



## Chapter 1

Towards a  
Zero Waste Nation

## The case for “Zero Waste”

Throughout Singapore's development over the years, sustainability has been a key consideration. However, as we are faced with the new challenges of climate change, growing resource constraints and rising consumption, we will need to do more. At the same time, more attention is being placed on sustainability, both internationally and locally. New business models from this shift will also present good economic opportunities for Singapore's companies and workers.

To prepare Singapore for the future, we must build three “Resiliences”:

**Climate Resilience**

Address existential threats of climate change especially rising sea levels

**Resource Resilience**

Ensure safe and secure supply of critical resources like food and water

**Economic Resilience**

Ensure the future Singapore economy remains competitive by overcoming carbon and resource constraints

## Singapore's solutions

Singapore has overcome similar environmental challenges in our past. Faced with a growing waste problem, we introduced several measures, which have formed the efficient waste collection and disposal system that we know today.

**District-based solid refuse collection system:**

Daily waste collection, with the use of waste collection vehicles.

**Waste-to-energy (WTE) incineration plants:**

In 1979, Singapore's first WTE incineration plant was completed at a cost of \$130 million. Incineration reduced waste to 10% of its volume while generating electricity. Since then, four other WTE plants have been commissioned to convert waste to resource.



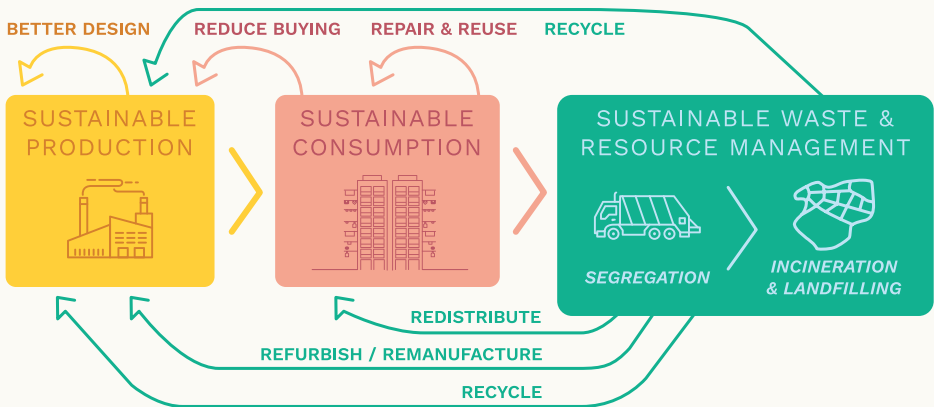
Aerial view of Semakau Landfill

**Semakau Landfill:** Space was running out at Singapore's last inland dumping ground at Lorong Halus in the 1990s. Hence, the sea space between Pulau Sakeng and Pulau Semakau was used to create Semakau Landfill. Today, it is the destination of all of Singapore's incineration ash and non-incinerable waste. However, it is projected to run out of space by 2035.

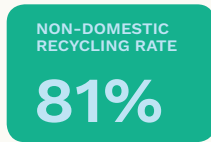
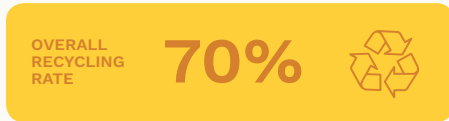
## Chapter 2

# Keeping our resources within a closed loop

Waste is no longer just something useless to be buried or burnt, but a valuable material that can be reintroduced into the production cycle. This is done through adopting the circular economy approach, where resource loops are closed and waste designed out of the system through the recovery of resources throughout the value chain.



Through all the efforts outlined in the Zero Waste Masterplan, we aim to reduce the amount of waste sent to Semakau Landfill each day by 30%, or from 0.36 kg/capita in 2018 to 0.25 kg/capita by 2030.



This is in addition to our existing 2030 targets under the Sustainable Singapore Blueprint, which aims to achieve a 70% overall recycling rate, 81% non-domestic recycling rate and 30% domestic recycling rate.

