ZERO WASTE CITY

The case for a deposit scheme in Singapore

Overview of the Norwegian Deposit Scheme and a comparison with Singapore

8th March 2019
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Zero Waste City combines engineering techniques with traditional financial analysis tools to help companies identifying and implementing zero waste practices to save costs and reduce waste. For further information, please visit our website at https://zerowastecity.com/

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ZERO WASTE CITY

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INFINITUM

Origin of this analysis

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SUSTAINABLE DEVELOPMENT GOALS

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

TOWARDS ZERO WASTE

This document aims to contribute to the discussion around strategies and technologies that could be implemented in Singapore and beyond to achieve Zero Waste goals. Worldwide, at least 23 countries have legislation about Container Deposit Schemes. This study focuses exclusively on the Norwegian scheme.

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1. Introduction

Plastic waste is a growing concern worldwide. Recent publications and reports have highlighted the significant risk related to the mismanagement of plastic for the environment, human health, and the communities. Also, the growing demand for plastic along with the depletion of resources raise concerns about the sustainability of the current modes of consumption.

It was estimated that, up to 2015, 6.3 billion metric tonnes of plastic waste had been generated worldwide. Around 9% of which was recycled, 12% was incinerated, and 79% was accumulated in landfills or the natural environment.[1]

These figures are representative of some of the challenges faced for the recovery of plastic:

- Low return rate: unlike other materials, used plastics historically had a low value, and little incentive was given for returning used plastic.
- Difficult segregation of materials: plastics cover a wide range of materials with similar chemical or physical properties making the segregation of plastic difficult.
- High level of contamination: plastic recovered from household waste streams is often combined with other materials or contaminated with organic matter making the separation and recycling difficult.

Among the many initiatives which have been implemented worldwide for the collection and the recycling of plastic waste, Norway is often mentioned as the best example. Implemented in 1999, the Container Deposit Return (CDR) scheme is considered as one of the most efficient and cost-effective systems. In 2017, the return rate of PET bottles (bottles returned to the outlet versus bottles sold) was at 86.1%.[2]

This document highlights the main principles and results of the Norwegian Container Deposit Return scheme and investigates how a similar scheme could be applied in Singapore.

Figure 1 - Example of a plastic bottle displaying the deposit label (NOK 1) being returned at an RVM[3]

[1] Roland Geyer, Jenna R, Jambeck, and Kara Lavender Law, Science Advances, 19th July 2017, Vol. 3, no. 7, e1700782, DOI: 10.1126/sciadv.1700782, http://advances.sciencemag.org/content/3/7/e1700782.full

[2] Infinitum Annual Report 2017, last accessed on 20th February 2019, https://infinitum.no/file/26/2d440b111f18545a2ed4f82600702f2f/Infinitum_annual_report_2017_Pages.pdf

[3] "Ny pantesats for første gang på over 25 år", published on 1st September 2018, by NRK, last accessed on 20th February 2019 https://www.nrk.no/norge/ny-pantesats-for-forste-gang-pa-over-25-ar-1.14190457

2. Deposit Scheme in Norway

1. Overview

Approved in 1995, the Norwegian deposit-return scheme was a response to the growing environmental concerns related to the use of plastic bottles and aluminium cans for beverages. The primary objective of the scheme was to reduce littering while implementing the most cost-effective approach to managing plastic waste from beverage consumption.

The scheme is based on the principle that the beverage producer or importer of the goods is 100% responsible for the management of the discards resulting in the consumption of its products.

The scheme has three main rules:

1. All plastic bottles and aluminium cans have a deposit value determined by the government.
2. All outlets selling a product with a deposit value must accept to take back the empties and pay the deposit in cash.
3. An environmental tax applies on all producers and importers for each plastic bottles or aluminium cans they sell. The value of this environmental tax decreases if the recycling rate of the plastic bottles or aluminium cans increases.

The operational management of the scheme is done by the private sector which has to report to the Norwegian Environment Agency. The Norwegian Environment Agency then validates the recycling rate achieved and the value of the environmental tax that will be applied to the different producers and importers.

