



# 3R Guidebook for Industrial Developments

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**National  
Environment  
Agency**

Safeguard • Nurture • Cherish

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## About this Guide

This 3R guidebook for industrial developments is produced by the National Environment Agency (NEA) to help industrial developments/companies assess their current waste management practices, and identify opportunities to reduce, reuse and recycle waste materials.

By adopting the 3Rs (reduce, reuse, recycle), industrial developments/companies can potentially reap some cost savings in waste disposal and treatment cost while contributing towards environmental sustainability.

## What can be learnt from this Guide?

This guide does not provide a “one-size-fits-all” solution to developing the best 3R programme for industrial developments. Rather, it seeks to provide general concepts and factors for consideration during the planning phase.

## National Environment Agency (NEA)

Formed on 1 July 2002, the NEA is the leading public organisation responsible for improving and sustaining a clean and green environment in Singapore. The NEA develops and spearheads environmental initiatives and programmes through its partnership with the People, Public and Private sectors. It is committed to motivating every individual to take up environmental ownership and to care for the environment as a way of life.

By protecting Singapore's environment from pollution, maintaining a high level of public health and providing timely meteorological information, the NEA endeavours to ensure sustainable development and a quality living environment for present and future generations.

Visit <https://www.nea.gov.sg> for more information.





## CHAPTER 1: INTRODUCTION

### Overview of the solid waste management in Singapore

Over the years, Singapore's waste disposal quantities have increased significantly. From 1,260 tonnes of waste disposed of per day in 1970, the amount of waste disposed of has risen more than six times to more than 7,900 tonnes per day in 2020, and is projected to continue to increase in tandem with population and economic growth.

Since the 70s, much investment has gone into the building of waste-to-energy plants and landfills to manage the increasing amount of waste disposed. The waste-to-energy plants are designed to incinerate waste safely and are equipped with air emission cleaning equipment. These plants reduce the volume of waste by up to 90%, and recover energy to supply about 3% of Singapore's electricity demand. Ferrous and non-ferrous metals are also recovered from the incineration bottom ash for recycling.

The remaining ash is then transported to the offshore Semakau Landfill, the only landfill in Singapore.

If waste quantities continue to grow, there would be a need to build more waste-to-energy plants and landfills. This presents a key challenge for land-scarce Singapore.



Tuas South Incineration Plant



Semakau Landfill

## CHAPTER 1: INTRODUCTION

### Strategies for sustainable solid waste management

As a small city-state with limited space, Singapore has to ensure prudent use of land for economic growth. Building more waste disposal facilities to handle the increasing amount of waste will mean less land for other uses such as industries, housing, water catchment areas, transportation and recreation.

The Zero Waste Masterplan was launched on 30 August 2019 and maps out Singapore's key strategies to build a sustainable, resource-efficient and climate-resilient nation. This includes adopting a circular economy approach to waste and resource management practices and shifting towards more sustainable production and consumption.

Based on current waste disposal rates, Singapore's only landfill, Semakau Landfill, will run out of space by 2035. The Masterplan has set a new waste reduction target to reduce the daily amount of waste sent to Semakau Landfill by 30 per cent by 2030. This will help to extend Semakau Landfill's lifespan beyond 2035.

In addition, Singapore also aims to increase our overall recycling rate to 70 per cent, non-domestic recycling rate to 81 per cent and domestic recycling rate to 30 per cent by 2030 under the Sustainable Singapore Blueprint.

To achieve our vision, the NEA has adopted a multi-pronged waste management strategy of waste minimisation. This is through the first 2Rs of Reduce and Reuse, maximising resource recovery through the third R of Recycling, and volume reduction through incineration of all remaining incinerable waste to reduce waste sent to the landfill.

NEA will continue to work in partnership with various organisations in the people, private and public sectors to plan and implement 3Rs and related educational programmes.

### What can be done at industrial developments

Large amounts of waste are generated at industrial developments, most of which are recyclable. There is potential to divert more waste away for recycling instead of incineration.

This guidebook aims to provide practical information on how to plan and implement a 3R programme. It also provides case studies of companies that have achieved cost savings and waste reduction as a result of their 3R efforts.



An artist's impression of Jurong Innovation District.

Photo: MTI

## CHAPTER 2: BENEFITS OF REDUCING, REUSING AND RECYCLING SOLID WASTE

### What are the 3Rs?

The **3Rs** stand for:

- **Reducing** waste – to avoid waste at source so as to minimise the amount of waste that needs to be treated or disposed of
- **Reusing** waste – to use an object or material again, either for its original or similar purpose, without significantly altering the physical form of the object or material
- **Recycling** waste – the process of transforming waste materials into reusable form which may or may not be similar to the original product



3R practices encompass all measures that minimise the amount of waste disposed of.

The preferred waste management practice is to **reduce** waste at source, i.e. to prevent waste from being generated. Where waste generation cannot be prevented other options such as **reusing** the item(s), followed by **recycling** of the waste should be considered.

More specifically, waste minimisation in industry refers to practices such as:

- Product design modifications,
- Inventory management changes,
- Operational & maintenance procedure changes,
- Material changes,
- Equipment replacement or modifications,
- Reuse/recycling of waste materials.



Scrap tyres for recycling

## CHAPTER 2: BENEFITS OF REDUCING, REUSING AND RECYCLING SOLID WASTE

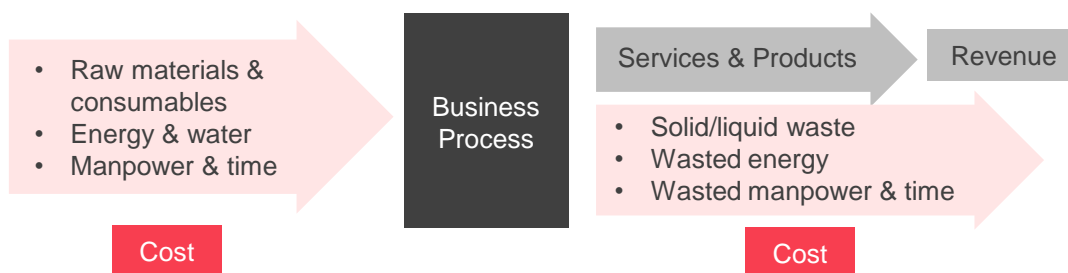
### Benefits to companies

Good waste management makes good business sense. The benefits of practising the 3Rs go beyond reducing waste sent to disposal sites. It can also provide competitive advantages to a company in areas such as:

#### Improved resource efficiency & reduced disposal costs

Waste generated as a by-product of a company's operations costs money to treat or dispose of.

All the resources will result in either products which can generate revenue, or waste which costs money to treat or dispose of. A representation of a resource throughput is shown below.



Practising waste minimisation in a business process can help reduce business costs. This can be done through improved resource and process efficiency, reduction of waste, and cutting down of waste handling and disposal costs.

#### Enhanced corporate image

With greater public awareness of environmental issues, the environmental profile of a company forms an increasingly important part of its corporate image.

Companies which incorporate environmental considerations into their business operations will benefit from enhanced corporate image which helps distinguish them in the marketplace as responsible service providers who are sensitive to environmental issues. This may give them a winning edge as preferred suppliers as well.

## CHAPTER 2: BENEFITS OF REDUCING, REUSING AND RECYCLING SOLID WASTE

### Benefits to the Environment

Practising the 3Rs is an effective way to protect our environment and conserve resources for the benefit of present and future generations.

Reducing waste at source leads to lower demand for virgin resources required to make new products, thereby conserving limited natural resources. Similarly, used products can be reused or recycled into new products, which would avoid further depletion of natural resources, reduce the amount of waste thrown away and lessen the need to build more disposal facilities.



### Benefits to Singapore

Singapore disposes of about 3 million tonnes of solid waste a year, which is enough to fill more than 5,700 Olympic-sized swimming pools. This amount could have been significantly higher if Singapore had not ramped up recycling over the years.

Singapore has had to increasingly commit more resources, including land to build disposal facilities, to manage the growing amount of waste.

Waste minimisation and recycling will help to conserve finite natural resources, prolong the lifespan of Semakau Landfill, reduce the need for more disposal facilities and help Singapore move a step closer to becoming a Zero Waste Nation.

The following pages will provide a step-by-step guide on how to implement a waste minimisation and recycling programme at your premises.

❖ If you are **managing** an industrial development, please proceed to Chapter 3A (page 9).

❖ If you are a **tenant** in an industrial development, please proceed to Chapter 3B (page 26).



## CHAPTER 3(A): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR MANAGERS OF INDUSTRIAL DEVELOPMENTS

There are seven steps in developing and implementing a waste minimisation plan.

Step 1: Obtain management's commitment and support

Step 2: Conduct a waste audit

Step 3: Identify opportunities to Reduce, Reuse and Recycle

Step 4: Engage recycling service provider(s)

Step 5: Assess the scope of savings and rank the options

Step 6: Develop a 3R programme

Step 7: Monitor, evaluate and improve the 3R programme

### Step 1: Obtain management's commitment and support

Management support is vital for the success of any 3R programme as 3R initiatives may require an investment of time and finances. It may also entail changes in operational procedures or in the responsibilities of some tenants.

A supportive management of the industrial development is crucial to the alignment of the environmental goals of all stakeholders, and supports the formation of a 3R culture amongst tenants. Therefore, the first step is to secure and project a clear and strong signal of the management's commitment to supporting 3R efforts.

To put up a case to management, there is a need to show how embarking on a 3R programme is advantageous for your industrial development e.g. in terms of cost savings and enhanced reputation.

To estimate the potential savings in waste disposal cost, gather data on the amount of waste generated within the development. This can be requested from the waste collector or by investing in a weighing machine. With the information, opportunities to reduce, reuse and recycle waste can be identified and the cost savings from the wasted raw materials/consumables can be estimated.