To do so, we will adopt sustainability in each of the three stages of the value chain: production, consumption and waste & resource management.

## Sustainable production

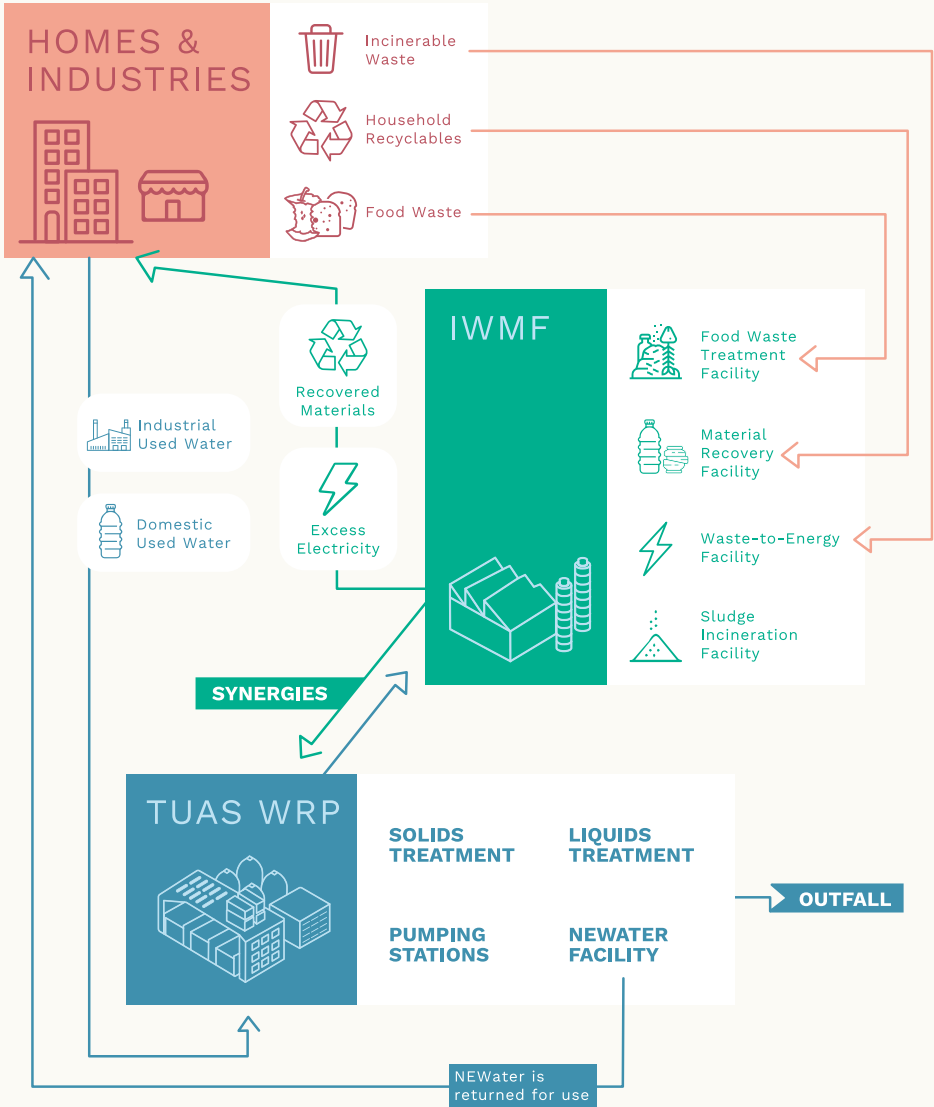
First, we need to shift our focus upstream and examine how companies can better manage their resources and reduce waste at the production stage.

**Sustainable design:** Design of products to be more durable and repairable, or easily recyclable, and with minimal packaging.

**Resource efficiency:** Companies can perform material and waste audits, enabling them to identify opportunities to reduce the use of materials and improve material efficiency.