To improve the efficiency and reduce the costs, most producers and importers are members of a non-profit organisation, Infinitum, which organises the collection and the recycling of the bottles and cans.

1. Rule #1: The deposit value (consumers)

The value of the deposit rates on the plastic bottles and aluminium cans are determined by the government in the Waste Regulations.[4]

The intent of the deposit is to incentivise the consumer to return the empties so they can be processed and recycled through a dedicated waste management system.

Table 1 - Value of the deposit on the packaging[5]

Nominal volume of primary packaging	After 1st September 2018	Before 1st September 2018
Up to and including 50 cl	2.00 NOK (S$0.32)	1.00 NOK (S$0.16)
Over 50 cl	3.00 NOK (S$0.48)	2.50 NOK (S$0.40)

2. Rule #2: The take-back policy (outlets)

Any outlets selling a product with a deposit mark must accept to take back the empties and pay the deposit in cash (Waste Regulations, Chapter 6, Section 7).[4]

This rule intends to ease the ability of consumers to return their empties to any shops.

[4] Unofficial translation of Chapter 6 of the Waste Regulation, Take-back systems for beverage packaging from the Norwegian Environment Agency, last accessed on 20th February 2019 http://www.miljodirektoratet.no/en/Legislation1/Regulations/Waste-Regulations/Chapter-6/

[5] Singaporean Dollar Conversion based on average rate in December 2018 https://www.norges-bank.no/en/Statistics/exchange_rates/currency/SGD

3. Rule #3: The environmental tax (producers and importers)

An environmental tax applies on all producers and importers of plastic bottles and aluminium cans selling products in Norway. The value of this tax is determined by the government:

- 3.55 NOK per plastic bottles (S$0.57)
- 5.88 NOK per aluminium cans (S$0.94)

Individually or collectively, the producers and importers must report on the recovery rate of their products. The value of the environmental tax decreases if the recovery rate of the plastic bottles or aluminium cans increases as illustrated in Figure 2. Note that a requirement for approval is that the take-back system achieves a minimum recovery rate of 25 % (Waste Regulations, Chapter 6, Section 4).[4] Beyond 95% recycling rate, the environmental tax ceases to exist.

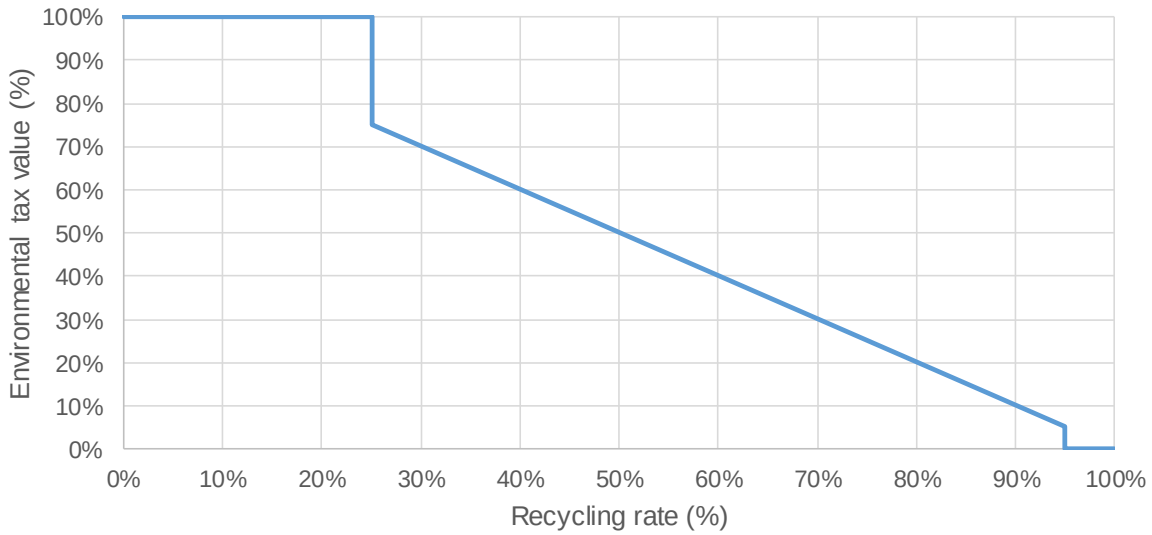

Figure 2 - Value of the environmental tax based on the recovery rate

This tax intends to incentivise the producers and importers to recover and recycle their bottles and cans.