Request your senior management to demonstrate its support and commitment as follows:

- Circulate or make known to all tenants a policy statement on waste minimisation and recycling.
- Incorporate waste minimisation and recycling requirements in the lease contract.
- Give recognition as appropriate to the tenants involved.

## CHAPTER 3(A): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR MANAGERS OF INDUSTRIAL DEVELOPMENTS

### 3R policy statement

A 3R policy statement, which can be used to convey waste minimisation objectives to tenants, may include these main points:

- Motivations for practising the 3Rs, such as environment responsibility, reducing waste to landfill, reducing waste disposal cost;
- Reducing waste at source as the main goal;
- Reusing and recycling materials before disposing of them as waste.

A 3R policy statement can also be part of the industrial estate's overall environmental policy, if there is one.

The following are some examples of 3R policy statements.

1. *[Industrial development's name]'s policy is to reduce all waste to minimum levels that are economically and technically feasible;*

*Each tenant is responsible for reducing waste, and for complying fully with all the waste reduction programme goals established for the [name of industrial development];*

*Tenants are encouraged to come forth with suggestions for further waste reduction, either in their own premises, or other areas.*

OR

2. *[Name of organisation managing the development] is committed to environment sustainability. In keeping with this policy, we strive to support resource efficiency and minimise adverse environmental impacts. By successfully reducing waste at its source, we can also achieve cost savings and increase operational efficiencies.*

Signature \_\_\_\_\_ Date \_\_\_\_\_

Position [in development's management team] \_\_\_\_\_

The policy statement, endorsed by the management of the industrial development, should be disseminated to all tenants and displayed prominently at strategic locations.

A meeting should also be convened to explain the rationale and/or disseminate the information to all tenants. This would be a good platform to seek feedback and ideas from tenants; and they would be more likely to get involved and align their efforts with the policy.

## CHAPTER 3(A): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR MANAGERS OF INDUSTRIAL DEVELOPMENTS

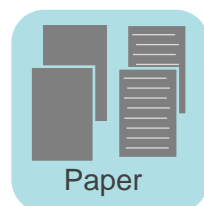
### Step 2: Conduct a waste audit

#### What is a waste audit?

A waste audit is a structured process of identifying and quantifying the sources, amount and types of waste generated in the industrial development.

The objective of a waste audit is to profile the waste types by obtaining information on:

- types and amount of waste;
- how they are generated;
- why they are generated;
- where they are being generated; and
- how they are managed after being generated.



Doing this will help to identify areas of wastage, and uncover opportunities to reduce, reuse or recycle waste materials. It will also help to gauge the effectiveness of the 3R programme.

#### How to conduct a waste audit?

Visit tenants to obtain information on their waste materials through:

- walking through different operational processing areas;
- surveying the waste that is bound for incineration; and
- talking to the relevant tenants.

Different types of waste are generated from different tenants. Solid waste from a manufacturing facility is usually generated in three areas:

- manufacturing (bulky waste, wastage of raw material and process waste, food waste);
- shipping and receiving (packaging waste);
- office operations (paper and ink cartridge waste, etc.).

Understanding the waste generated in these areas is an essential step and can be done through conducting a waste audit. This helps to identify areas of wastage, and uncover opportunities to reduce them.

## CHAPTER 3(A): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR MANAGERS OF INDUSTRIAL DEVELOPMENTS

### Conduct an inspection with tenants

Work with individual tenants to walk through their various operational areas on different days of the week and make a visual inspection of the contents of the industrial waste *that would be sent for incineration*. Take note of the types of waste, gather information from relevant operational staff and document the findings.

Pay attention to tenants that tend to generate large amounts of waste. Create an audit checklist and indicate the different types of waste streams observed during the inspection.

### Sample audit checklist

Types of waste sent for incineration	Point/s of origin
Paper	
Cardboard	
Metal	
Plastic	
Glass	
Food	
Wood	
Others	

### Step 3: Identify opportunities to Reduce, Reuse and Recycle

Identify opportunities for intervention and develop strategies and procedures for 3R outreach and initiatives to target each waste stream.

#### General areas for waste reduction

In general, industrial waste can be reduced in three areas: manufacturing (raw material and process waste), receiving/shipping (packaging waste) and office (paper, cartridges, etc.). The waste minimisation techniques or practices listed on the following page provide suggestions to reduce waste at the premises.



## CHAPTER 3(A): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR MANAGERS OF INDUSTRIAL DEVELOPMENTS

### General areas for waste reduction (cont'd)

#### 1. Manufacturing waste (raw material and process waste)

Proper control over raw materials, intermediate products, final products, by products and associated waste streams is an important waste reduction technique. Better inventory control and material handling can reduce raw material waste.

Thus, do **encourage tenants** to do the following and recognise them for their efforts:

##### Inventory control

- Purchase only the amount of raw materials needed for a production run or a set period of time where possible.
- Work with their suppliers to minimise packaging or take back excess unused materials.
- Develop procedures to review all materials purchased to minimise the chances of storing them beyond their shelf life.



##### Material handling

- Ensure that raw materials reach the production process without loss through contamination, spills or leaks.
- Handle and process materials efficiently so that they do not become waste. For example, refine your production process such that raw materials are fully utilised without incurring wastage.
- Handle waste/rejects like a product. Do not allow a recyclable or clean waste material to be contaminated as this can reduce/eliminate its recovery potential.
- Segregate recyclables from waste that would be sent for incineration/landfill. Place and label recycling and trash bins in strategic locations of production areas.

##### Product process modification

Improving the efficiency of a production process can significantly reduce process waste. It can be achieved through the modification of operational and maintenance procedures, material change and equipment.

## CHAPTER 3(A): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR MANAGERS OF INDUSTRIAL DEVELOPMENTS

**Encourage your tenants** to do the following:

### Operational and maintenance procedures:

- Look for opportunities to further improve the efficiency of operational procedures.
- Document the improved operating procedures completely, and make them part of the regular employee training programme.
- Implement a strict maintenance programme, which stresses preventive and corrective maintenance, to reduce waste generation caused by equipment failure. Such a programme can help spot potential sources of waste generation and correct a problem before any material is lost.
- Maintain a strict schedule of all maintenance activities and keep records accurate.

### Material change

- Consider material change that can eliminate one or more steps of the process. This could lead to elimination or reduction of raw material used and waste generated, and improve process efficiency.
- Use a less hazardous material in a production process where possible.
- Look for ways to use waste as a raw material in another process.
- Look for ways to avoid contamination of waste so that it can be used as a substitute for a raw material.

### Process equipment modification

- Modify existing or install more efficient process equipment to take advantage of better production technologies: New or updated equipment usually processes materials more efficiently, reduce the amount of raw material used, and cut down the number of off-specification products or rejects. This will reduce waste and its associated costs.

## CHAPTER 3(A): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR MANAGERS OF INDUSTRIAL DEVELOPMENTS

### 2. Receiving/Shipping waste (Packaging waste)

Packaging materials include cardboard, plastics and drums which come from the tenants' suppliers who deliver the materials needed for their operations, or from tenants who use packaging materials to pack and ship their products to customers.

If tenants' suppliers use more packaging materials than necessary, or use single-use packaging, more waste will be generated at your premises. This requires more time to handle and incurs a higher disposal cost if the packaging is not recyclable.

Thus, encourage your tenants to look into ways to modify the design or change the material of packaging that can:

- improve packing/shipping efficiency,
- reduce the amount of packing materials, and/or
- allow packaging to be reused or recycled.



Packaging waste



Cardboard packaging waste

### 3. Office waste

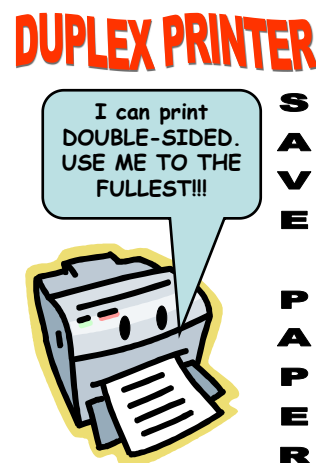
In a typical office, usually half the amount of office waste is paper-based. Paper is therefore a major purchasing and disposal cost to the average office. Yet, it is a cost that can be brought down easily through reduction, reuse and recycling. The following can be considered in minimising paper waste.

Implement the following practices **at your management office** and **encourage your tenants** to do the same.

## CHAPTER 3(A): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR MANAGERS OF INDUSTRIAL DEVELOPMENTS

### Tips to reduce

- Make it a company policy that all printing, photocopying and publications are to be done in double-sided format where possible.
- Place posters near printers and photocopiers to remind staff to avoid unnecessary prints.
- Cancel subscriptions of unnecessary publications.
- Encourage staff not to print out e-mails unless necessary. Add a note in your email signature to encourage the receiver to consider the environment before printing out the email.
- Reduce confidential paper waste by giving instructions as to which material is confidential, and which can be considered general paper waste.
- Encourage the use of single-spacing for report or memo writing.
- Set narrower margins for drafts.
- Change margins to avoid having little text on the last page.
- Edit and proofread carefully on the computer before printing.
- Share newspapers/magazines.



### Tips to reuse:

- Reuse single-sided printed paper or convert them into scrap message pads.
- Reuse envelopes wherever possible, especially for sending information internally.
- Reuse files/folders.