**Industrial symbiosis:** One company's waste could be another's raw material. Such mutually beneficial collaborations, or industrial symbiosis, is illustrated through the design of the Tuas Nexus, where the National Environment Agency's (NEA) Integrated Waste Management Facility will be integrated with PUB's Tuas Water Reclamation Plant. Output from one facility will be used as feedstock for another, while keeping land use and environmental impact to a minimum.

# TUAS NEXUS



Synergies at Tuas Nexus

## Sustainable consumption

Our consumption habits are far from ideal. We often over-order during meals, buy items that are hardly used or change our smartphones frequently. We can all play our part to consume sustainably.

**Reduce:** In 2019, the NEA launched two campaigns to encourage consumers to “reduce”.

- Food waste reduction campaign to encourage consumers to buy, order or cook just enough.
- Say YES to Waste Less campaign to encourage consumers to choose reusables instead of disposables to reduce our impact on the environment.



Outreach to consumers to encourage them to “buy, order, or cook just enough”



The Say YES to Waste Less campaign was launched by Senior Minister of State for the Environment and Water Resources, Dr Amy Khor

**Reuse:** Faulty items could be saved through repair, a trade that the NEA is promoting by allocating space in some new and existing hawker centres to promote a repair culture. Ground-up initiatives like Repair Kopitiam also promote repair workshops and courses in the community.

**Donate:** Items that are still in good condition but are no longer needed can be donated instead of thrown away.

**Promote green-labelled products:** Choose environmentally-friendly products when shopping. Companies can also design their products with environmental considerations, import more green-labelled products or adopt a green procurement policy.

# Sustainable waste & resource management

When reducing our consumption and reusing our items are not feasible, recycling comes in, helping us to turn waste into resources.

We have been successful in closing the waste loop for some waste streams, with a 99%

recycling rate for construction debris, ferrous metals and non-ferrous metals. However, more needs to be done to improve our domestic recycling rate and tackle the high contamination rate of our recycling bins.

