vocabulary, principles and guidance for implementation
ISO 59010:2024 – Guidance on the transition of business models and value networks
ISO 59020:2024 – Measuring and assessing circularity performance

Date : **4 Dec 202**
Time : **1.30pm –**
Venue : **Enterprise**
230 Victo
Singapore

Enquiries: Email to sdo@

Organised by:

SCIC SINGAPORE CHEMICAL INDUSTRY COUNCIL | Standard Developn Organisat

Enterprise Singapore | Singapore Standards Council

ISO Circular Economy Standards awareness session

(9 Oct 2024, 10 am – 11 am)

SCIC SINGAPORE CHEMICAL INDUSTRY COUNCIL | Standards Development Organisation

https://www.linkedin.com/posts/seeram-ramakrishna_iso-standards-circulareconomy-activity-7270017326467424256-2HMU?utm_source=share&utm_medium=member_desktop


ISO 59020:2024 – Circular Economy — Measuring and Assessing Circularity Performance
SCIC
Standards Development Organisation
International and National Standards
Enterprise Singapore
EXIT

National Mirror Committee (NMC) on ISO/TC 323 Circular Economy

The NMC was formed in 2020 to participate actively in ISO/TC 323 standards development (ISO 59004, ISO 59010 and ISO 59020)

NMC Task:

- Consulting national stakeholders (such as manufacturers, users, professionals and government officials) to formulate the national viewpoint and voting on draft international standards
- Adoption of International Standards into Singapore Standards
- Promoting the national implementation of International Standards

ISO 59000 family of standards

ISO 59004, *Circular economy — Vocabulary, principles and guidance for implementation*

ISO 59010
Circular economy — Guidance on the transition of business models and value networks

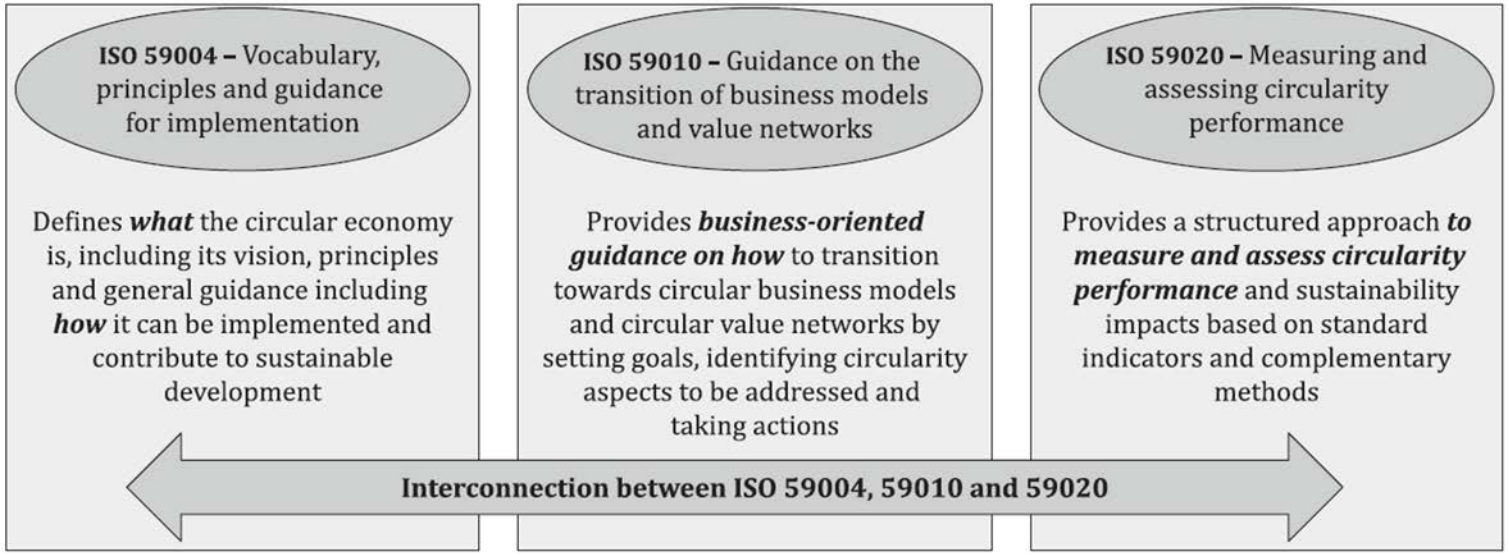
ISO 59020
Circular economy — Measuring and assessing circularity performance

ISO 59040
Circular economy — Product circularity data sheet

ISO 59014
Environmental management and circular economy — Sustainability and traceability of the recovery of secondary materials — Principles and requirements

ISO/TR 59031, *Circular economy — Performance-based approach — Analysis of case studies*
ISO/TR 59032, *Circular economy — Review of existing value networks*

Extracted from Figure 1 of ISO 59004:2024. Copyrighted by ISO.



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Terms related to resources

- **virgin resource:** natural resource or energy that is used as a resource for the first time as input in a process or for creating a solution

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- **recovered resource:** secondary resource that is obtained from one that has already been processed or used

Extracted from Clause 3.3.5 of ISO 59004:2024. Copyrighted by ISO.

- **non-recoverable resource:** resource that cannot be recovered and used again after it has been processed or used

Extracted from Clause 3.3.4 of ISO 59004:2024. Copyrighted by ISO.

- **cascading:** repeated use of a resource usually starting at a level of high value with decreasing quantity and quality at each subsequent stage or cycle, depending on the processes used

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- **closed loop system:** system by which products or resources are used and then recovered and turned into new products or recovered resources, without losing their inherent properties

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Terms related to processes

- **reuse:** use a product or its component parts after their initial use, for the same purpose for which they were originally designed

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- **refurbish:** recondition or restore an item, during its expected service life, to a useful condition for the same purpose with at least similar quality and performance characteristics

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- **remanufacture:** return an item to a like-new condition from both a quality and performance perspective using an industrial process

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- **repurpose:** adapt a product or its component parts for use in a different function than it was originally intended for, without making major modifications to its physical, chemical or mechanical structure

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- **circularity indicator:** metric used to measure one or more circularity aspects

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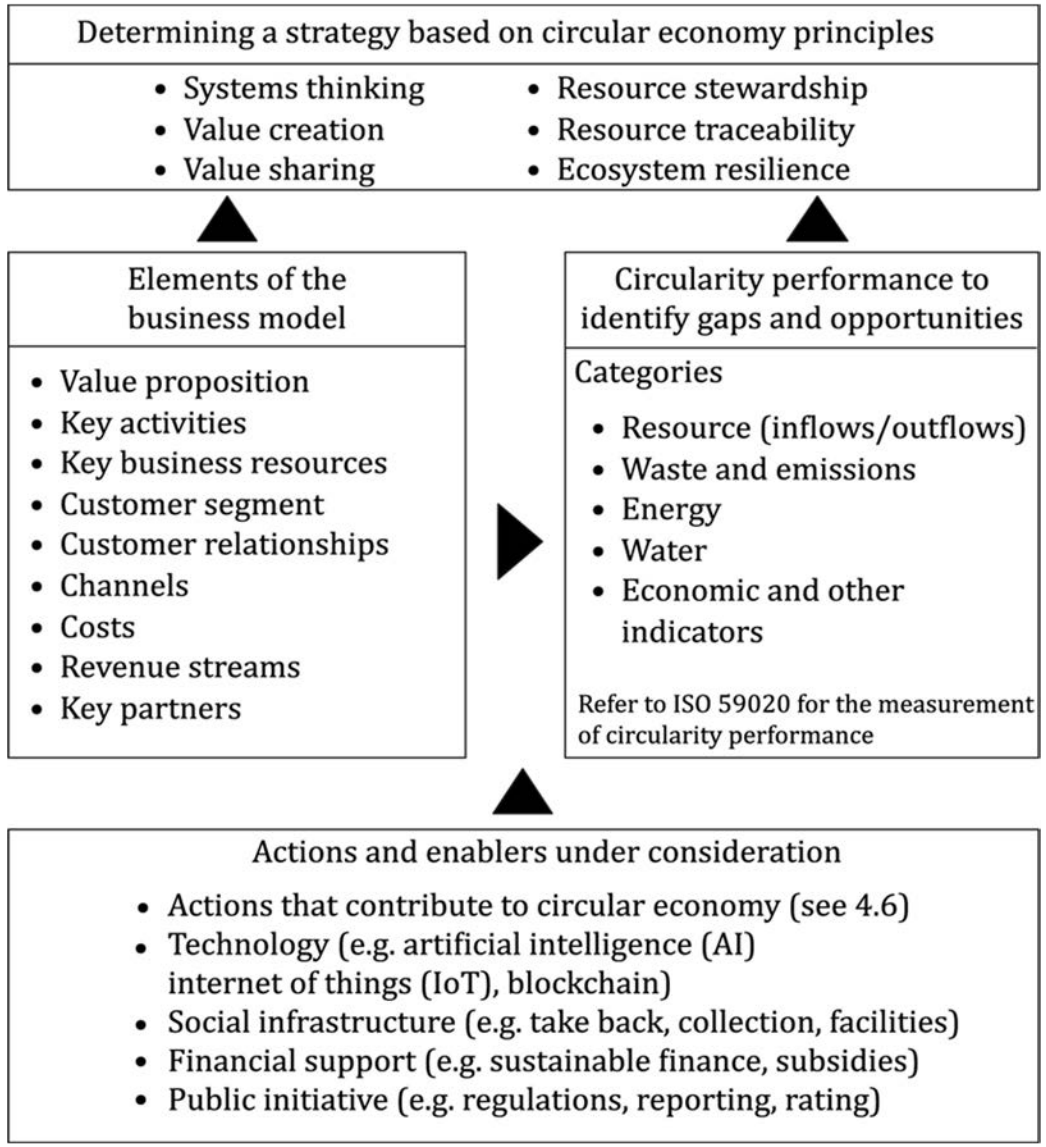
Enablers for Circular Economy Transition