4. Infinitum

Founded in 1996, Infinitum (originally Norsk Resirk), monitor, collect, recycle, and report on the CDR scheme. Infinitum is a non-profit organisation and is equally owned by retailers and producers through their industry associations.

Infinitum partners with retailers for the collection of bottles. The bottles might be collected either manually or through reverse-vending machines (RVMs).

2. Timeline

Below are some of the key dates for the Norwegian deposit scheme:

- 1902: A container deposit scheme is implemented in Norway and applies to the glass bottles.
- 1980s: The industry expresses interest in having recyclable disposable packaging that can be compressed upon return.
- 1989-1996: Investigation and analysis to start a take-back system for plastic containers.
- 1995: The Norwegian Pollution Control Authority (today the Norwegian Environment Agency) approves the deposit scheme.
- 11th November 1996: The company Norsk Resirk is founded to operate the national recycling scheme for beverage packaging in aluminium, steel and plastic. The retailing and manufacturing industries are equal owners of Norsk Resirk, through their respective organisations.
- 1999: Infinitum's deposit system for beverage cans and recycling bottles is established. The system is open to everyone.
- April 2000: The first recycling bottles enter into the Infinitum system.
- 2010: The deposit scheme celebrates its 10th anniversary.
- 2012: The environmental tax on both recycling bottles and cans disappears, after the Climate and Pollution Agency (currently the Norwegian Environment Agency) confirmed that the return rate had reached 95%.
- 2014: Norsk Resirk A/S becomes Infinitum A/S

Figure 3 shows the evolution of the total number of items collected by Infinitum. This growth is the result of a higher return rate and new producers and importers joining the scheme.

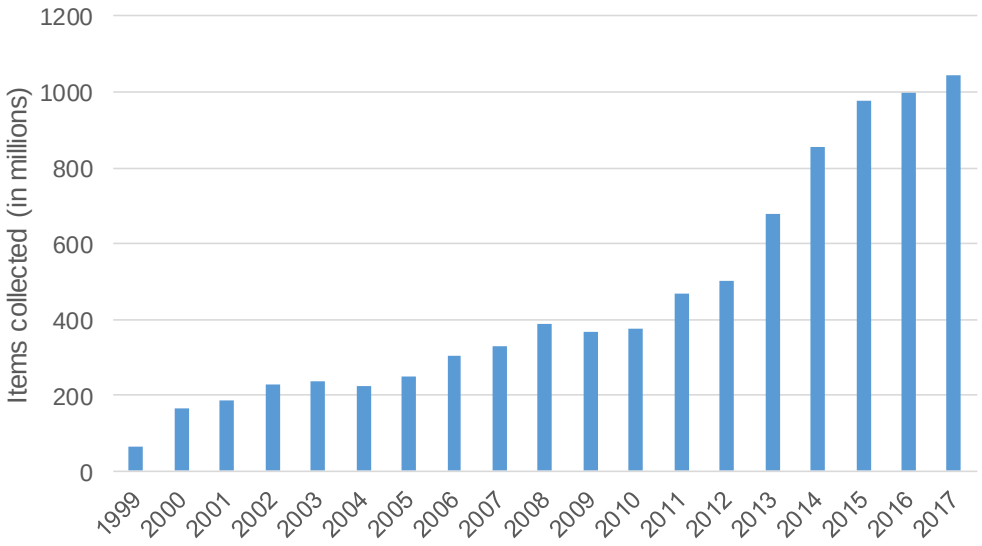

Figure 3 – Total number of items collected by Infinitum (bottles and cans) from 1999 to 2017