## WASTE STATISTICS 2018

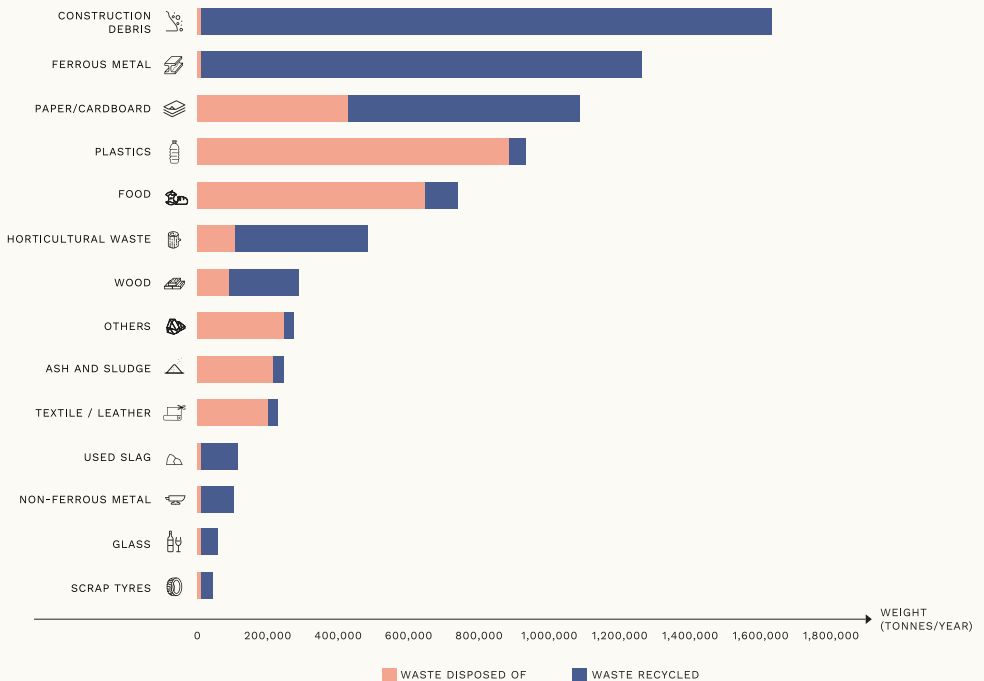


Photo: REMEX

### Closing the metal resource loop:

A metal recovery facility operated by REMEX Minerals Singapore Pte Ltd at Tuas Marine Transfer Station recovers ferrous and non-ferrous metals from incineration bottom ash (IBA) using special magnets, micro-grain eddy current separators and multi-stage sieving techniques.



# RCA PROCESS



1

CONSTRUCTION AND DEMOLITION (C&D) WASTE



2

PRELIMINARY CRUSHING AND REMOVAL OF FERROUS METALS



3

REMOVAL OF FOREIGN MATERIALS SUCH AS BRICKS, PLASTICS AND ASPHALT



4

FURTHER CRUSHING AND SCREENING OF RCA INTO VARIOUS SIZES



5

STOCKPILE OF RCA FOR USAGE



6

**VARIOUS APPLICATIONS OF RCA**  
The Eco-Green Building was constructed using concrete with up to 100% recycled construction aggregates.

Photo: Samwoh Corporation Pte Ltd

**Building with waste:** Under the Demolition Protocol, reusable and non-reusable parts of a building have to be identified, then separately dismantled and removed to facilitate recycling into new materials such as recycled concrete aggregate (RCA).

**Recycle Right:** To tackle the high contamination rate of our blue recycling bins, the NEA has re-designed the labels on them so that consumers are clearer on what can and cannot be deposited into the bins.



The recycling bin label was re-designed to help the public #RecycleRight



Chapter 3

# A circular economy approach to closing three resource loops

We are adopting a circular economy approach to close three resource loops: electrical and electronic equipment (EEE), food and packaging, including plastics.

These waste streams are generated in large amounts but have a low recycling rate. E-waste also contains toxic substances and needs to be properly managed.



## Electrical and electronic equipment

To improve e-waste management, we will implement the Extended Producer Responsibility (EPR) framework, which extends producers' responsibilities to the proper end-of-life management of their products.

This has been used effectively to promote the recycling of e-waste and recovery of valuable materials in other countries, including South Korea and Sweden.

### WHAT DOES EPR ENTAIL?

Under the **Resource Sustainability Act**, in 2021, producers of certain categories of EEE – including manufacturers and importers – will be physically and/or financially responsible for the end-of-life treatment of their products. They will need to collect and ensure that the products are recycled by licensed companies. Producers of covered consumer EEE will have to join a

Producer Responsibility Scheme (PRS), which takes on producers' responsibilities for collecting and recycling consumer EEE.

Retailers will have to provide free one-for-one take-back services upon delivery of new products. Large EEE retailers with a floor area above 300m<sup>2</sup> will have to provide in-store e-waste collection points.

**COVERED EEE AND PRS COLLECTION TARGETS**

PRODUCT CATEGORY	PRODUCT TYPE	COLLECTION TARGET
ICT EQUIPMENT	Printers / Personal computers / Laptops / Mobile phones / Tablets / Routers / Modems / Set-top boxes / Servers	<b>20%</b> of put-to-market (PTM) by weight
LARGE APPLIANCES	Refrigerators / Air-conditioners / Washing machines / Dryers / Televisions / Electric mobility devices, including personal mobility devices, power assisted bicycles and electric mobility scooters	<b>60%</b> of PTM by weight
BATTERIES	Portable batteries	<b>20%</b> of PTM by weight
	Industrial batteries Hybrid / electric vehicle batteries	NA NA
LAMPS	Bulbs and tubes	<b>20%</b> of PTM by weight
SOLAR PV PANELS	All types	NA



**SAVING FOOD FROM THE BIN**

The NEA developed resources to encourage sustainable consumption of food, including a food waste reduction guide for consumers, and food waste minimisation guidebooks for establishments and supermarkets.