7. Digitalization

- Organizations can use digital technology to share information along the value chain, enhance product design and processes, improve recycling methods, understand resource flows and develop circular value creation models



ISO 59000 family of standards

ISO 59004, *Circular economy — Vocabulary, principles and guidance for implementation*

ISO 59010
Circular economy — Guidance on the transition of business models and value networks

ISO 59020
Circular economy — Measuring and assessing circularity performance

ISO 59040
Circular economy — Product circularity data sheet

ISO 59014
Environmental management and circular economy — Sustainability and traceability of the recovery of secondary materials — Principles and requirements

ISO/TR 59031, *Circular economy — Performance-based approach — Analysis of case studies*
ISO/TR 59032, *Circular economy — Review of existing value networks*

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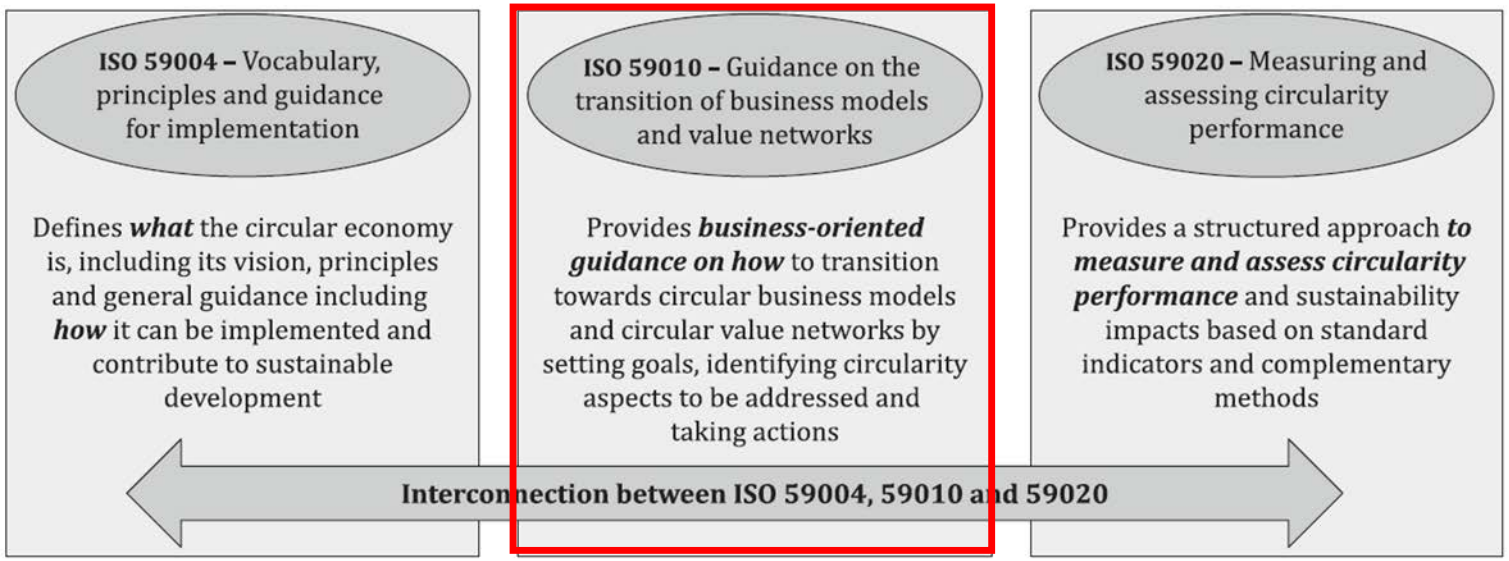

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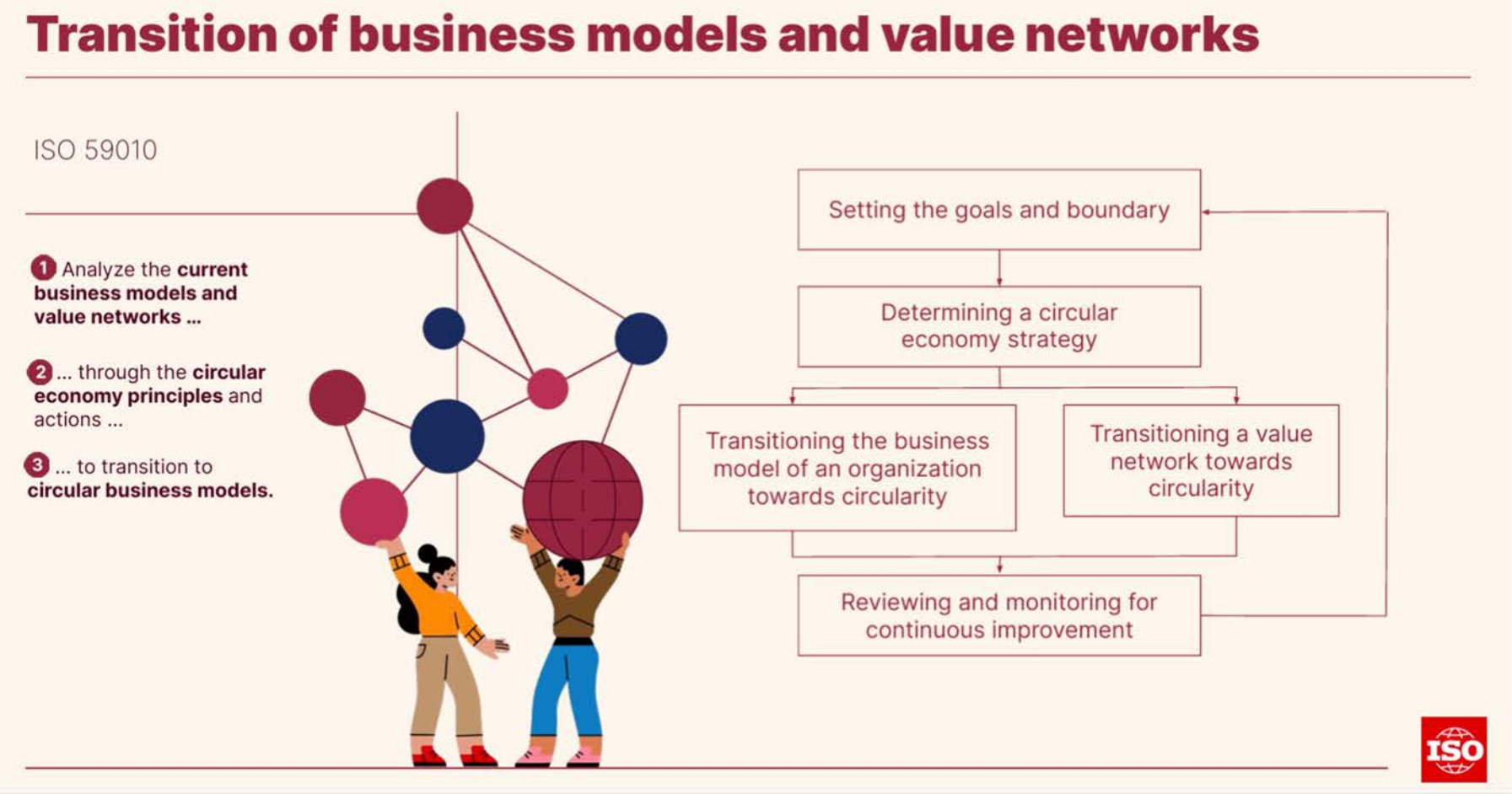
ISO 59010 overview