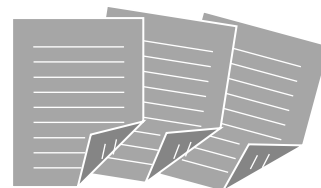




## CHAPTER 3(A): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR MANAGERS OF INDUSTRIAL DEVELOPMENTS

### Tips to recycle:

- Set up a waste paper collection system to recycle waste paper. Place paper recycling bins around the office. A guide is one bin for six staff, and one in the photocopier room. Use paper ream lids as additional collection trays for waste paper reuse.
- Ensure that collection and segregation of recyclables from general waste is part of the cleaning staff's contracted work.
- Promote the recycling scheme by putting up posters at notice boards, and labelling recycling bins to explain the types of recyclables that can be accepted for recycling.
- Update staff/tenants on the scheme, including figures on the amount of paper waste collected. An incentive may be provided when waste reduction targets are met.



### Use recycled paper

Paper is a natural resource that can be recycled five to seven times. This substantially reduces the impact on the environment. By using recycled paper, you can help boost the market for recycled products. This will in turn support the recycling industry and reduce unnecessary use of virgin materials.

Today, the quality of paper containing some recycled fibre is comparable with that of virgin paper. Where possible, consider purchasing recycled paper.



Logos which indicate that the product has been sustainably sourced

Reduction of other office waste

- Collect used ink cartridges for recycling. Some local recycling companies can pick up and buy back used cartridges, depending on the quantity and model of the cartridges, and whether they can recover their transportation cost.
- Purchase re-manufactured ink cartridges from cartridge recycling companies. Look for the companies that can provide warranty on the re-manufactured cartridges.



Step 4: Engage recycling service provider(s)

There are a number of recycling companies and waste disposal contractors in Singapore which accept the four common waste types (paper, plastic, metal, glass) for recycling.

A list of licensed collectors and recyclers is available [here](#) (The list can be found under item 1 of the section “List of general waste disposal facilities”).



Consider engaging a contractor who can provide both recycling and waste disposal services. Alternatively, engage separate contractors who can collect the recyclable waste generated at your premises.

Cost components of waste disposal and recycling contracts

Disposal costs

i. Container rental fee	This is the monthly fee charged by the contractor for the rental of a compactor, open top container or waste bins.
ii. Haulage charge	This is the fee charged by the contractor for collecting and transporting waste to a waste-to-energy plant for disposal.
iii. Disposal fee	This is the fee charged at the waste-to-energy plant/landfill for the tonnage of waste disposed of.



The fee standard can be found [here](#).

## CHAPTER 3(A): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR MANAGERS OF INDUSTRIAL DEVELOPMENTS

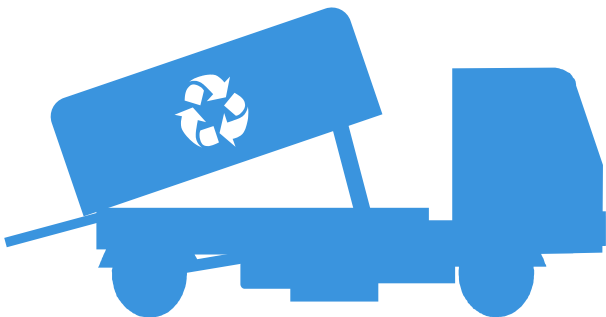
Some waste contractors may charge a flat fee, combining all three cost components, while some contractors charge a variable monthly fee and provide a cost breakdown, depending on the contract agreed upon.

Having a usage-based waste disposal contract is recommended, i.e. pay less when less waste is disposed and vice versa, as this would allow immediate savings to be reaped from any reduction in the waste disposed of.

### Recycling costs

For recycling service fees, there are a few elements of costs involved:

i. Container rental fee	This is the monthly fee charged by the contractor for rental of recycling receptacles (e.g. open top container, bulk bins).
ii. Haulage charge	This is the fee charged by the contractor for collecting and transporting recyclables to a Materials Recovery Facility (MRF) or to other recycling companies for further processing.
iii. Processing fee	This is the fee charged by the MRF or recycling companies for sorting, baling and processing the recyclables.



There is also market value for recyclables when they are sorted and sold to traders or recycling plants. You may consider bundling waste and recycling collection services to reap cost savings from the reduced amount of refuse. If the value of the processed recyclables (revenue) is greater than the total cost of (i) to (iii), it is likely that the contractor will be able to offset part of the cost. If the total cost is higher than the revenue, the contractor will charge a fee for the recycling service.

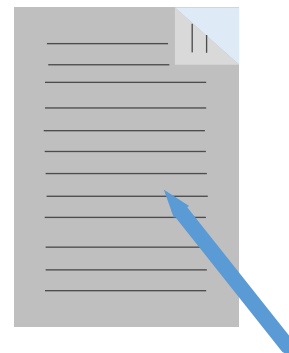
## CHAPTER 3(A): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR MANAGERS OF INDUSTRIAL DEVELOPMENTS

### Step 5: Assess the scope of savings and rank the options

Having generated options to minimise waste, the next step is to assess their feasibility, savings, then rank and decide on the options that can be implemented.

Some factors to consider include:

- How much waste can be reduced through the proposed solution/s?
- Does the proposed solution bring about the lowest environmental impact compared with other solutions (e.g. a solution that reduces or eliminates waste is better than one which identifies a recycling route for the waste)?
- Will the change create problems in other environmental areas (e.g. the decrease of solid waste increases liquid/hazardous waste)?



### Step 6: Develop a 3R programme

You can develop a 3R programme, and assist tenants to develop one, including the following:

- Identify targeted waste types for waste reduction, reuse or recycling
- Discuss details of the proposed 3R initiatives for targeted waste types
- Discuss estimated quantity of waste to be reduced for each waste type
- Discuss and determine measurable performance indicators and targets, such as waste reduction or recycling rate
- Assist in meeting the timeline for achieving the targets
- Provision of space within the development for consolidation of tenants' recyclables for recycling

In addition, a summary table of the 3R programme, similar to the one below, can be created for ease of reference.

Location	Waste Type	Proposed 3R Measure <sup>1</sup>	3R Goal <sup>2</sup>	Estimated Costs/Savings	Estimated Payback Period <sup>3</sup>	Start Date	End Date	Status

1. Proposed 3R measure: Measures to reduce, reuse or recycle waste

2. 3R goal: Estimated amount of waste to be reduced, reused or recycled through the proposed 3R measure/s

3. Estimated payback period: Calculated by dividing the total one-off cost of the project by the net saving of the project (the difference between savings and operating & maintenance costs). This gives a payback figure in years.



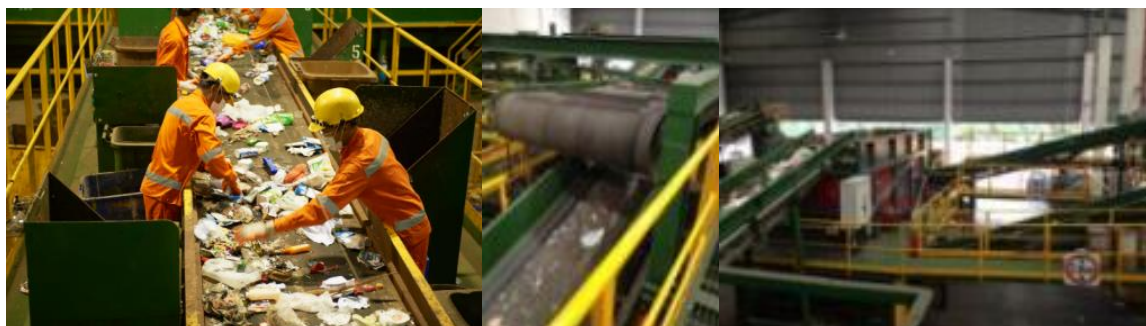
## CHAPTER 3(A): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR MANAGERS OF INDUSTRIAL DEVELOPMENTS

### Segregated or commingled recycling bins

Non-industrial recyclables (that are usually generated in smaller quantities) can be collected in segregated or commingled recycling bins, depending on the collection method of the recycling service provider.

**Segregated recycling bins** can be provided for different types of materials such as paper, plastics and metal. Please ensure that the cleaners do not mix the segregated recyclables during collection. While segregated recyclables might result in higher collection costs, the value of properly sorted recyclables is also generally higher.

**In a commingled recycling system**, all recyclable materials are mixed and stored together. Please ensure that the cleaners do not mix the recyclables with general waste during collection. Commingled recyclables are sent to a Materials Recovery Facility (MRF) where they are sorted and baled for recycling. This system requires fewer recycling bins, and hence occupies less space.



Semi-automated process of sorting out recyclables at a Materials Recovery Facility

### Other types of waste

For **used wooden pallets**, encourage tenants to work with their suppliers to take back the pallets for reuse/recycling.

**Horticultural waste** produced from landscaping activities would be removed by the landscape contractor for recycling, or it could be composted on site.

For **food waste**, the preferred way to manage food waste is to avoid food wastage at the outset. NEA has developed various outreach materials on food waste minimisation and treatment. Organisations keen to embark on their own Food Waste Reduction programme may tap on the resources available [here](#). NEA and the Singapore Food Agency (SFA) have also worked with various industry stakeholders to publish [food waste minimisation guidebooks](#) for food retail establishments, supermarkets and food manufacturing establishments to reduce food waste across the supply chain.

NEA encourages both organisations and members of the public to donate their unsold and excess food to food distribution organisations. Food manufacturers and food retail establishments can contact these organisations to make arrangements for the donation of their unsold and excess food.

## CHAPTER 3(A): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR MANAGERS OF INDUSTRIAL DEVELOPMENTS

Under the Resource Sustainability Act, owners and occupiers of commercial and industrial premises that generate large amounts of food waste will be required to segregate their food waste for on-site or off-site treatment from 2024.

There are suppliers of on-site food waste treatment systems that can convert food waste into organic fertiliser/compost or non-potable water. The organic fertiliser/compost can be used for landscaping and gardening, while the non-potable water can be used for cleaning the system.

A non-exhaustive list of Food Distribution Organisations, Local Recycling Facilities and Suppliers of on-site food waste treatment system can be found at the [NEA Food Waste Management webpage](#).