Find the food waste reduction guides here:



Food waste minimisation guidebooks developed by the NEA to reduce food waste across the supply chain

## FOOD WASTE? DON'T WASTE!

### On-site food waste treatment systems:

Implemented at several hawker centres, such systems convert food waste into non-potable water, liquid nutrient or compost. A food waste segregation and recycling pilot was also conducted to gather insights on household routines that encourage such practices.

**Off-site waste treatment:** Co-digesting food waste and used water sludge can triple biogas yield as compared to digesting used water sludge alone, enhancing energy generation. This system will be implemented at the upcoming Tuas Nexus.

### Mandatory food waste segregation and treatment:

Under the new **Resource Sustainability Act**,

- **2021:** Developers of new commercial and industrial premises, where large amounts of food waste are expected to be generated, must set aside space for on-site food waste treatment systems in their design plans.
- **2024:** Large commercial and industrial food waste generators must segregate food waste for treatment. Developments that have set aside space in 2021 must implement on-site treatment.

A resident disposes of food waste into a food waste recycling bin under the "Food Waste? Don't Waste!" household food waste segregation and recycling pilot





## Packaging, including plastics

Packaging is any material that is used to contain, protect, handle, deliver or present goods.

### ENCOURAGING SUSTAINABLE CONSUMPTION OF PACKAGING



**Singapore Packaging Agreement:** Joint initiative between Government, industry and non-governmental organisations (NGOs) to reduce packaging waste. It has helped reduce 54,000 tonnes of packaging waste and save \$130 million in packaging material costs since its inception in 2007.



**Zero Waste SG's Bring Your Own (BYO) campaign:** Supported by the NEA's Call for Ideas Fund, the BYO campaign encourages consumers to use reusable bags and containers when they buy takeaway food, beverages and groceries. With more than 850 outlets joining the campaign since 2017, more than two million pieces of plastic disposables have been saved.

### ENCOURAGING SUSTAINABLE PRODUCTION OF PACKAGING

In 2020, producers of packaged products and supermarkets with an annual turnover of more than \$10 million will have to report packaging data and submit 3R (reduce, reuse and recycle) plans for packaging. This will be legislated under the **Resource Sustainability Act**. It will lay the foundation for an EPR framework for managing packaging waste, including plastics, which we aim to have in place no later than 2025.

Chapter 4

## Optimising infrastructure for maximum resource recovery

Even as new policies are implemented and infrastructure developed, we will need to continually improve existing waste management technologies to enhance our treatment and recovery of waste.

### Pilot Mechanical Biological Treatment (MBT) facility

It will have a mechanical process to recover recyclables like plastics, ferrous and non-ferrous metals, and an aerobic biological treatment process to convert the waste into Solid Recovered Fuel. Only a small amount of residue will be left for disposal.

### Harvesting IBA for construction

With about 500,000 tonnes of IBA and 200,000 tonnes of non-incinerable waste being disposed of at Semakau Landfill each year, it is projected to be full by 2035. To extend Semakau Landfill's lifespan, we are developing ways to use IBA in non-structural applications as "NEWSand". The NEA is developing environmental standards to regulate the use of NEWSand, and will conduct field trials to ensure treated IBA is environmentally-safe for use.



IBA pit at Tuas South Incineration Plant. The NEA is studying the use of IBA for non-structural applications

Chapter 5

# Transforming the environmental services industry

The environmental services industry is often viewed as low-skilled and low-tech, and overlooked by young job seekers due to poor career prospects.

However, through the Environmental Services Industry Transformation Map (ES ITM), about 30,000 people from the industry will benefit from higher-value jobs through skills upgrading and technology adoption by 2025.

The ES ITM focuses on four main areas: technology and innovation, jobs and skills, productivity and internationalisation.