Key definitions

- **Value creation model (business model)**
  - Organization's chosen system of interconnected and interdependent decisions and activities that determines how it creates, delivers and captures value (3.16)
- **Extended producer responsibility (EPR)**
  - Environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle (ISO 24161)
- **Life cycle perspective (life cycle thinking)**
  - Consideration of the circularity aspects relevant to a solution during its life cycle which includes consideration of the relevant environmental, social and economic impacts (3.2.5)
- **Materiality**
  - Information related to circular economy that is essential for decision-making and can be applied to identify issues that reflect an organization's environmental and social impacts, as well as information that supports interested party and strategic decision-making (ISO 14100)
- **Materiality assessment**
  - Method to identify and prioritize the issues most important to an organization and its interested parties, and relevant to its circular economy strategy

ISO 59020:2024 – Circular Economy — Measuring and Assessing Circularity Performance

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ISO 59000 family of standards

ISO 59004, *Circular economy — Vocabulary, principles and guidance for implementation*

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ISO 59020
Circular economy — Measuring and assessing circularity performance

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Circular economy — Product circularity data sheet

ISO 59014
Environmental management and circular economy — Sustainability and traceability of the recovery of secondary materials — Principles and requirements

ISO/TR 59031, *Circular economy — Performance-based approach — Analysis of case studies*
ISO/TR 59032, *Circular economy — Review of existing value networks*

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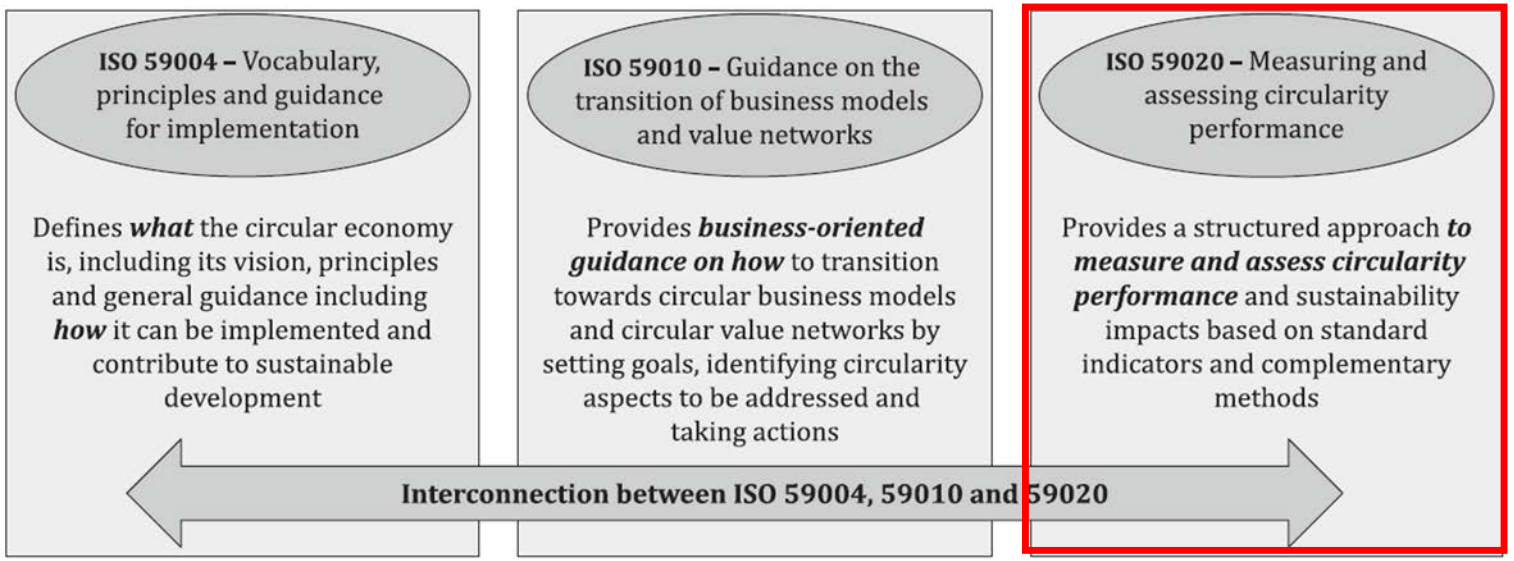

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Definitions

- **circular economy:** economic system that uses a systemic approach to maintain a circular flow of resources, by recovering, retaining or adding to their value, while contributing to sustainable development

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- **circularity:** degree of alignment with the principles for a circular economy

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- **circularity aspect:** element of an organization's activities or solutions that interacts with the circular economy

Extracted from Clause 3.1.4 of ISO 59020:2024. Copyrighted by ISO.

- **system boundary:** boundary representing physical, process, temporal and geographical limits of what is included and what is not included in an assessment

Extracted from Clause 3.2.1 of ISO 59020:2024. Copyrighted by ISO.

- **system in focus:** system that is defined by selected system boundaries and is the subject of a circularity measurement and circularity assessment

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Definitions

- **circularity performance:** degree to which a set of circularity aspects align with the objectives and principles for a circular economy

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- **circularity measurement:** process to help determine the circularity performance through collection, calculation or compilation of data or information

Extracted from Clause 3.3.2 of ISO 59020:2024. Copyrighted by ISO.

- **circularity assessment:** evaluation and interpretation of results and impacts from a circularity measurement

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- **circularity indicator:** metric used to measure one or more circularity aspects

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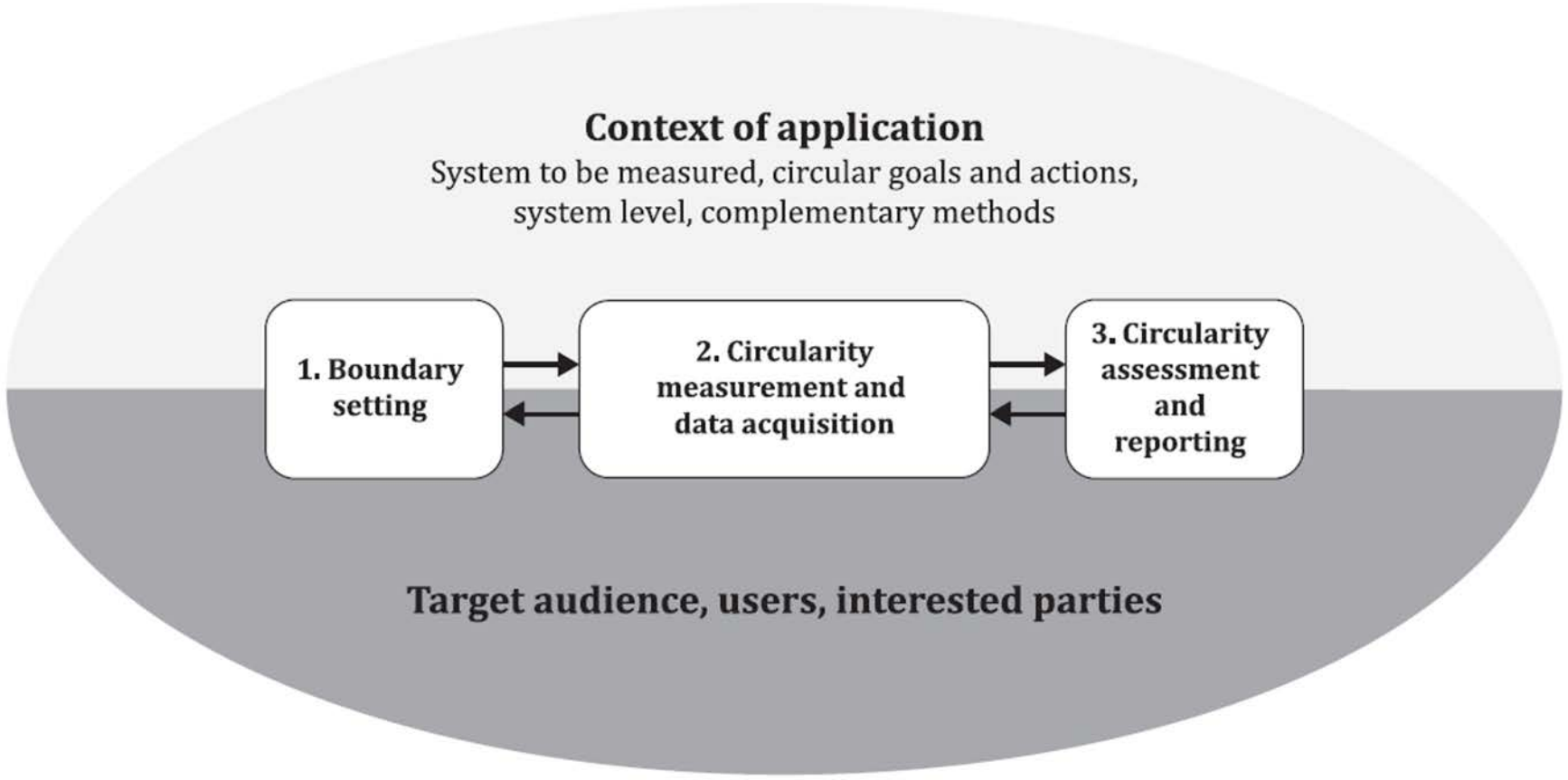
Framework for measuring and assessing circularity