3. Material and cash flow

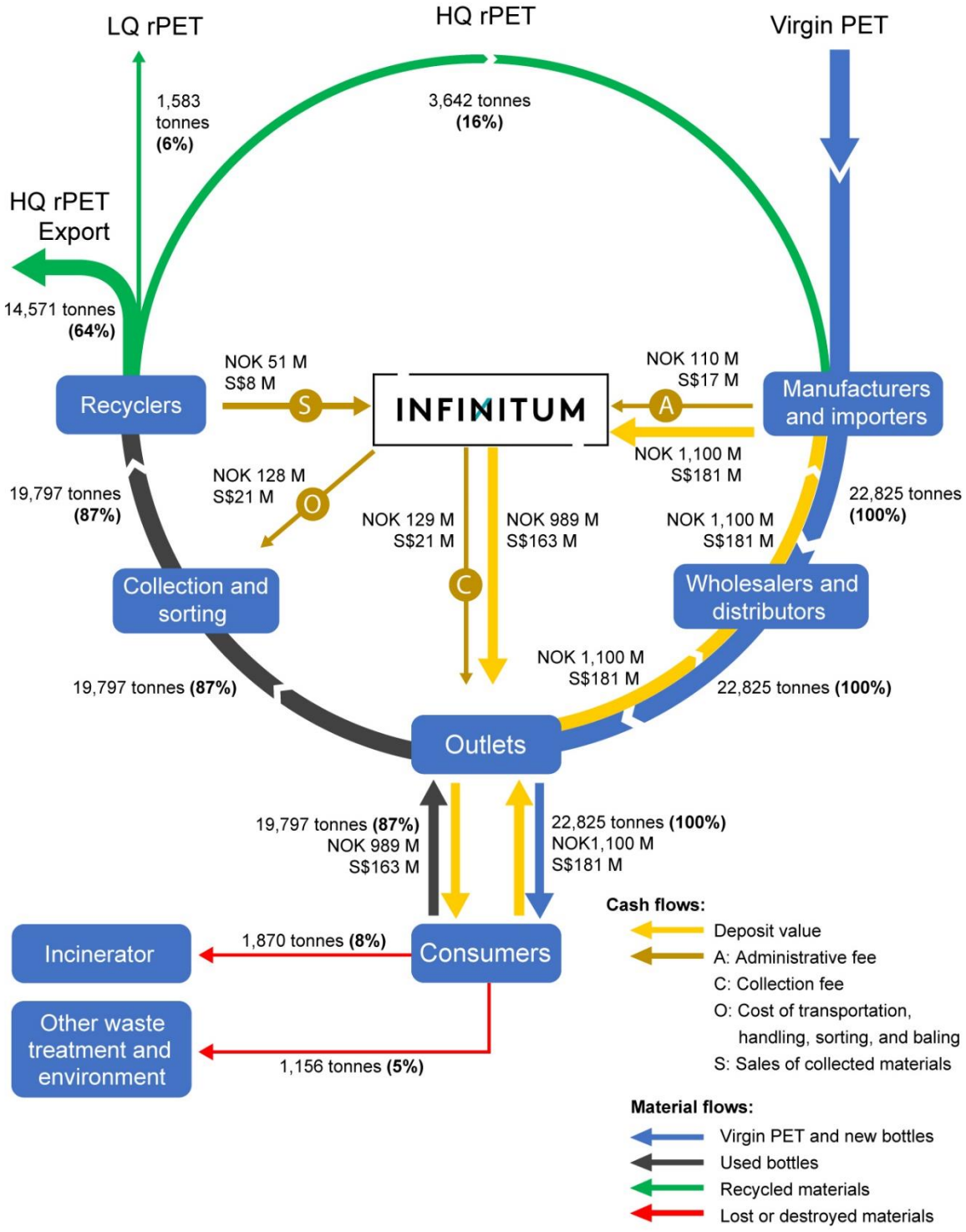

Figure 4 – Material and cash flows for the PET bottles (calendar year 2016)[6]

Figure 4 illustrates the material and cash flows related to the management of the plastic bottles in the deposit scheme.

[6] Infinitum Annual Report 2016, last accessed on 6th January 2019, https://infinitum.no/arsmelding-vis/22/06d586916b14fecacb6580135fd2b7f7/ENG_Infinitum_a%CC%8Arsrapport_WEB.pdf

4. Responsibilities

1. Manufacturers and importers

To be a member of the deposit scheme, the plastic bottles sold in Norway must meet strict technical requirements as illustrated in Figure 8 (page 22). This approach ensures that the different components of the bottles can be easily segregated and then recycled.