## Technology and innovation

By ramping up the use of technology, the industry will find innovative ways to get the job done with less sweat. This will also create new and more highly-skilled jobs that will attract younger Singaporeans to join the industry.

We will spur innovation and drive technology adoption by giving local enterprises more opportunities to supply technological solutions to the Government. We will also provide companies with a list of solutions they can adopt easily, and support them with various funding schemes.



The use of the side loader for collection of recyclables means that only the driver is required to empty recycling bins from the comfort of the truck cabin



Skills and knowledge that Mr Koh Kheng Huat learns at the SkillsFuture Work-Study Programme leading to a Part-Time Diploma in Applied Science (Environmental Services and Management) by Republic Polytechnic will prepare him for his job at PV Vacuum Engineering Pte Ltd

## Jobs and skills

It is crucial to improve the skills of workers to take on higher-value jobs within the industry. The goal is to reduce manpower needs through better infrastructure and building design, and make it a norm for people to clean up after themselves.

## Productivity

To transform the industry, Singapore is looking at ways to better optimise land use or raise land productivity, which includes developing a multi-storey recycling facility or reusing closed landfills.

## Internationalisation

Given Singapore's small market size, companies can only grow by venturing overseas. Hence, Singapore collaborates with foreign counterparts and participates in international projects and platforms to enhance market access for local enterprises. The NEA also supports companies that venture overseas by developing their capabilities in high potential growth areas. The NEA aims to develop integrated solutions for city planning and development projects overseas by tapping on the unique capabilities of different industry sectors in the Built Environment Cluster.



Westcom Solutions Pte Ltd has successfully exported its microbial treatment that breaks down food waste at a low operating temperature  
Photo: Westcom Solutions Pte Ltd



## Chapter 6

# Shaping a greener future with science and technology

Using microbes to convert food waste into compost, or turning incineration ash into construction materials – these are just two of the many possible ways to close our waste and resource loops through recycling or reuse.

These innovations are a result of our experiments with cutting-edge science and technology, to create more sustainable solutions. However, this requires collective effort. We are bringing together the expertise and resources of academia, enterprise and the Government to create a cohesive R&D ecosystem.



(From left) Chief Executive Officer of the NEA, Mr Tan Meng Dui; Minister for the Environment and Water Resources, Mr Masagos Zulkifli; and President of Nanyang Technological University, Professor Subra Suresh, holding pieces of concrete made with slag produced from the waste gasification processes. This highlights the potential of turning waste into material for useful applications, which contributes to closing the waste loop.



WTE Research Facility at Tuas South  
Photo: Nanyang Technological University, Singapore

### Closing the Waste Loop (CTWL) R&D Initiative:

\$45 million programme which encourages partnerships between Institutes of Higher Learning, Research Institutes and private sector enterprises. It aims to develop ways to utilise resources efficiently, extend the lifespan of Semakau Landfill, while maintaining high standards of public health.

### Waste-to-Energy (WTE) R&D programme:

\$25 million programme to boost energy recovery efficiency and explore alternative WTE technologies. Under this programme, a \$40 million WTE Research Facility was set up to provide local researchers and industry players with a physical, open platform for pilot testing. Its plug-and-play features support experimentation and test-bedding at scale.

## Chapter 7

## Towards a Zero Waste Nation, together

2019 was designated as the Year Towards Zero Waste to rally Singaporeans to care for our environment and treasure our precious resources



The Government cannot move towards a Zero Waste Nation without the partnership of businesses, individuals and organisations.

**Co-creating solutions:** We consulted more than 6,000 stakeholders, including companies, non-governmental organisations and individuals, in developing the Zero Waste Masterplan.

**Ground-up efforts:** Initiatives by our partners from the people, public and private sectors include the Singapore Environment Council's "One Less Plastic" campaign in December 2018, which encouraged shoppers to use reusable bags, and the Waste Management and Recycling Association of Singapore's regular community outreach to promote waste reduction and recycling.