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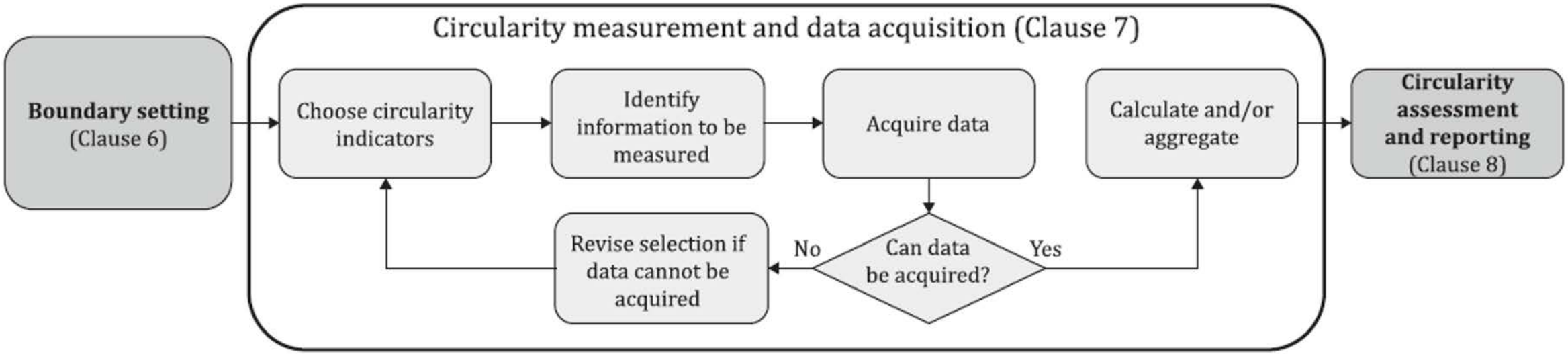
Circularity measurement and data acquisition process steps



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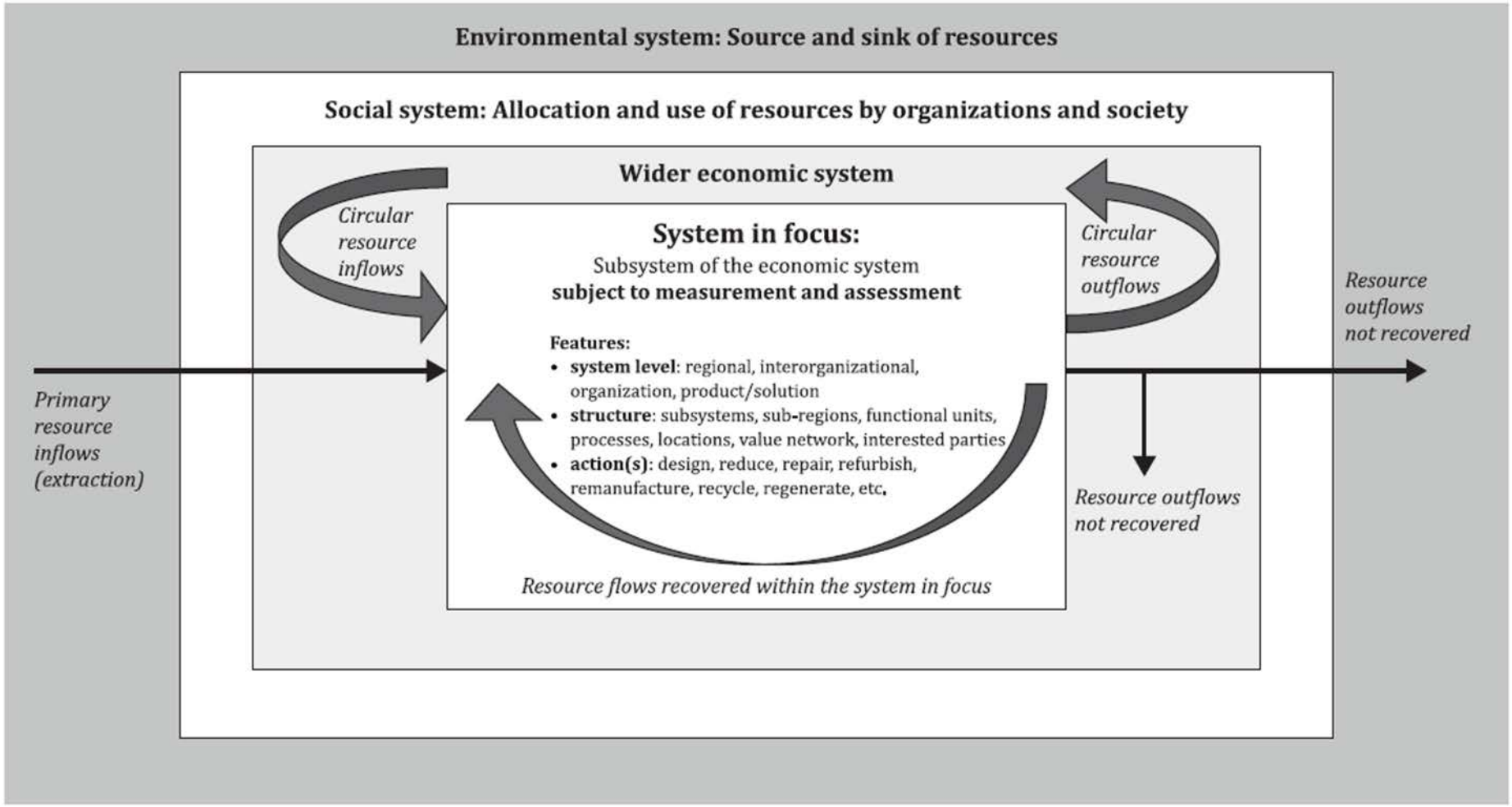
System in focus and its boundaries