For each product sold to the wholesalers and distributor, the manufacturers and importers pay the relevant deposit value to Infinitum.

In addition, as part of their responsibility to manage the discards related to the consumption of their plastic bottles, manufacturers and importers pay an administrative fee to Infinitum which contribute to the costs of collection, sorting, and recycling of the materials.

2. Wholesalers and distributors

The wholesalers and distributors pay the deposit value of the products and pass on the cost to the outlets.

3. Outlets

Like the wholesalers and distributors, the outlets pay the deposit value of the products and pass on the cost to the consumers.

When a consumer returns their empties, the outlet pays the relevant deposit fee back to the consumer.

Once an outlet receives empties from consumers, it will store them in bags. The bags are then picked up by Infinitum and sent to the sorting facility. Upon collection of the empties (either manually or via the RVM), Infinitum pays the relevant value of the deposit and a handling fee (see Table 2) to the outlet.

Table 2 - Handling fees per container (1st February 2016)

Collection type	Aluminium cans	Plastic bottles
RVM with compaction	NOK 0.20 (S$0.032)	NOK 0.25 (S$0.040)
RVM without compaction and manual collection	NOK 0.05 (S$0.008)	NOK 0.10 (S$0.016)

4. Consumers

The introduction of a deposit scheme tends to shift the perspective of the consumers on the products, from ownership to rental. It is the responsibility of the consumer to return the product after use.

In 2016, 86.7% of all plastic bottles were returned to outlets and processed in the recycling facilities. For the plastic bottles which were not returned to the outlets, waste composition study (which are conducted every year) calculated that:

- 8.2% of the bottles were incinerated,
- 0.2% of the bottles were collected in alternative waste collection facilities
- 4.8% of the bottles were either discarded in the environment or collected in other waste disposal systems.

Marketing campaigns led by Infinitum, supports from the industry officials, and an increase of the deposit value are tools which are used to promote the value and benefits of the deposit scheme.

5. Recyclers

The implementation of strict rules regarding the manufacturing of the bottles, allow recyclers to separate the different materials more efficiently and to produce a high-quality plastic resin which can then be used to make bottles again.

As shown in Figure 4, the outputs of the recycling process are approximately:

- 8% of the plastic bottles is transformed into a low-quality recycled PET (LQ rPET),
- 74% of the recycled PET is exported and,
- 18% is used directly in Norway.

The main reason for such a low percentage of rPET used in Norway is the lower price of vPET (virgin PET) versus rPET (recycled PET).

6. Infinitum

As the scheme administrator, the role of Infinitum is to run and operate the scheme in the most cost-effective and most environmentally sustainable way possible. Also, Infinitum reports to the regulatory body on the performances of the scheme.

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5. Benefits of the scheme

1. Producer and importer

Cost-effectiveness
Although taking the responsibility of the management of the discards adds a cost to the businesses, the deposit system has proven to be the cheapest solution to collect empties and maximise the recovery of the materials to make new bottles.

Marketing
Companies and producers which are members of Infinitum show to the consumers:

- a clear commitment to reducing their environmental footprint,
- the production of high-quality containers, and
- a guarantee that the container can be returned and recycled into new bottles.

2. Outlets

Although the collection of bottles can take time and space, the use of reverse-vending machine tends to increase the traffic in shops from the people returning their bottles.

3. Communities

For communities, the CDR scheme has three major advantages:

- Reduction of cost from the management of waste: all the bottles and cans are managed in a dedicated recycling chain instead of being mixed with other recyclables.
- Create jobs: the collection, transportation, and processing of bottles create jobs which cannot be outsourced.
- Cleaner environment from a reduction in littering.

4. Environment

A comprehensive life cycle analysis (LCA) was conducted to estimate the carbon emissions related to the operations of the CDR Scheme. This study compares the Infinitum system with other waste management strategies: recycling from kerbside collection and incineration.[7]

The study shows that making bottles from virgin PET is the most carbon-intensive part of the life cycle. The carbon emissions related to the making of bottles are:

- 112 kg CO2-eq/functional unit when using 100% virgin PET, and
- 3.4 kg CO2-eq/functional unit when using 100% recycled PET.