For owners and operators of premises that are not able to adopt on-site treatment due to limitations such as space constraints, they may opt to send their food waste for off-site treatment in future upon completion of Tuas Nexus, Singapore's first integrated water and solid waste treatment facility.

To do so, they are required to engage an [NEA-licensed General Waste Collector \(GWC\)](#) with Class B licence for the transportation of segregated food waste to a licensed waste disposal facility for treatment. An example of a licensed waste disposal facility for the treatment of segregated food waste will be the upcoming food waste treatment facility in Tuas Nexus (expected to be operational in 2025).

More information on how to set up a food waste segregation workflow can be found in the [Food Waste Segregation and Treatment Guidebook](#).

## CHAPTER 3(A): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR MANAGERS OF INDUSTRIAL DEVELOPMENTS

### Considerations for scheduling the implementation

Packaging usually provides the easiest waste reduction opportunity and thus the greatest potential for savings.

Options which do not involve equipment change, are inexpensive and quick to implement (e.g. operation procedural changes or material changes) should be implemented as soon as possible.

Options that have shorter payback period and produce greater savings can be scheduled for early implementation as well.

Waste minimisation plans that call for equipment changes will include planning, design, procurement, construction or installation. They should be implemented at a later stage when resources and manpower are available.

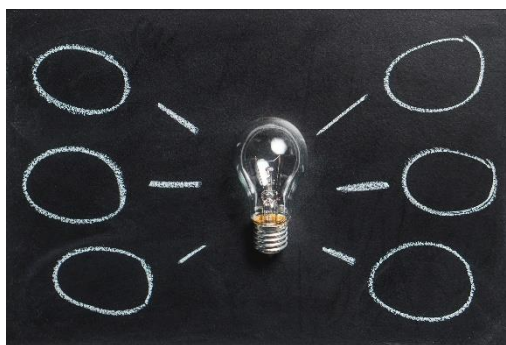
### Establishment of goals & measuring indicators

To measure the success of the waste minimisation plan, numeric performance goals need to be established. Waste reduction should be measured in tonnes or kilograms of waste generated per standard unit of production.

If the establishment of numeric performance goals is not practical, include a clearly stated list of actions in the waste minimisation plan.

Ensure that the goals are:

- Understandable;
- Acceptable to those who will work to achieve them;
- Flexible to adapt to changing requirements;
- Measurable over time;
- Suitable to the overall corporate goals; and
- Achievable with a practicable level of effort.



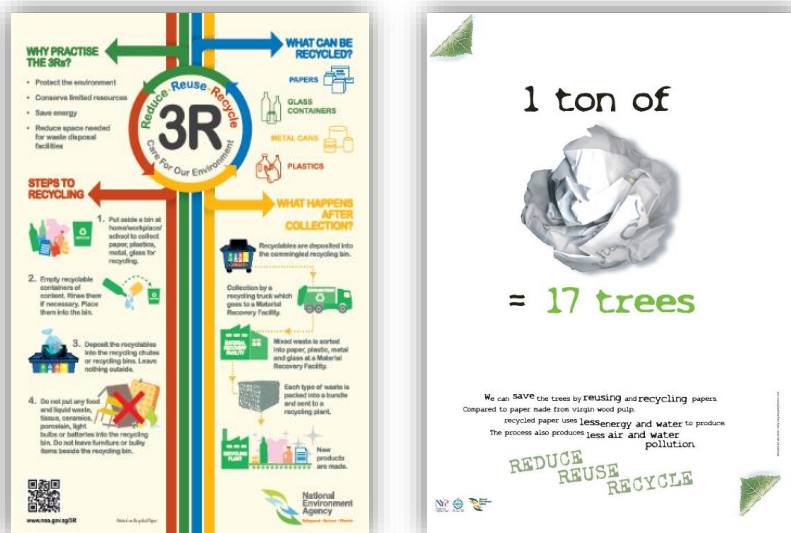
## CHAPTER 3(A): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR MANAGERS OF INDUSTRIAL DEVELOPMENTS

### Step 7: Monitor, evaluate and improve the 3R programme

For successful implementation of the 3R programme, the following are necessary:

#### Responsibilities and resources

Be clear about the goals and objectives of the plan. Make the right resources available, and ensure that implementation is carried out according to schedule.



Educational 3R posters\* can be placed at strategic locations to raise tenants' awareness.

#### Education and promotion

The success of the 3R programme depends on the collective efforts of the tenants within the industrial development. Before launching the programme, the recycling initiatives should be effectively communicated and promoted to tenants.

A checklist for developing and maintaining a 3R programme can be found in the Appendix.

#### Communication of the 3R programme

Wherever possible, face-to-face communication should be done with tenants to explain and elaborate on the details of the programme, and to align their waste management with the waste management policy of the industrial development.



\*Complimentary 3R posters are available at NEA's Customer Service Centre at the Environment Building, for use at your premises. Softcopies are also available for download [here](#).



## CHAPTER 3(A): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR MANAGERS OF INDUSTRIAL DEVELOPMENTS

### For Tenants:

- Conduct briefing for all tenants on 3R initiatives for the industrial development and how they can participate (e.g. 3R tips, locations of recycling receptacles, how not to contaminate the recyclables, etc.).
- Circulate the industrial development's environmental policy to tenants
- Organise visits to waste management facilities (e.g. waste-to-energy plants, Semakau Landfill) as part of 3R outreach to tenants.

More information on visits to waste management facilities can be found [here](#).



- Make the 3R programme (implementation schedule with goals, 3R tips) easily accessible through an online portal, emails or via notices/posters at locations accessed frequently by tenants.
- Display reminder notices at strategic locations, e.g. poster/e-message to reduce paper waste at the printing or photocopying room, poster to reduce food waste at staff canteen.
- Share and update 3R initiatives and waste reduction results periodically with tenants.

### For Cleaners:

- Educate new cleaning staff on the 3R programme and the need to segregate recyclables from general waste.
- Engage the industrial development's cleaners periodically on the need to properly segregate the recyclables from general waste during their collection rounds.



Left to right: Bins for general waste, recyclables and food waste

## CHAPTER 3(A): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR MANAGERS OF INDUSTRIAL DEVELOPMENTS

### Promotion of the 3R programme

Memos to be sent by the management of the industrial development to the tenants, announcing the programme and requesting their full participation. The memos should highlight the benefits of the 3R programme and explain the procedures that will be implemented/changed.

The goals, plans and implementation timeline of the 3R programme should be displayed prominently in common areas within the industrial development. Regular updates on the progress of the programme should also be communicated to tenants.

To ensure a sustainable programme:

- make all implemented options or measures a part of the industrial development's standard operating procedures;
- include operational procedures, and training;
- make ongoing reviews and improvements.

Monitor waste reduction performance against the goals established and conduct annual reviews to compare the current performance with that of the previous year. During the process, additional waste reduction opportunities might arise. More action might be needed or different methods might become available.

As such,

- make changes to the planned actions and adjust operating procedures if needed,
- incorporate new options or methods,
- establish new priorities for action, and
- set reviewed waste reduction goals, ideally upwards.

By following the steps in this guidebook, your industrial development could achieve sizeable cost savings and waste reductions, and contribute to solving Singapore's waste disposal problem.



## CHAPTER 3(B): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR TENANTS OF INDUSTRIAL DEVELOPMENTS

There are eight steps in developing and implementing a waste minimisation plan.

Step 1: Obtain management's commitment and support

Step 2: Appoint a 3R manager and form a 3R team

Step 3: Conduct a waste audit

Step 4: Identify opportunities to Reduce, Reuse and Recycle

Step 5: Engage waste and recyclables collector/s

Step 6: Assess the scope of savings and rank the options

Step 7: Develop a 3R programme

Step 8: Monitor, evaluate and improve the 3R programme

### Step 1: Obtain management's commitment and support

The company's management support is vital for the success of any 3R programme as 3R initiatives could require an investment of time and finances. It could also entail changes in operational procedures or in the responsibilities of some staff.

A supportive management from the company is crucial to the alignment of the environmental goals of all stakeholders and supports the formation of a culture of practicing the 3Rs amongst tenants. Therefore, the first step is to secure and project a clear and strong signal of the management's commitment to supporting 3R efforts.

To put up a case to management, there is a need to show how embarking on a 3R programme is advantageous for your company, e.g. cost savings and enhanced reputation.

To estimate the potential savings in waste disposal cost, obtain data on the amount of waste generated by the company's production process. This can be obtained from the waste collector or by investing in a weighing machine. With the information, opportunities to reduce, reuse and recycle waste can be identified and cost savings can be estimated.



## CHAPTER 3(B): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR TENANTS OF INDUSTRIAL DEVELOPMENTS

Request your company's senior management to demonstrate its support and commitment as follows:

- Circulate or make known to all staff a policy statement on waste minimisation and recycling;
- Appoint a member of the senior management to lead the 3R team.
- Announce the formation of a 3R team and give the team the authority and responsibility to implement 3R initiatives;
- Keep staff informed of plan and the progress of the project
- Give recognition as appropriate to the staff involved; and
- Participate in key activities on waste minimisation and recycling.



### 3R policy statement

A 3R policy statement to convey waste minimisation objectives to staff may include these main points:

- Motivations for practising the 3Rs, such as environment responsibility, reducing waste to landfill, reducing waste disposal cost.
- Reducing waste at source to eliminate waste as the main goal.
- Reusing and recycling materials before disposing them as waste.

The 3R policy statement can also be part of the company's overall environmental policy, if there is one.