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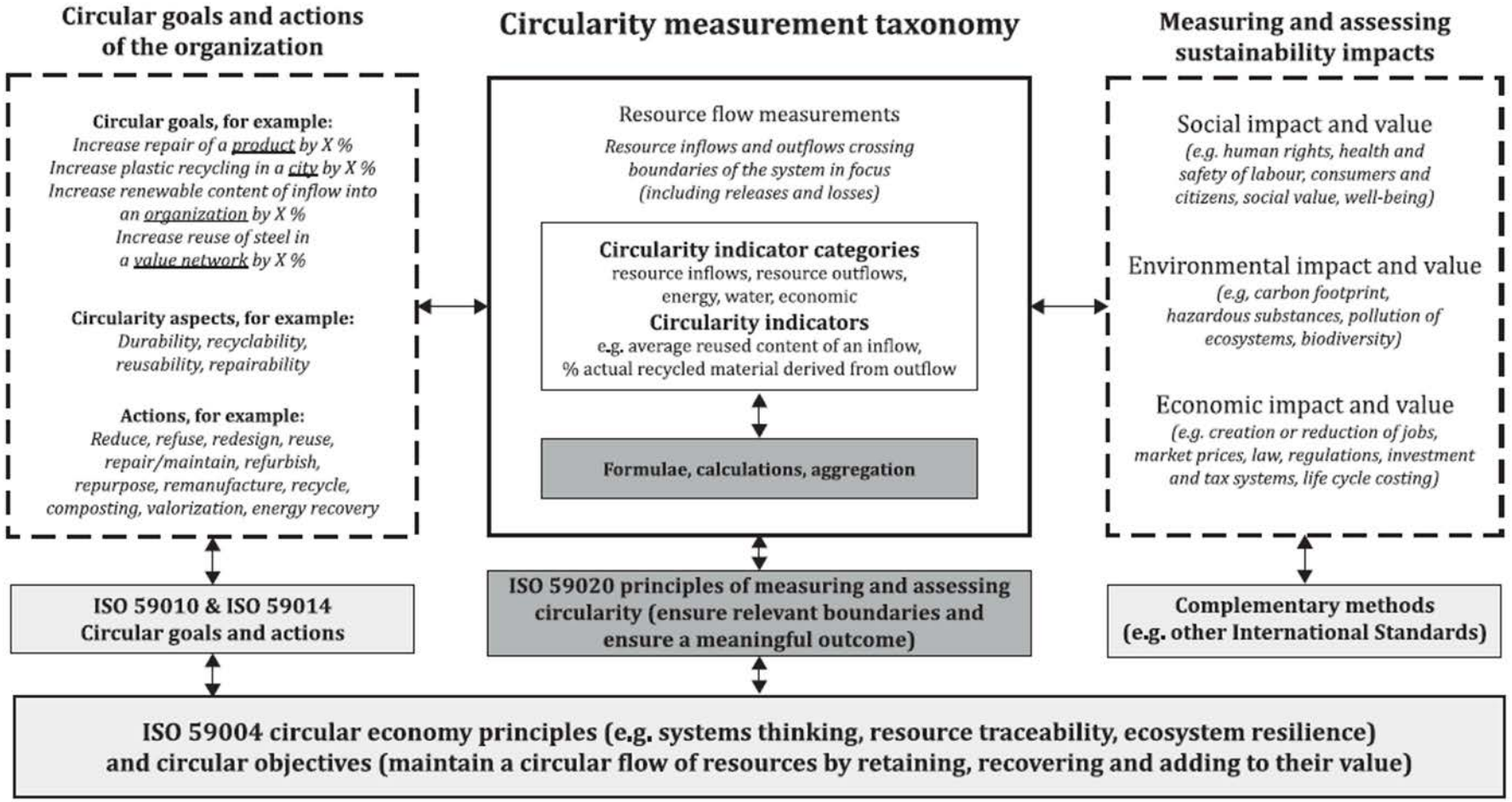
Circularity measurement taxonomy and interactions



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Examples of circularity measurement at an organizational level

Example 1:

Circular economy measurement	Indicator category		
	Resource inflow	Energy	Water
Objective: Value recovery	Average recycled content of an inflow (X) (see A.2.3)	Average per cent of energy consumed that is renewable energy (see A.4.2)	Ratio (on-site or internal) water reuse or recirculation (see A.5.4)
Actions	Circular procurement	Use of renewable energy	Reuse

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Example 2:

Circular economy measurement	Indicator category		
	Resource inflow	Economic	Resource outflow
Objective: Retaining resource value	Average reused content of an inflow (X) (see A.2.2)	Resource intensity index (see A.6.3)	Per cent actual reused products and components derived from outflow (X) (see A.3.3)
Actions	Reuse	Reduce	Design for circularity

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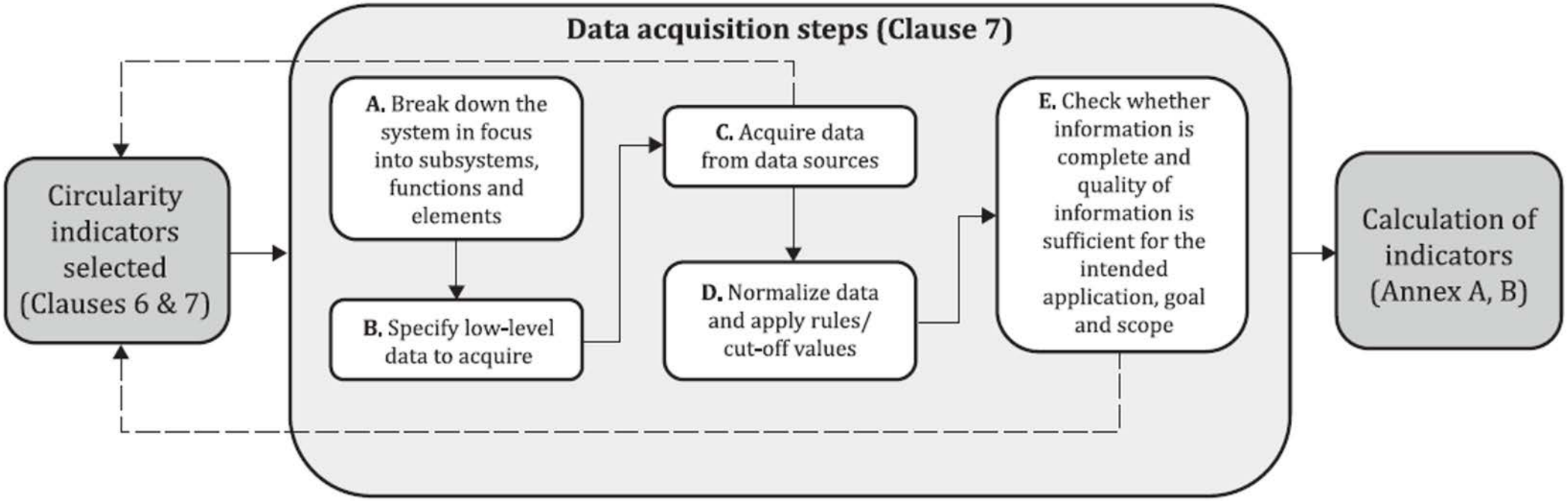
Core circularity indicators

Indicator category	Mandatory/ optional	Circularity indicator	Summary description (see Annex A for technical specifications)	Additional information
Resource Inflows	Mandatory	A.2.2 Average reused content of an inflow (X)	Fraction of input material resources that are reused components and products	Retaining resource value
	Mandatory	A.2.3 Average recycled content of an inflow (X)	Fraction of input material resources that is recycled material	Add resource value
	Mandatory	A.2.4 Average renewable content of an inflow (X)	Fraction of material resources inflow (X) that is sustainably produced renewable material	Add resource value
Resource outflows	Optional	A.3.2 Average lifetime of product or material relative to industry average	Indicator of time that an output resource (e.g. product) will remain in use compared to an industry average for the resource	Retaining resource value
	Mandatory	A.3.3 Per cent actual reused products and components derived from outflow (X)	Fraction of outflow that is reused	Retaining resource value
	Mandatory	A.3.4 Per cent actual recycled material derived from outflow (X)	Fraction of outflow that becomes recycled material	Recovering resource value
	Mandatory	A.3.5 Per cent actual recirculation of outflow in the biological cycle	Fraction of outflow content that is recirculated at end of life for safe return to the biosphere and meets the qualifying conditions for recirculation	Recovers resource value
Energy	Optional	A.4.2 Average per cent of energy consumed that is renewable energy	Fraction of net consumed energy that qualifies as renewable energy, taking into account both energy inflows and energy outflows	Recovering resource value

Core circularity indicators

Indicator category	Mandatory/ optional	Circularity indicator	Summary description (see Annex A for technical specifications)	Additional information
Water	Optional	A.5.2 Per cent water withdrawal from inflow circular sources	Per cent of annual water demand that is derived from circular sources	Maintains a circular flow of resources
	Optional	A.5.3 Per cent water discharged in accordance with quality requirements	Per cent (by volume) of total water withdrawn that is discharged in accordance with circularity principles	Maintains a circular flow of resources
	Optional	A.5.4 Ratio (on-site or internal) water reuse or recirculation	Reuse cycles of on-site water	Maintains a circular flow of resources
Economic	Optional	A.6.2 Material productivity	Ratio of revenue generated by total mass of all linear resource inflows	Indicates resource reduction
	Optional	A.6.3 Resource intensity index	Quantitative measure of economic growth versus total resource use	Indicates resource reduction