Therefore, using recycled PET is 33 times less carbon intensive than using virgin PET.

For all the other environmental indicators assessed (Abiotic Depletion, Acidification and Eutrophication Potential), as well as for littering volumes, the incineration system performs worst. This is mainly due to the assumption that, in the incineration scenario, bottles are made of 100% virgin PET whereas, in the recycling scenario, bottles are made of 80% virgin PET.

Overall, the estimated carbon savings from the Norwegian CDR scheme are 155,000 tonnes of CO_2/year.

[7] LCA of beverage container production, collection and treatment systems, Hanne Lerche Raadal, Ole M. K. Iversen and Ingunn Saur Modahl, Østfoldforskning, 15th September 2016 https://infinitum.no/file/17/988962eef456938f489a304f4da9ac49/LCA%20beverage%20containers_report.pdf and https://www.ostfoldforskning.no/no/publikasjoner/Publication/?id=2010

6. Costs of the scheme

1. Perspective of the producers and importers of plastic bottles

In 2016, the total cost of the deposit scheme for the producers and importers of plastic bottles, members of Infinitum, was NOK 101 M (S$16.6 M). This cost is paid through the administration fee to Infinitum. In comparison, the full environmental tax would have cost NOK 628 M (S$103 M) to the producers and importers.

In other words, the deposit scheme costs NOK 0.16/bottle (S$0.026/bottle), whereas the environmental tax would have cost NOK 3.55/bottle (S$0.57/bottle). Since 2016, improvements have been implemented which reduced further the cost for the producers and importers. In 2018, the deposit scheme cost NOK 0.12/bottle (S$0.020/bottle)

Joining the deposit scheme is approximately 30 times cheaper than the environmental tax.

2. Perspective of Infinitum

The total expenditures for Infinitum to operate the scheme was NOK 257 M (S$42.3 M). Figure 5 shows the overall cost breakdown.

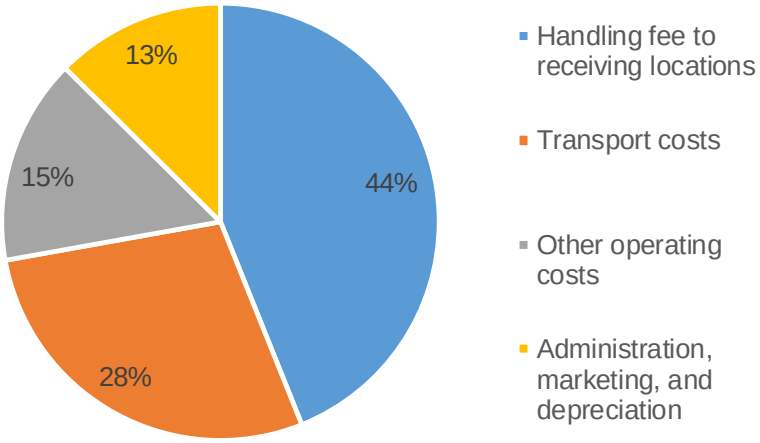


Figure 5 - Operational cost breakdown (calendar year 2016)

The revenue of Infinitum come from:

- the administration fee paid by producers and importers of plastic bottles,
- the sales of materials to recyclers, and
- the unclaimed deposit.

7. Challenges of the scheme

1. Return rate

Although 86.7% return rate for plastic bottles is high, improving it further yields substantial savings in virgin plastic consumption and carbon emissions. The recent increase in the deposit value (see Table 1) is expected to drive an improvement of 2 to 4% of the return rate. This expected improvement is based on the experience in Sweden where the deposit value had increased from SEK 0.5 to SEK 1, leading to a return rate increase of 3.7%.

2. Low cost of virgin PET (vPET)

As illustrated in Figure 4, 80% of the high-quality recycled PET (rPET) is exported instead of being used in Norway. The reason is that, in Norway, vPET is cheaper than rPET. New regulations such as enforcing a minimum percentage of recycled materials in packaging could support the national market for recycled materials and further close the loop on waste.