CHAPTER 3(B): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR TENANTS OF INDUSTRIAL DEVELOPMENTS

Example of a 3R policy statement

1. *[Your company’s name]’s policy is to reduce all waste to the minimum levels that are economically and technically feasible;*

*Each employee is responsible for reducing waste, and for complying fully with all the waste reduction programme goals established for the [name of company];*

*Employees are urged to come forth with suggestions for further waste reduction in their own work areas, and in any other areas that they are familiar with.*

OR

2. *[Your company’s name] is committed to environment sustainability. In keeping with this policy, we strive to support resource efficiency and minimise adverse environmental impacts. By successfully reducing waste at its source, we can also achieve cost savings and increase operational efficiencies.*

Signature \_\_\_\_\_ Date \_\_\_\_\_

Position [in company’s management team] \_\_\_\_\_

The policy statement, endorsed by the company’s management, should be disseminated to all staff and displayed prominently at strategic locations.

Apart from posting the message on a notice board, a meeting should also be convened to explain the rationale and/or disseminate the information to staff. This would be a good platform to seek feedback and ideas from staff; and the stakeholders would be more likely to get involved and align their efforts to the policy.



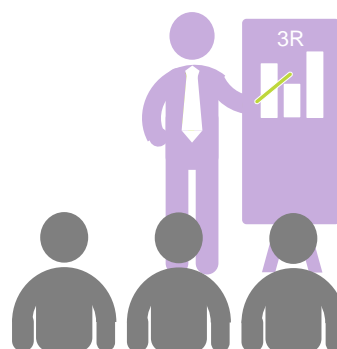


## CHAPTER 3(B): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR TENANTS OF INDUSTRIAL DEVELOPMENTS

### Step 2: Appoint a 3R manager and form a 3R team

The next step is to appoint a 3R manager. He/she should be an individual:

- with a passion for protecting the environment
- who possesses leadership and communication skills
- who is knowledgeable about the facility, its production processes, and its waste management operations



The formation of a 3R team helps to ensure the success of the 3R programme.

Together with the 3R manager, they will plan, develop and implement the 3R programme for the company. The team should be well represented in terms of experience and knowledge of waste management issues. It should comprise personnel from different departments, such as:

Shipping/receiving	Engineering	Accounting/Finance
Production	Purchasing	Facilities and tenant management

It is useful to involve the company's **suppliers** as they have the technical knowledge about the raw materials, equipment or packaging that they supply. They may also have experience with other customers on similar waste minimisation efforts and can share success stories.

Inputs from the **cleaning manager** should be sought as cleaning staff are involved in waste management operations and are pivotal to the successful implementation of the programme.

Lastly, work with the **recycling service provider** to determine the location/s of the recycling receptacles and frequency of collection.

## CHAPTER 3(B): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR TENANTS OF INDUSTRIAL DEVELOPMENTS

### **Role of 3R team**

The functions of the 3R team are to:

1. Plan, develop and implement a 3R programme, including:
  - Setting of goals and targets for the company's 3R programme.
  - Establishing 3R procedures and providing the necessary infrastructure to complement the operational practices of the company.
  - Organising programmes to train staff in the 3Rs.
  - Organising regular activities to raise overall awareness of the 3Rs.
  - Engaging partners and customers in 3R initiatives.
2. Propose a budget for the company's 3R programme.
3. Conduct waste audits to:
  - Determine baseline waste tonnage and composition.
  - Identify areas where waste can be reduced, reused or recycled.
  - Monitor waste output over time.
4. Monitor and ensure compliance with the established 3R procedures.
5. Establish an accounting system that reflects monthly waste management tonnages and costs, as well as savings arising from the waste avoided.
6. Generate progress reports on meeting the 3R programme goals and targets.
7. Keep management and staff informed of the progress in meeting the goals and targets of the 3R programme.
8. Meet regularly to track the progress in implementing 3R initiatives, and brainstorm for new initiatives to cut waste further.



## CHAPTER 3(B): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR TENANTS OF INDUSTRIAL DEVELOPMENTS

### Step 3: Conduct a waste audit

#### What is a waste audit?

A waste audit is a structured process of identifying and quantifying the sources, amount and types of waste that is generated at the premises.

The objective is to profile the waste types by finding out information on:

- types of waste;
- quantity of each waste type;
- where they are being generated;
- how they are generated;
- why they are generated; and
- how they are managed after being generated.



This will help to identify areas of wastage, uncover opportunities to reduce, reuse or recycle waste materials, and gauge the effectiveness of the 3R programme.



Paper



Plastic



Glass



Metal

#### How to conduct a waste audit?

The 3R team may obtain information on waste materials through:

- material purchasing records, waste disposal invoices, records of waste and rejects produced at generation points in daily operations;
- walking through different operational processing areas;
- surveying the waste that is bound for incineration; talking to relevant staff.

An estimate should be made of the resources required to carry out the audit. Resource requirements include:

- adequate time to carry out audit tasks to ensure the quality of the audit data;
- storage containers to isolate, move, and sort waste and recyclables;
- different coloured bags, tags, or labelled containers to identify waste from various generation points;
- space for sorting and storing waste during the audit; and
- a weighing scale.

Determine a few days of the week to make unannounced collection of waste samples. To ensure that waste samples are representative, collect a full week's worth of samples.

If the operation of your company is complex, or resources are limited, you can consider hiring a third party to conduct the waste audit.

CHAPTER 3(B): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR TENANTS OF INDUSTRIAL DEVELOPMENTS

Create an audit checklist and indicate the different types of waste streams observed during the inspection.

Sample audit checklists

Checklist A

Type of waste sent for incineration	Point/s of origin	Disposal <sup>1</sup> (kg/mth)	Cost of Disposal	Recycled (kg/mth)	Cost of Recycling
Paper					
Cardboard					
Metal					
Plastic					
Glass					
Wood					
Food					
Others					

<sup>1</sup>To calculate the weight, obtain a one-time measurement of the weight of the receptacle filled completely with the waste stream, e.g. cardboard. Thereafter, the weight of the waste can be obtained based on the approximate volume it takes up in the receptacle.

Once preliminary waste data using Checklist A has been collected, further analyse the waste generated at the premises using Checklist B.

Checklist B

Type of waste sent for incineration	Rate of generation (i.e. kg/unit of product)	Potential for contamination (e.g. mixed with other types of waste)	Why it is generated (e.g. due to frequent machine breakdown)	How it is managed after being generated (i.e. reused/ recycled/ disposed)
Paper				
Cardboard				
Metal				
Plastic				
Glass				
Wood				
Food				
Others				

## CHAPTER 3(B): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR TENANTS OF INDUSTRIAL DEVELOPMENTS

### a) Conduct an inspection

Walk through various operational areas on different days of the week and make a visual inspection of the contents of the receptacles containing industrial waste that would be sent for incineration.

Certain types of waste may not be seen in the refuse receptacles during a waste audit, but have been identified as possible waste materials from purchasing records. In such cases, types and quantities of the wastes based on the volume of materials purchased throughout the year may be estimated.

### b) Collect waste samples

Give clear instructions to staff and cleaners involved in the waste audit on the locations and types of waste to collect, and to label the collection bags/bins for identification of waste sources. Supervise the waste sample collection process.

### c) Sort the waste

After the sample bags of waste are collected, labelled and recorded, the bags from each area are weighed and emptied onto a large plastic sheet. The waste materials can then be sorted into different types/categories according to the audit checklist.

### d) Analyse the data

Analyse the information gathered by location to reveal opportunities for localised 3R initiatives. Pay special attention to how the waste was generated, why it was generated, at which point it was generated, and how it was managed after being generated. The analysis will be useful for developing 3R strategies and procedures.





## CHAPTER 3(B): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR TENANTS OF INDUSTRIAL DEVELOPMENTS

### Step 4: Identify opportunities to Reduce, Reuse and Recycle

Using the analysis, identify opportunities for intervention and develop strategies and procedures for 3R initiatives to target each waste stream. After determining the true costs of each type of waste, identify the opportunities to improve efficiency, reduce waste and cut down costs.

The objective of this step is to generate a comprehensive set of waste minimisation options. Consider every waste stream as a reduction opportunity until proven otherwise.

Most of the time, an opportunity exists if a waste stream exists.

#### Prioritising waste streams

One way of prioritising which waste streams to tackle is to assess their true costs. Higher-cost waste streams can be targeted first as they may represent a higher cost of raw materials, higher process inefficiency, and thus more potential for cost savings. Other factors, such as whether the high waste cost can easily be reduced, and the payback period for high investment measures to reduce waste, can also play a part.

#### General areas for waste reduction

Solid waste at an industrial development is usually generated in three areas:

1. manufacturing (bulky waste, raw material and process waste, food waste);
2. shipping and receiving (packaging waste); and
3. office operations (paper and printer cartridge waste, etc.).

The 3R team should tap on all resources available and involve as many employees as practically possible. Consulting staff from different departments, such as purchasing officers, engineers, machine operators and maintenance technicians, would be useful too. They know their working areas best and may be able to suggest good options for waste reduction. Your suppliers / vendors and customers are also valuable resources.

## CHAPTER 3(B): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR TENANTS OF INDUSTRIAL DEVELOPMENTS

### Waste minimisation tips

#### 1. Manufacturing waste (raw material and process waste)

Proper control over raw materials, intermediate products, final products, and associated waste streams is an important waste reduction technique. Better material handling can reduce raw material waste as well.

##### Inventory control

- Purchase only the amount of raw materials needed for a production run or a set period of time
- Purchase materials in the right amount and the right size container
- Work with your suppliers for them to take back excess materials or minimise packaging
- Develop procedures to review all materials purchased to minimise the chances of storing them beyond their shelf-life period.



##### Material handling

- Ensure that raw materials reach the production process without loss through contamination, spills or leaks
- Ensure that the material is efficiently handled and used in the production process, and does not become waste
- Handle waste or rejects like a product. Allowing a recyclable or clean waste material to be contaminated can reduce/eliminate its recovery potential
- Encourage staff to segregate recyclables from waste that would be sent for incineration/landfill. Label and place recycling and trash bins in strategic locations of production areas.