Data acquisition process



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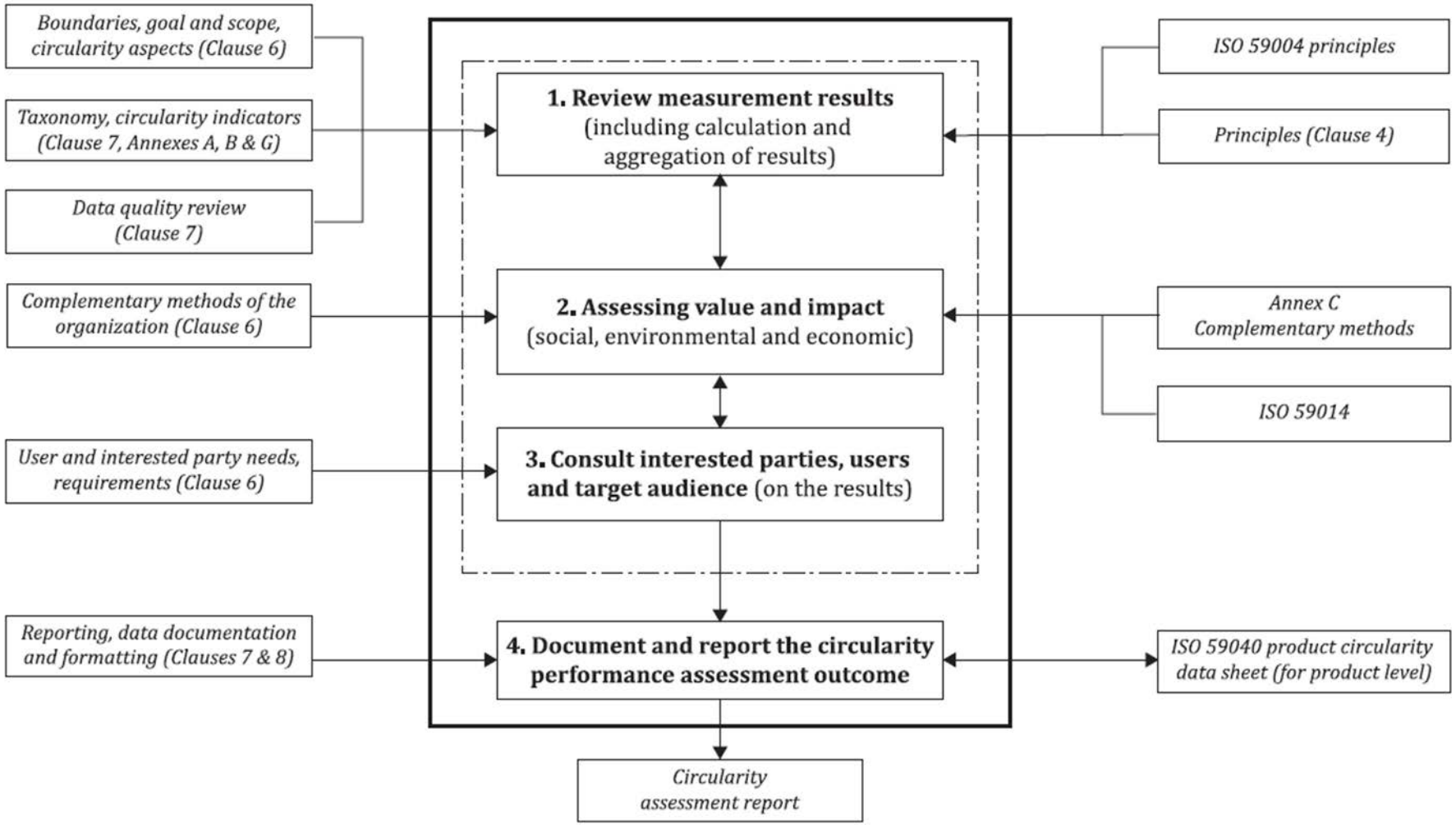
Steps for assessing circularity performance



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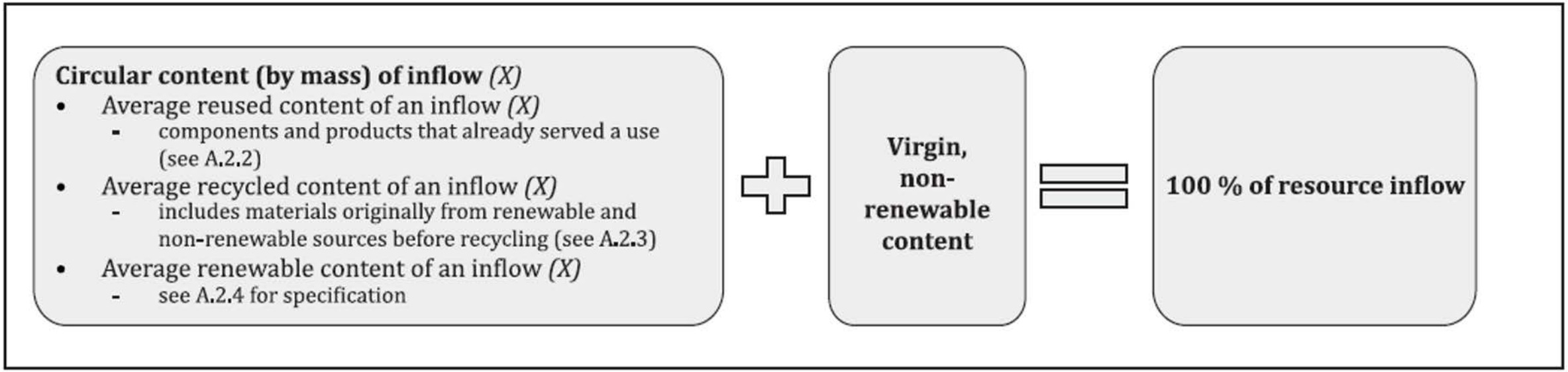
100% resource inflow formula



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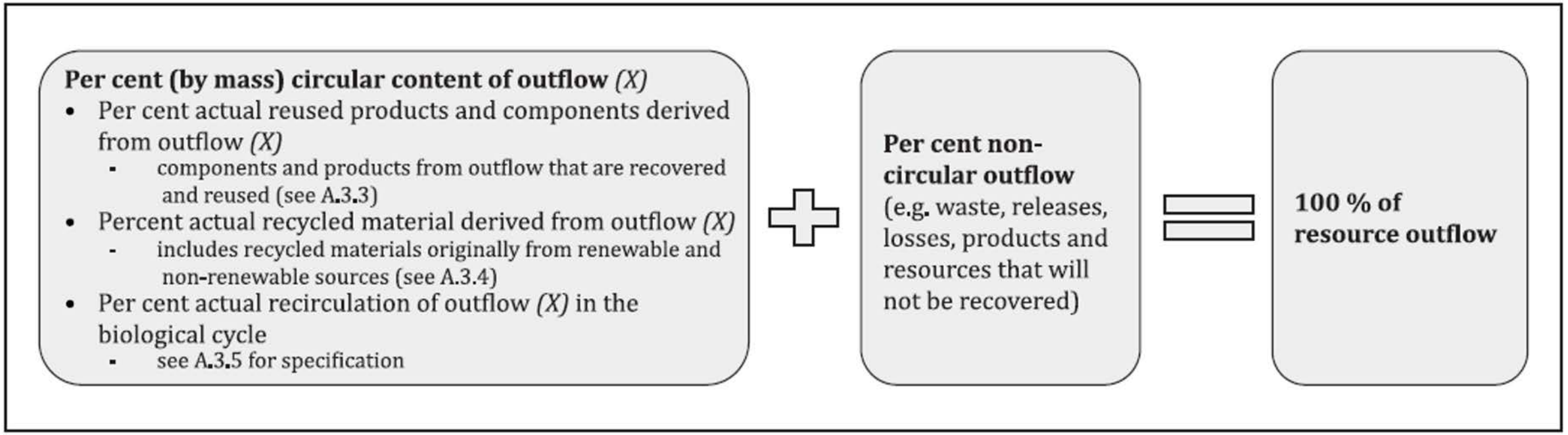
100% resource outflow formula