In his study, Geyer et al. (2015) state that "A robust recycling system must ensure a steady supply of recyclable feedstock and an equal demand for the resulting secondary outputs, but that is not enough. An *environmentally successful* recycling system must also make sure that the secondary resources displace their primary competitors."[8]

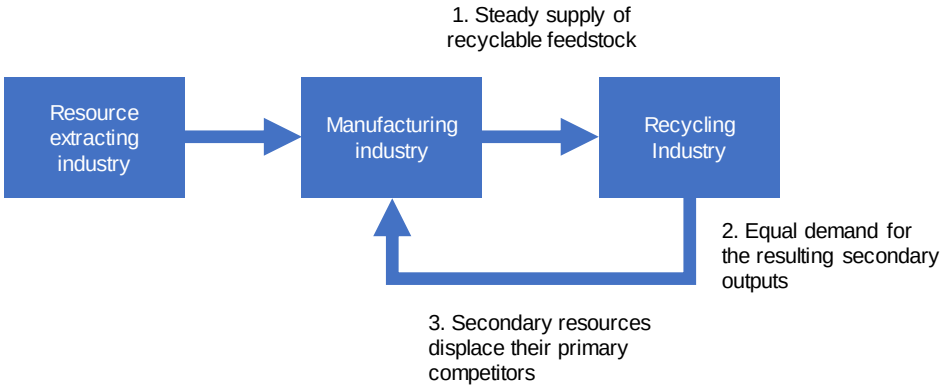


Figure 6 – Simplified representation of a robust and environmentally successful recycling system

The existing Norwegian deposit scheme has successfully fulfilled the conditions 1 and 2 for a robust recycling system. Additional work will be required to fulfil the condition 3 for an environmentally successful recycling system.

8. Future developments

After almost 20 years of operations, the Norwegian deposit scheme is expected to expand its capabilities to other waste streams.

[8] Geyer, R., Kuczenski, B., Zink, T., & Henderson, A. (2015). Common Misconceptions about Recycling. Journal of Industrial Ecology, 20(5), 1010–1017. doi:10.1111/jiec.12355

3. Singapore

1. Key figures

Introduced in 2001, the Singaporean National Recycling Program has ensured that HDBs, landed properties, and some private condominiums are provided with recycling services. Since 2012, the recycling rate from the domestic sector has been stable at around 20%. Although significant successes have been achieved, substantial improvements are still possible: recent articles have highlighted that over 40% of the recyclables sent to the Material Recovery Facilities (MRFs) are directed to the incinerators because of contamination.[9]

In 2017, approximately 815,000 tonnes of plastic waste were generated in Singapore, from which only 51,800 tonnes (6%) were recycled.

These figures illustrate a low return rate and low quality of the recyclables discarded by households.

According to a study conducted by the Singapore Environment Council (SEC), in 2017, 467 million PET bottles were consumed (approximately 83 bottles per inhabitant per year).[10] This represents approximately 17,000 tonnes of plastic, so 2% of the total amount of plastic waste generated.

The rest of this document focuses on these 17,000 tonnes of plastic bottles which could be recovered if a deposit scheme similar to the Norwegian one was implemented.

[9] The afterlife of trash in Singapore, published on 28th November 2018, by Ashley Tan, Eco-Business, https://www.eco-business.com/videos/the-afterlife-of-trash-in-singapore/

[10] Consumer Plastic and Plastic Resource Ecosystem in Singapore, A position paper by the Singapore Environment Council, August 2018, last accessed on 20th February 2019, http://sec.org.sg/seaa/wp-content/uploads/2018/09/SEC-Plastic-Resource-Study-Paper_Final1.pdf