##### Product process modification

Improve the efficiency of a production process so that process waste can be reduced significantly. It can be achieved through modifying operational and maintenance procedures, material change and equipment.

## CHAPTER 3(B): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR TENANTS OF INDUSTRIAL DEVELOPMENTS

### Operational and maintenance procedures

- Look for opportunities to further improve the efficiency of operational process procedures.
- Document improved operating procedures, and make them part of the regular staff training programme.
- Implement a strict maintenance programme which stresses preventive and corrective maintenance, to reduce waste generation caused by equipment failure. Such a programme can help spot potential sources of waste generation and correct a problem before any material becomes waste.
- Maintain a strict maintenance schedule and keep accurate records of maintenance activities.

### Material change

- Consider material change that may have an impact on overall waste reduction.
- Use a less hazardous material in a production process where possible.
- Look for ways to use a waste material as raw material in another process, and avoid contamination of this waste material.

### Process equipment modification

- Modify existing or install more efficient process equipment to take advantage of better production technologies: New or updated equipment usually processes materials more efficiently, reduce the amount of raw material used, and cut down the number of off-specification products or rejects. This will reduce waste and its associated costs.

## CHAPTER 3(B): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR TENANTS OF INDUSTRIAL DEVELOPMENTS

### 2. Receiving/Shipping waste (Packaging waste)

Packaging materials include cardboard, plastics, and drums. Packaging waste will be either from your suppliers, or in the form of packaging materials used to pack and ship your products to customers.

Using more packaging materials than necessary to pack and ship your products may cost more in purchasing, materials handling, and shipping. This generates more packaging waste at your customers' end as well.

If your suppliers use more packaging materials than necessary, or use single-use packaging, it generates more waste at your industrial development. This requires more time to handle and incurs a higher disposal cost if the packaging is not recyclable.

Look into ways to modify the design or change the material of packaging that can:

- improve packing / shipping efficiency,
- reduce the amount of packing materials, and / or
- allow packaging to be reused or recycled.

Work with your suppliers and customers for opportunities to reduce, reuse and/or recycle packaging materials.



Industrial packaging waste

Cardboard packaging waste

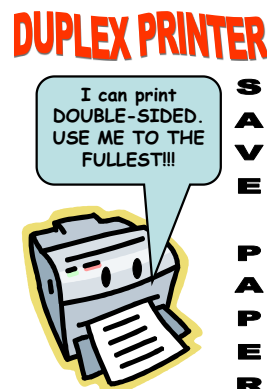
## CHAPTER 3(B): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR TENANTS OF INDUSTRIAL DEVELOPMENTS

### 3. Office waste

In a typical office, usually half of the total waste is paper-based. Paper is therefore a major purchasing and disposal cost to the average office. Yet, it is a cost that can be brought down easily through reduction, reuse and recycling. The following can be considered in minimising paper waste:

#### Reduce

- Make it a company policy that all printing, photocopying and publications are to be done in double-sided format where possible.
- Put reminder posters near printers and photocopiers.
- Cancel subscriptions of unnecessary publications.
- Avoid overproduction of marketing and publicity material by reviewing distribution lists and regularly updating databases.
- Use electronic communication where possible to reduce printing. Ensure that staff is comfortable with new technology and provide training where necessary. Add a note in your email signature to encourage the receiver to consider the environment before printing out the email.
- Reduce confidential paper waste by giving instructions to staff as to which material is strictly confidential, and which is general paper waste.
- Use single-spacing for report or memo writing.
- Set narrower margins for drafts.
- Change margins to avoid having little text on the last page.
- Edit and proofread carefully on the computer before printing.
- Share newspapers/magazines.



#### Reuse

- Reuse single-sided printed paper or convert them into scrap message pads.
- Reuse envelopes wherever possible, especially for sending information internally.
- Reuse carton boxes.





## CHAPTER 3(B): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR TENANTS OF INDUSTRIAL DEVELOPMENTS

### Recycle

- Set up a waste paper collection system to recycle waste paper. Place paper recycling bins around the office. A guide is one bin for six staff, and one in the photocopier room. Use paper ream lids as additional collection trays for waste paper reuse.



- Ensure that cleaning staff are involved in the recycling effort, and that collection and segregation of recyclables from general waste is part of their contracted work.
- Display paper recycling posters at strategic locations in the office, and label paper recycling bins.
- Update staff on the scheme, including the amount of paper collected. Provide an incentive (e.g. making a donation to charity or planting a tree) when waste reduction targets are met.
- Collect used ink cartridges for recycling. Some local recycling companies can pick up and buy back used cartridges, depending on the quantity and model, and whether they can recover their transportation cost.
- Purchase re-manufactured ink cartridges from cartridge recycling companies. Look for the companies that can provide warranty on the re-manufactured cartridges.



### Use recycled paper

Paper is a natural resource that can be recycled about five to seven times. This substantially reduces the impact on the environment. By using recycled paper, you can help boost the market for recycled products. This will in turn support the recycling industry and reduce unnecessary use of virgin materials.

Today, the quality of paper containing recycled fiber is comparable with that of virgin paper. Where possible, consider purchasing recycled paper.



The mark of  
responsible forestry



Logos which indicate that the product has been sustainably sourced.

CHAPTER 3(B): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR TENANTS OF INDUSTRIAL DEVELOPMENTS

Step 5: Engage waste and recyclables collector/s

There are a number of recycling companies and waste disposal contractors in Singapore which accept the four common waste types (paper, plastic, metal, glass) for recycling.

A list of licensed collectors and recyclers is available [here](#)  
(The list can be found under item 1 of the section “List of general waste disposal facilities”).



Consider engaging a contractor who can provide both recycling and waste disposal services. Alternatively, engage separate contractors who can collect the recyclables generated at your premises.

Cost components of waste disposal and recycling contracts

Disposal costs

i. Container rental fee	This is the monthly fee charged by the contractor for the rental of a compactor, open top container or waste bins.
ii. Haulage charge	This is the fee charged by the contractor for collecting and transporting waste to a waste-to-energy plant for disposal.
iii. Disposal fee	This is the fee charged at the waste-to-energy plant/landfill for the tonnage of waste disposed of.

Some waste contractors may charge a flat fee, combining all three cost components, while others charge a variable monthly fee and provide a cost breakdown, depending on the contract agreed upon.

Having a usage-based waste disposal contract is recommended, i.e. pay less when less waste is disposed and vice versa, as this would allow immediate savings to be reaped from any reduction in the waste disposed of.



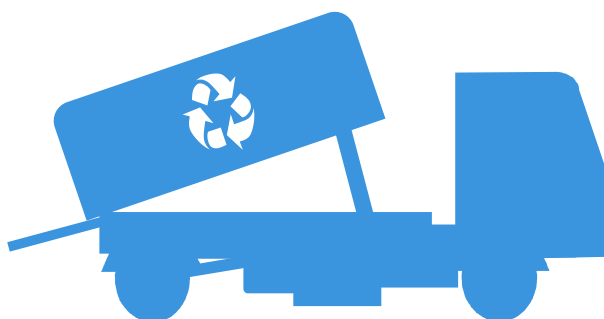
The fee standard can be found [here](#).

## CHAPTER 3(B): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR TENANTS OF INDUSTRIAL DEVELOPMENTS

### Recycling costs

For recycling service fees, there are a few elements of costs involved:

i. Container rental fee	This is the monthly fee charged by the contractor for rental of recycling receptacles (e.g. open top container, bulk bins).
ii. Haulage charge	This is the fee charged by the contractor for collecting and transporting recyclables to a Materials Recovery Facility (MRF) or to other recycling companies for further processing.
iii. Processing fee	This is the fee charged by the MRF or recycling companies for sorting, baling and processing the recyclables.



There is market value for recyclables when they are sorted and sold to traders or recycling plants. Companies may consider bundling waste and recycling collection services to reap cost savings from the reduced amount of refuse. If the value of the processed recyclables (revenue) is greater than the total cost of (i) to (iii), it is likely that the contractor will be able to offset part of the cost. If the total cost is higher than the revenue, the contractor will charge a fee for the recycling programme.

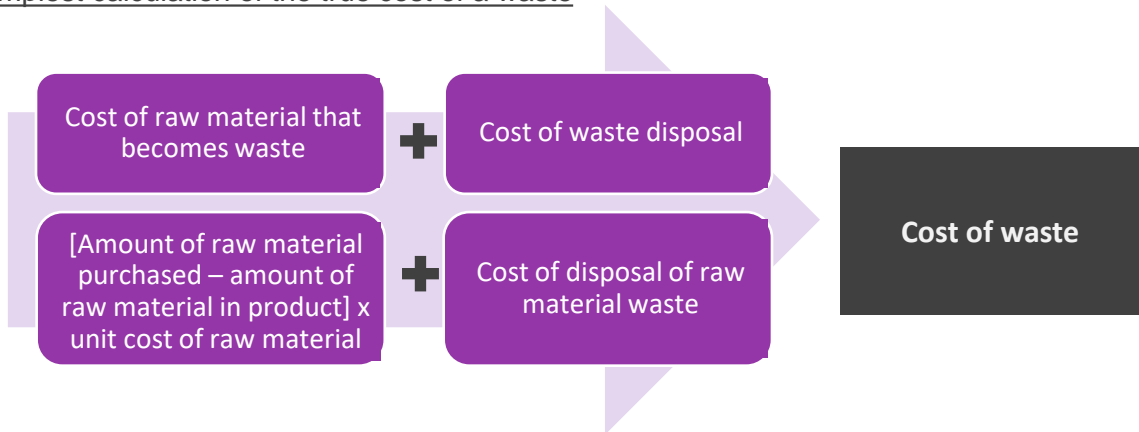
If your company does not generate many recyclables, sharing of recycling and disposal services with nearby tenants may help reduce the service cost.