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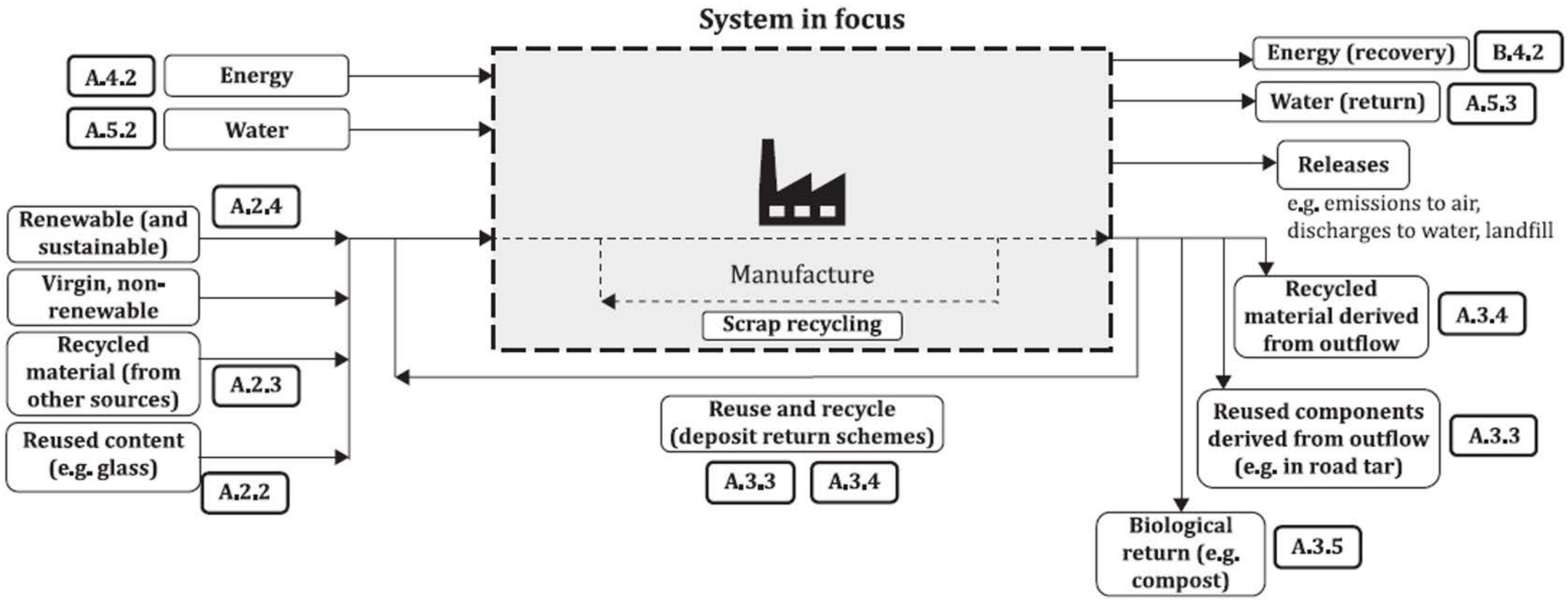
Beverage container manufacture system and boundaries



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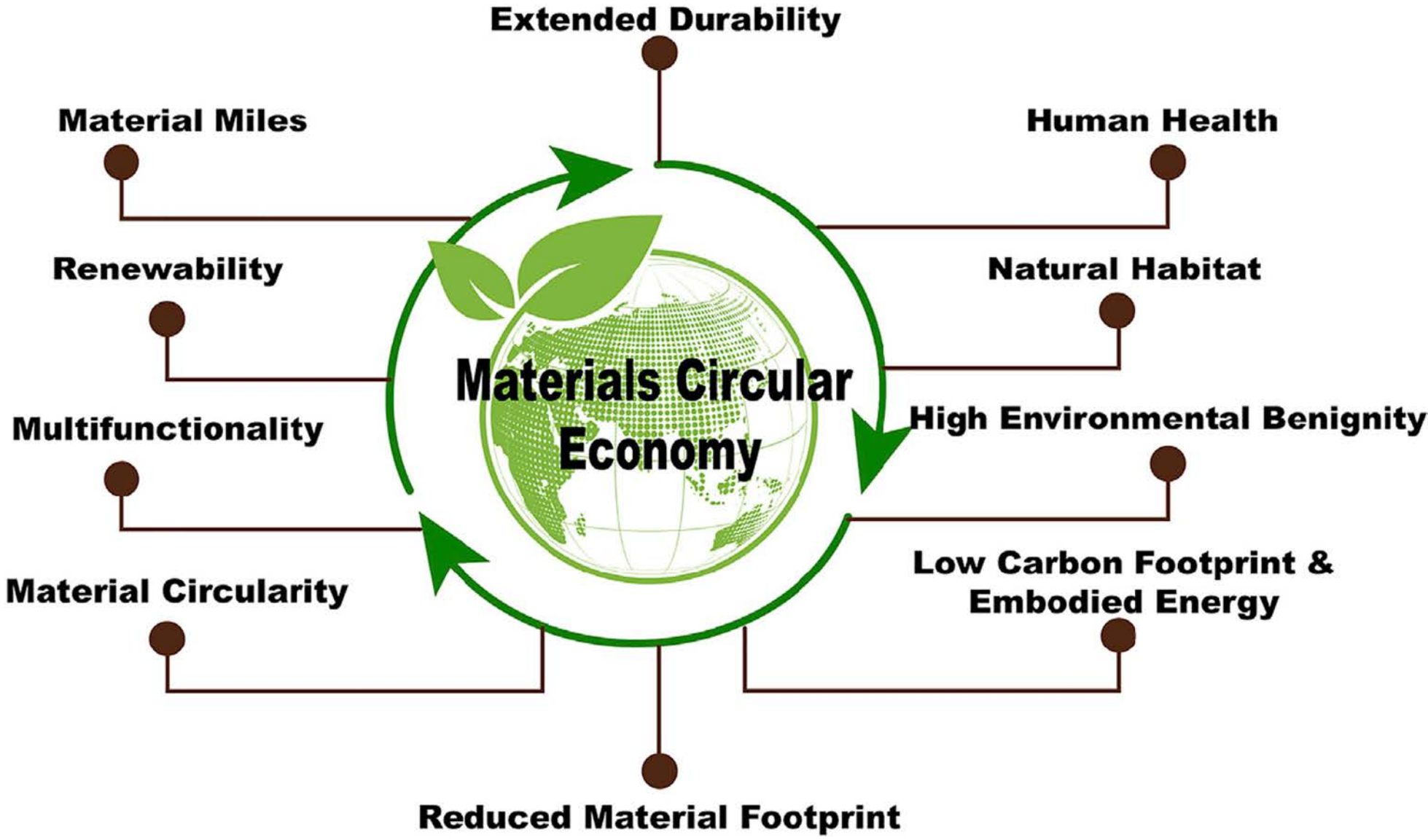
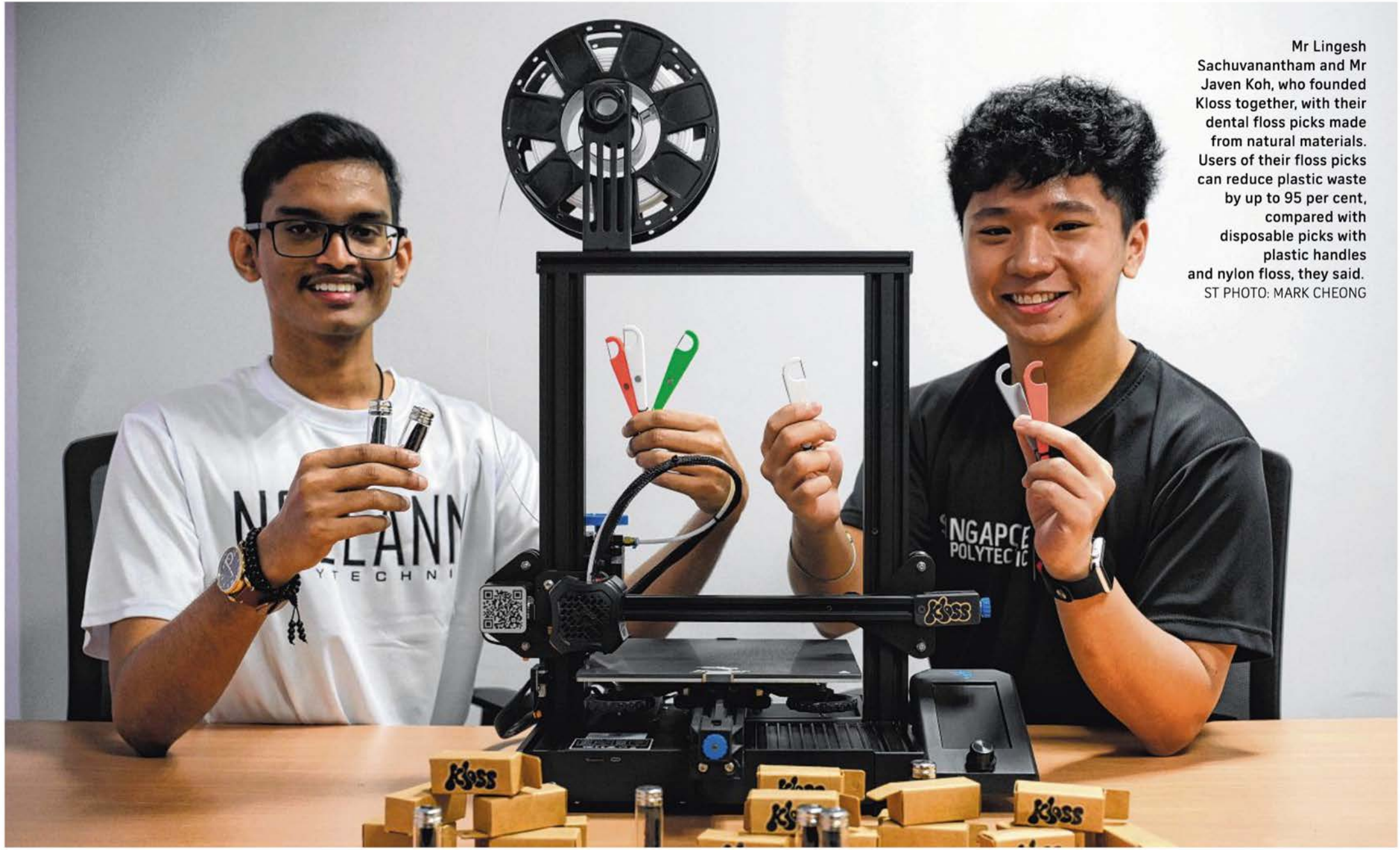
Ten principles of material circular economy