**Schools and youth:** The NEA promotes environmental initiatives in schools through funding support or platforms to showcase exemplary student projects. The Ministry of the

Environment and Water Resources (MEWR) also partners the National Youth Council in engaging youth leaders on environmental policies and programmes.

**Partnerships beyond borders:** Singapore has partnered countries like China, Japan, South Korea, the Netherlands, Oman, Jordan and the United Arab Emirates through Memorandums of Understanding, policy exchanges as well as industry workshops and demonstration projects.

**Sustained 3P Partnerships:** MEWR is convening a Citizens' Workgroup to co-create solutions with Singaporeans to improve household recycling and reduce the contamination rate of our blue recycling bins, which is currently 40%.

We will continue to work with all our stakeholders and partner them to co-create solutions for a sustainable Singapore. Together, we can move closer towards our vision of becoming a Zero Waste Nation.

# Zero Waste Masterplan

to Achieve a Sustainable, Resource-Efficient and Climate-Resilient Singapore

## STRENGTHENING THREE RESILIENCES



### Climate Resilience

Address existential threats of climate change especially rising sea levels



### Resource Resilience

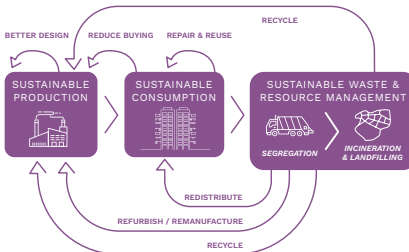
Ensure safe and secure supply of critical resources like food and water



### Economic Resilience

Ensure the future Singapore economy remains competitive by overcoming carbon and resource constraints

To achieve this, we will adopt a circular economy approach



## GOVERNMENT TAKING THE LEAD

### Three Priority Waste Streams



Food waste



E-waste



Packaging waste, including plastics

### Resource Sustainability Act

Mandatory packaging reporting in **2020**

Extended Producer Responsibility for e-waste by **2021**

Mandatory food waste segregation for treatment from **2024**



Extended Producer Responsibility for packaging, including plastics, no later than **2025**

# Our Targets

- 1 Extend Semakau Landfill's lifespan **beyond 2035**
- 2 Reduce amount of **waste sent to landfill per capita per day by 30%** by 2030
- 3 By 2030, achieve a **70% overall recycling rate**:  
81% non-domestic recycling rate  
30% domestic recycling rate

## PUSHING BOUNDARIES THROUGH RESEARCH AND INFRASTRUCTURE



**Pneumatic Waste Conveyance Systems**

**TuasOne Waste-to-Energy Incineration Plant**

**Pilot Mechanical Biological Treatment facility**



### Tuas Nexus

Comprising Integrated Waste Management Facility and Tuas Water Reclamation Plant to harness synergies across the water-waste-energy nexus



### NEWSand

Use of incineration bottom ash in construction materials

**\$45 million** **\$25 million**

**Closing The Waste Loop R&D Initiative**

8 projects worth almost \$20 million funded as of 2019

**Waste-to-Energy Programme**

Prototype testing at \$40 million Waste-to-Energy Research Facility

## TRANSFORMING THE ENVIRONMENTAL SERVICES INDUSTRY

More than **2,000 firms**

**30,000 workers** to benefit from the Environmental Services Industry Transformation Map by 2025

Gov-PACT innovation calls

**\$30 million** Productivity Solutions Grant (PSG)

Regulatory Sandbox

INCUBATE partnerships

## CO-CREATING SOLUTIONS WITH THE COMMUNITY

**#RecycleRight campaign**

More than **250 companies** consulted

**New design for recycling bin labels**

Over **5,000 households** surveyed on recycling

**Citizens' Workgroup on household recycling**

More than **1,300 people** participated in public consultation

## Zero Waste Masterplan Singapore

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[www.towardszerowaste.sg](http://www.towardszerowaste.sg)

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