CHAPTER 3(B): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR TENANTS OF INDUSTRIAL DEVELOPMENTS

Associated costs

The true cost of waste goes beyond its disposal cost. In its simplest form, the cost of raw material in the waste and the cost of disposal should be included. Where more than one material is in the waste, the calculation should be made for each component.

Simplest calculation of the true cost of a waste



In reality, any business process involves the use of many resources on top of the raw materials. Hence, all the associated costs contributing to the true cost of waste should be calculated, and can include the following:

Associated costs	Examples
Raw materials costs	<ul style="list-style-type: none"><li>• Raw materials that exceed the shelf-life</li><li>• Raw material lost before it gets to the production process</li><li>• Raw material in the rejects</li></ul>
Manpower costs	<ul style="list-style-type: none"><li>• Operating labour and supervision</li><li>• Maintenance work</li><li>• Material handling</li><li>• Inspection</li><li>• Record keeping</li><li>• Training</li></ul>
Utilities costs	<ul style="list-style-type: none"><li>• Electricity</li><li>• Water</li><li>• Steam</li><li>• Refrigeration</li><li>• Fuel</li><li>• Sewerage</li></ul>
Equipment depreciation	
Loss of revenue	<ul style="list-style-type: none"><li>• Downgraded product</li><li>• Seconds</li><li>• Off-standard rejects that cannot be sold</li></ul>
Cost of waste handling	<ul style="list-style-type: none"><li>• Storage</li><li>• Internal transport</li><li>• Managing waste-disposal contractors</li></ul>

## CHAPTER 3(B): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR TENANTS OF INDUSTRIAL DEVELOPMENTS

In summary, the true cost of waste should include all associated waste and the disposal costs.



### Step 6: Assess the scope of savings and rank the options

Having generated options to minimise waste, the next step is to assess their feasibility and savings. Then rank and decide on the options that can be implemented.

#### (a) Technical assessment

Conduct a technical assessment to determine whether a proposed option will work, and whether there are facility constraints or product requirements which will make it technically unwise to implement. The completed technical assessment should be reviewed by all affected departments of the company.

In assessing the options, the following questions can be asked:

- Does the proposed option of equipment or technology change have a good track record in the market? If not, is there evidence that the option will work?
- Is the option compatible with the manufacturing process?
- Does the change maintain product quality requirements?
- Does the change meet shipping or packing criteria to protect the products from damage?
- Is the option appropriate to the problem (e.g. installing automatic controls when a simple change to operating procedures would be just as effective)?
- Who can implement this? (i.e. Is external help needed or can it be done in-house?)
- When can it be implemented? Some solutions may take longer than others to come to fruition.

Any options that are deemed technically feasible will require economic assessment.



## CHAPTER 3(B): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR TENANTS OF INDUSTRIAL DEVELOPMENTS

### (b) Economic assessment

An economic assessment of a potential solution includes:

- one-off cost of implementation (i.e. capital investment, cost of design, testing and implementation);
- ongoing cost of operating or maintaining the solution (i.e. running costs, maintenance costs);
- savings from the associated costs (i.e. raw material cost and other relevant costs listed in step 5) and disposal costs;

In many cases, a simple payback calculation is sufficient to assess the economic feasibility of an option or to identify an optimum option.

### Calculating payback

The payback can be calculated by dividing the project's total one-off cost by the net savings (the difference between savings and operating & maintenance costs). This gives a payback figure in years.

In some cases, more in-depth assessment methods may be required. These could include undiscounted and discounted financial analysis. You can approach your company accountant for assistance in calculating cost and benefit.

### (c) Other considerations

Other factors to consider include:

- How much waste can be reduced through the proposed solution?
- Does the proposed solution bring about the lowest environmental burden or impact compared with other solutions (e.g. a solution that reduces or eliminates waste is better than one which identifies a recycling route for the waste)?
- Will the change create problems in other environmental areas (e.g. the decrease of solid waste increases liquid waste or hazardous waste)?

The overall assessment based on the technical and economic assessments, and considerations of the factors above should lead to the final ranking of the most feasible options for reduction of waste streams.

## CHAPTER 3(B): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR TENANTS OF INDUSTRIAL DEVELOPMENTS

### Step 7: Develop the 3R programme

The 3R team can develop a 3R programme that covers the following:

- Identify targeted waste types for waste reduction, reuse and recycling,
- Set out details of the proposed 3R initiatives for targeted waste types,
- Estimate costs and/or cost savings involved,
- Estimate quantity of waste to be reduced (i.e. kg) for each waste type,
- Implement a schedule for the proposed solutions (steps/phases and timing of implementation)
- Implement requirements, such as equipment, tasks and manpower,
- Provide training of personnel involved,
- Determine measurable performance indicators and targets, such as waste reduction or recycling rate,
- Set a timeline for achieving the targets

A summary table of the 3R programme, similar to the one below, can be created.

Location	Waste Type	Proposed 3R Measure <sup>1</sup>	3R Goal <sup>2</sup>	Estimated Costs/Savings	Estimated Payback Period <sup>3</sup>	Start Date	End Date	Status

1. Proposed 3R measure: Measures to reduce, reuse or recycle waste.  
 2. 3R goal: Estimated amount of waste to be reduced, reused or recycled through the proposed 3R measure/s.  
 3. Estimated payback period: Calculated by dividing the total one-off cost of the project by the net saving of the project (the difference between savings and operating & maintenance costs). This gives a payback figure in years.

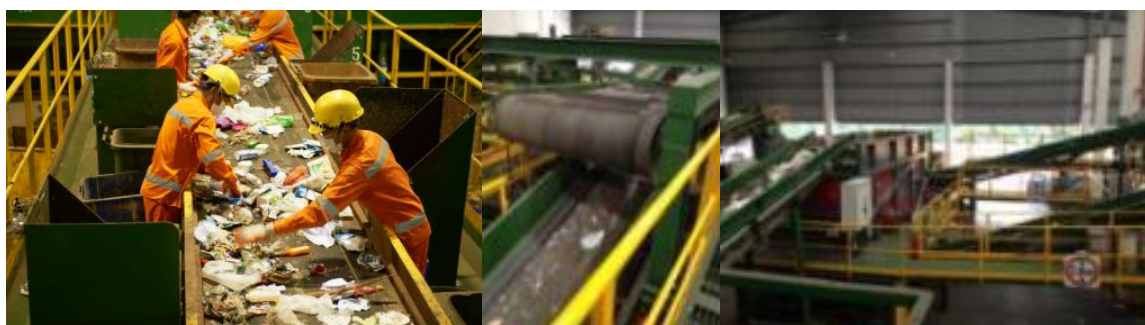
## CHAPTER 3(B): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR TENANTS OF INDUSTRIAL DEVELOPMENTS

### Segregated or commingled recycling bins

Non-industrial recyclables (that are usually generated in smaller quantities) can be collected in segregated or commingled recycling bins, depending on the collection method of the recycling service provider.

**Segregated recycling bins** can be provided for different types of materials such as paper, plastics and metal. Please ensure that the cleaners do not mix the segregated recyclables during collection. While segregated recyclables might result in higher collection costs, the value of properly sorted recyclables is also generally higher.

**In a commingled recycling system**, all recyclable materials are mixed and stored together. Please ensure that the cleaners do not mix the recyclables with general waste during collection. Commingled recyclables are sent to a Materials Recovery Facility (MRF) where they are sorted and baled for recycling. This system requires fewer recycling bins, and hence occupies less space.



Process of sorting out recyclables at a Materials Recovery Facility

### Other types of waste

For **used wooden pallets**, the 3R/purchasing team can work with suppliers to take back the pallets for reuse/recycling.

**Horticultural waste** produced from landscaping activities would be removed by the landscape contractor for recycling, or it could be composted on site.

## CHAPTER 3(B): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR TENANTS OF INDUSTRIAL DEVELOPMENTS

### Considerations for scheduling the implementation

Packaging usually provides the easiest waste reduction opportunities and thus the greatest potential for savings.

Options which do not involve equipment change, are inexpensive and quick to implement like operation procedural changes or material changes should be implemented as soon as possible.

Options that have shorter payback period and/or produce greater savings can be scheduled for early implementation as well.

Waste minimisation plans that call for equipment changes, will include planning, design, procurement, construction or installation. They should be implemented at a later stage when resources and manpower are available.

### Establishment of goals & measurement of indicators

To measure the success of the waste minimisation plan, numeric performance goals need to be established. Waste reduction should be measured in tonnes or kilograms of waste generated per standard unit of production.

The following are some measurements for setting waste and cost reduction goals:

- Ratio of waste generated to production rate, before and after implementation of the option
- Ratio\* of raw materials consumed to production rate, before and after implementation (an indirect measure of waste reduction)
- Savings on raw materials costs and waste disposal costs
- Changes in utilities and maintenance costs
- Changes in manpower and other associated costs
- Changes in production capacity and product quality
- The programme's actual costs and savings compared with the initial estimates

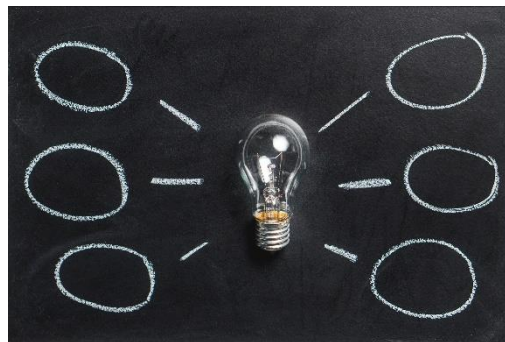
\*Obtaining quality data for waste stream volume, flow, and composition can be costly and time-consuming. Thus, expressing waste reduction indirectly in terms of the “ratio of input materials consumption to production rate” may be more practical. These data are easier to obtain although the measure is not direct.