Seeram Ramakrishna and Rajan Jose, Principles of Materials Circular Economy, Matter 5, 4097–4099, December 7, 2022, https://doi.org/10.1016/j.matt.2022.11.009

THE STRAITS TIMES



Mr Lingesh Sachuvanantham and Mr Javen Koh, who founded Kloss together, with their dental floss picks made from natural materials. Users of their floss picks can reduce plastic waste by up to 95 per cent, compared with disposable picks with plastic handles and nylon floss, they said.
ST PHOTO: MARK CHEONG

THE STRAITS TIMES

Saturday, February 01, 2025

A worker handling photovoltaic modules for solar panels at a factory in China's Jiangsu province. The *neijuan* phenomenon is particularly pronounced in sectors such as solar panels and cars, where many firms touting similar products are fighting for limited consumer dollars. This has led them to slash prices in a downward spiral in an attempt to secure a share of the market.
PHOTO: AFP

An excavator loading copper ore onto a truck at a mine near Karaganda, central Kazakhstan, in March. The world's transition to renewable energy, including electric cars, requires huge amounts of copper in addition to nickel, lithium and other so-called critical minerals, and Kazakhstan has many of them.

The Reminiscence Ring features 35.9 carats of lab-grown diamonds set in recycled gold. PHOTO: UNSAID

The Reminiscence Ring features 35.9 carats of lab-grown diamonds set in recycled gold. With 14 diamonds intricately connected to form a delicate cluster of spherical shapes, each stone possesses its own unique angle and size. At the heart of this extraordinary piece lies the largest stone that is about 10 carats.

This piece is priced between $25,000 and $1 million, depending on the size of the diamonds.

https://www.greenworlddiamonds.ch/lab-diamonds/advantages-lab-diamonds/?lang=en

https://www.straitstimes.com/life/style/diamond-disrupters-more-taking-a-shine-to-lab-grown-options-and-coloured-stones?_gl=1*59ygad*_gcl_au*MTU0OTkzNjM1NS4xNzI0MjQ0OTU2

Circular Economy Business Models are the Way Forward (*UNEP Report 2024*)

Economic Growth

Resources Resiliency

Co-opting Hearts | Minds

Human Health

Planet Health

Sustaining Life on Earth!

Circular

https://www.istockphoto.com/photos/tree-two-branches

Facilitating circular economy | sustainability

Ramasubramanian et al., Ten major challenges for sustainable lithium-ion batteries, Cell Reports Physical Science (2024),

Symbiosis Of Climate Finance And Technological Innovations To Foster The Energy Transition

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Abstract

As climate change intensifies, it becomes increasingly critical to address its impacts through climate finance and technological innovation. This article delves into the symbiotic relationship between climate finance and digital technologies, focusing on their role in the decarbonization of the energy sector. By examining the case of Singapore, a nation facing unique constraints, we elucidate the significance of innovations in climate finance and digital technologies in increasing cleaner energy generation, greener technologies, and interconnection infrastructure. We further elaborate the discussion to other countries. Despite a promising future, integrating climate finance with technology mechanisms encounters formidable challenges, including the need for clearer incentives, inadequate pace and scale of investments, shortage of quality skilled human capital, considerations of ecological impacts, and alignment with short-term investor perspectives. To surmount these hurdles, concerted efforts from both public and private sectors are crucial to facilitate climate finance in steering the transition towards a sustainable and decarbonized energy future.

Introduction

In recent decades, climate change has become a pressing global concern, driven by natural processes and human activities. This has led to unprecedented ecological shifts, including but not limited to extreme weather events, wildfires, biodiversity loss, disruptions to the Earth's life support systems, and rising sea levels (Pörtner et al., 2022; Clarke, Otto, Stuart-Smith, & Harrington, 2022). To date, the Paris Agreement has been ratified by 193 nations, and 194 Parties have submitted their Nationally Determined Contributions (NDCs). With the inclusion of these newly revised NDCs, the combined effect of current and announced net zero commitments is anticipated to lead to a further reduction in emissions by 2030. This has the potential to cap global warming at 2.1°C, preventing a more severe increase beyond 2.8°C, as outlined in the initial NDCs (IRENA, 2022). In the ASEAN region, although the member states have established their NDCs for Greenhouse Gas (GHG) emission reduction (Figure 1), there is a substantial gap in achieving net zero emissions for the power sector as the share of low-carbon technologies is less than 25% (Handayani et al., 2022). Several ASEAN member countries have set renewable energy targets and are taking steps to increase the share of renewable energy in their respective energy mixes. This includes investments in solar, wind, and hydroelectric projects. However, the pace and extent of this transition can vary from country to country due to factors like policy frameworks, available resources, and infrastructure.

While there is a pressing necessity to address climate issues, many decisions around climate actions are still driven by financial considerations (Giglio, Kelly, & Stroebel, 2021). For instance, the pricing of risk mitigation measures, the attitudes of investors towards transitions, and government decisions for taxation plans. Climate actions need to be supported by funding mechanisms such as investments, subsidies, and loans, collectively known as climate finance. The Global Commission on Adaptation has presented that an investment amount of $1.8 trillion would provide $7.1 trillion in benefits, in return (Global Commission on Adaptation, 2019). Nonetheless, existing studies have presented that there is a significant financial shortfall to execute the transition plans and develop green technologies (Bhandary, Gallagher, & Zhang, 2021). Indonesia's struggle to secure funding for coal retirement (Sudarshan Varadhan, 2023) is one of the many examples that mirrors the broader challenge of financing sustainable transitions. With Western nations bogged down with their own economic issues, thus showing reluctance, concerted efforts are required to garner support for this crucial shift. Bridging this gap necessitates concerted efforts from governments and public endorsement. A recent study by the National Bureau of Economic Research has shown that providing the public with information regarding the mechanics of climate policies and the allocation of climate finance results in increased public support, particularly for measures with initially low levels of support, such as carbon taxes. Therefore, it is important to understand how climate finance can be applied to facilitate technological innovation and