If the establishment of numeric performance goals is not practical, include a clearly stated list of actions in the waste minimisation plan.

## CHAPTER 3(B): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR TENANTS OF INDUSTRIAL DEVELOPMENTS

Ensure that the goals are:

- Understandable;
- Acceptable to those who will work to achieve them;
- Flexible to adapt to changing requirements;
- Measurable over time;
- Suitable to the overall corporate goals; and
- Achievable with a practicable level of effort.



### Step 8: Monitor, evaluate and improve the 3R programme

For successful implementation of the 3R programme, the following are necessary:

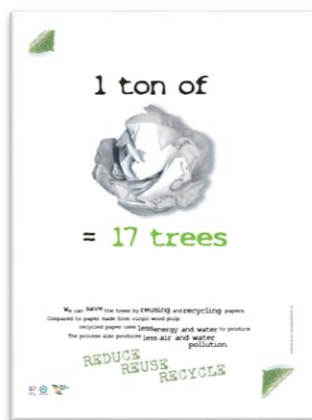
#### Responsibilities and resources

Be clear about the goals and objectives of the programme. Assign responsibility and authority to appropriate personnel in the administrative, operating and maintenance areas. Make the right resources available, and ensure that the personnel take implementation actions according to schedule.

#### Education and promotion

Before launching the programme, the recycling initiatives should be effectively communicated and promoted to staff.

A checklist for developing and maintaining a 3R programme can be found in the Appendix.



3R posters are available at NEA's Customer Service Centre at the Environment Building, for use at your premises.

Softcopies are also available [here](#).



Educational 3R posters can be placed at strategic locations to raise awareness



## CHAPTER 3(B): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR TENANTS OF INDUSTRIAL DEVELOPMENTS

### Communication of the 3R programme

A meeting should be arranged with staff to explain and elaborate on the details of the 3R programme, and to engage them to align their waste management with the waste management policy of the industrial development.

Training sessions should be organised for staff who will be involved in operationalising the 3R programme. Ensure that they understand their roles and take their feedback into account.

#### **Staff:**

- Conduct briefing to all staff on 3R initiatives and how they can participate (e.g. 3R tips, locations of recycling receptacles, how not to contaminate the recyclables, etc.). For new staff, this should be part of the orientation programme.
- Circulate the environmental policy to staff.
- Organise visits to waste management facilities (e.g. waste-to-energy plants, Semakau Landfill) as part of 3R outreach to staff.

More information on visits to waste management facilities can be found [here](#).



- Make the 3R programme (implementation schedule with goals, 3R tips) easily accessible through the intranet, emails or via notices/posters at prominent staff locations.
- Display reminder notices at strategic locations, e.g. poster to reduce paper waste at printing or photocopying room, poster to reduce food waste at staff canteen.
- Share and update 3R initiatives and waste reduction results periodically with staff.

#### **Cleaners:**

- Educate new cleaning staff on the 3R programme and the need to segregate recyclables from general waste.
- Engage the industrial development's cleaners periodically on the need to properly segregate the recyclables from general waste during their collection rounds.



Left to right: Bins for general waste, recyclables and food waste

## CHAPTER 3(B): A STEP-BY-STEP GUIDE TO IMPLEMENTING A 3R PROGRAMME – FOR TENANTS OF INDUSTRIAL DEVELOPMENTS

### Promotion of the 3R programme

Send memos from the management to the staff, announcing the programme and requesting their full participation. The memos should highlight the benefits of the 3R programme and explain the procedures that will be implemented/changed.

The goals, plans and implementation timeline of the 3R programme should be displayed prominently in staff offices. Regular updates on the progress of the programme should also be communicated to the staff.

To ensure a sustainable programme, the 3R team should:

- make all implemented measures a part of the company's standard operating procedures;
- Conduct 3R training sessions for staff
- make on-going product development improvements.

The 3R team needs to monitor waste reduction performance against the goals established and conduct annual reviews. During the process, additional waste reduction opportunities might arise. More action might be needed or different methods might become available.

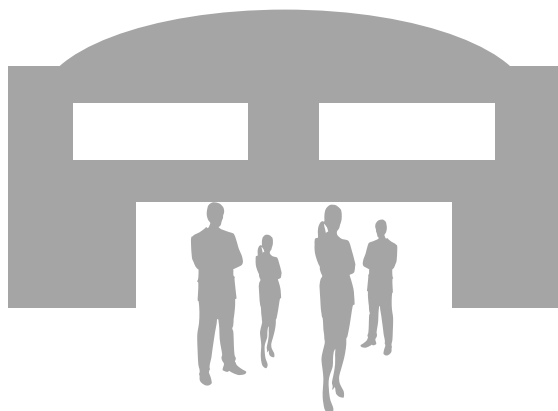
As such, the 3R team needs to:

- make changes to the planned actions and adjust operating procedures,
- incorporate new options or methods,
- establish new priorities for action, and
- set reviewed waste reduction goals, ideally upwards.

By following the steps in this guidebook, your company can achieve sizeable cost savings and waste reductions, and help Singapore move a step closer to becoming a Zero Waste Nation.



## CHAPTER 4: MANDATORY WASTE REPORTING FOR INDUSTRIAL PREMISES



### Mandatory Waste Reporting (MWR) for Large Commercial Premises

From 2020, factories with more than 20,000 sqm of Gross Floor Area (GFA) and warehouses with more than 50,000 sqm of GFA are required under the Environmental Public Health Act to submit waste data and a waste reduction plan on an annual basis.

The mandatory reporting requirement aims to better draw and sustain greater management attention to the amount of waste produced by the premises, and help build greater awareness of the potential for improving their waste management systems.

### Method of Data Collection

Industrial premises can engage their waste/recyclables collectors to provide waste and recyclables tonnages.

More information on MWR can be found [here](#).

## APPENDIX

### CHECKLIST

#### STEP 1: REVIEW THE CURRENT SYSTEM

CHECK	NOTES
<input type="checkbox"/> Establish the location boundaries of the project and tenants involved	
<input type="checkbox"/> Review the current waste collection arrangement <ul style="list-style-type: none"> <li>- Are there existing systems (e.g. efforts to educate cleaners/tenants/staff or infrastructure) to handle waste properly?</li> <li>- What elements in the current waste collection arrangement can be revised to increase effectiveness and efficiency?</li> </ul>	
<input type="checkbox"/> Determine the types of waste to be recycled	
<input type="checkbox"/> Conduct waste audit	
<input type="checkbox"/> Types and locations of current rubbish/recycling receptacles	
<input type="checkbox"/> Feedback from tenants, cleaners and waste contractors on the current waste collection arrangement	

#### STEP 2: DESIGN A NEW SYSTEM

CHECK	NOTES
<input type="checkbox"/> Draw up a detailed project plan <ul style="list-style-type: none"> <li>- How will operational procedures be revised or developed to cater for the planned 3R programme?</li> </ul>	
<input type="checkbox"/> Are tenants, cleaners and waste collection contractors involved in the proposed 3R programme? <input type="checkbox"/> Are tenants given an incentive to reduce/reuse/recycle their waste? <input type="checkbox"/> Does the management give their full support for the planned 3R programme?	
<input type="checkbox"/> Set targets and objectives	
Deployment of recycling receptacles: <ul style="list-style-type: none"> <li><input type="checkbox"/> Placement</li> <li><input type="checkbox"/> Label</li> <li><input type="checkbox"/> Volume</li> <li><input type="checkbox"/> Number</li> <li><input type="checkbox"/> Collection frequency</li> </ul>	
<input type="checkbox"/> Continued cooperation between bin supplier, waste collection contractor and tenants	

## APPENDIX

### CHECKLIST

#### STEP 3: IMPLEMENTING THE SYSTEM

CHECK	NOTES
<input type="checkbox"/> Develop a communications plan <ul style="list-style-type: none"> <li>- Have the priorities been identified for the target audience?</li> <li>- What are the messages to be communicated?</li> </ul>	
<input type="checkbox"/> Understanding by tenants, cleaners and waste contractors of their roles and responsibilities in executing the 3R programme	
Promotion of the new infrastructure through: <ul style="list-style-type: none"> <li><input type="checkbox"/> Website</li> <li><input type="checkbox"/> Email</li> <li><input type="checkbox"/> Posters</li> </ul>	

#### STEP 4: MONITORING AND MAINTAINING THE NEW SYSTEM

CHECK	NOTES
<input type="checkbox"/> Review the implemented 3R programme <ul style="list-style-type: none"> <li>- Have the waste reduction and recycling objective and targets been met?</li> <li>- Do the contracts with tenants, cleaners and waste recyclables collectors meet the expectations for monitoring and reporting waste and recyclables?</li> </ul>	
<input type="checkbox"/> Waste and recyclables reporting system in place	
<input type="checkbox"/> Conduct waste audit after implementation of the 3R programme	
<input type="checkbox"/> Regular maintenance of the recycling bins	
<input type="checkbox"/> Training of new staff and retraining of existing ones	
<input type="checkbox"/> Provide an open channel for communication and feedback among all stakeholders	

## For More Information

More information can be found at:



- <https://www.nea.gov.sg/our-services/waste-management/overview>
- this QR code

Locations of collection points for electronic waste and Cash-for-Trash stations – where recyclables can be exchanged for cash and food distribution organisations can be viewed at the following websites:

- Electronic waste [here](#)
- Cash-for-Trash stations and other recycling/collection points [here](#)
- Food Distribution Organisations, Local Recycling Facilities and Suppliers [here](#)