2. Comparison: Norway and Singapore

Table 3 - Comparative table of Norway and Singapore

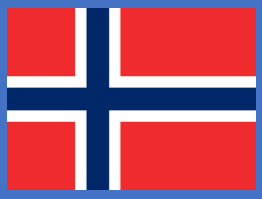
Country	Norway 	Singapore 
Population (2017)	5.258 million	5.612 million
Area **Density**	385,203 km^2 13.6/km^2	721.5 km^2 7,778/km^2
GDP per capita (2018 estimate)	$82,711	$98,014
Recycling rate and Waste generation intensity	39% recycling or composting 59% incineration <2% landfill (2013) 448 kg/capita (2013)[11]	21% recycling or composting 78% incineration <2%landfill (2017) 366 kg/capita (2017)[12]
Annual consumption of plastic bottles	622 million[13]	467 million[14]

Table 3 shows that Norway and Singapore share similarities in terms of total population, overall wealth, and consumption of plastic bottles. However, it is obvious that Singapore is space constraint and is 500 times as densely populated as Norway.

[11] Includes household waste originating from households (i.e. waste generated by the domestic activity of households) and similar waste from small commercial activities, office buildings, institutions such as schools and government buildings, and small businesses that treat or dispose of waste at the same facilities used for municipally collected waste.
[12] Includes only the domestic sector.
[13] Total number of plastic bottles with a deposit value in 2017
[14] Estimation from the 2018 Singapore Environment Council study

3. The Norwegian deposit scheme in Singapore

The Household Recycling Study conducted in January 2013 by the Ministry of the Environment and Water Resources (MEWR) shows that the majority of Singaporean are committed to recycling. Although a deposit scheme was not mentioned in the survey, there was an interest in financial incentives for better recycling.[15]

1. The deposit value

Like Norway, the deposit value could be as follow.

Table 4 - Suggested deposit value in Singapore

Nominal volume of primary packaging	Deposit value
Up to and including 50 cl	S$0.30
Over 50 cl	S$0.50

2. The reverse vending machine

In order to ease the collection of containers, reverse vending machines will be installed. In Norway, there are approximately 3,600 reverse-vending machines (RVM), so 1 RVM for 1,500 inhabitants.

Although, RVM price ranges from $10,000 to $100,000, an experiment led in FairPrice shows that up to 50,000 bottles were collected within 3 months by one RVM.[16] In this experiment, the outlet offers a 50 cent voucher for every five bottles or can recycled.

If the same collection fee was given to outlets installing an RVM with compaction (NOK 0.25, ~S$0.04 per bottle), it would represent a revenue of S$8,000/year for the outlet, in addition to the additional sales resulting in an increase of traffic in the store.

Figure 7 - RVM at Waterway Point's FairPrice Finest outlet[16]

[15] Household Recycling Study, January 2013, by MEWR, last accessed on 15th February 2019 https://www.mewr.gov.sg/docs/default-source/default-document-library/grab-our-research/mewr_rc_report.pdf

[16] "'Reverse vending machine' to encourage recycling launched at Waterway Point", by Raffaella Nathan Charles, Strait Times, published on 9th January 2018, last accessed on 20th February 2019 https://www.straitstimes.com/singapore/reverse-vending-machine-to-encourage-recycling-launched-at-waterway-point

3. The environmental tax

The environmental tax represents the main driver for the deposit scheme in Norway. If the same tax were applied in Singapore, its value would be:

- S$0.57 per plastic bottles
- S$0.94 per aluminium cans

Note that the value of the environmental tax was decided in relation to the specific context of Norway. A deposit system for refillable bottles existed since 1902 and employed a significant workforce. One of the main concerns around the introduction of plastic bottles was the destruction of jobs.

Therefore, the environmental tax had to be high enough so businesses will support a deposit scheme and retain jobs in Norway but not too high so it will be still profitable to switch from glass bottles to plastic bottles.

Singapore has a very different context. Most of the plastic bottles and aluminium cans come from overseas and so the environmental tax will primarily affect importers. An impact assessment will have to be carried out to understand if importers could hold the cost of this tax and how it could be fairly passed over to producers.

Also, to promote a circular economy and ensure that the recycled materials are actually used to make new bottles, regulations around a minimum recycled content in new bottles could be investigated.

4. Infrastructures

In addition to the reverse-vending machines (RVMs), a facility will be required to aggregate the returned bottles. The facility should have a capacity of 17,000 tonnes per year, and will be responsible for:

- sorting the bottles,
- separating the components (main body of the bottle, cap, ring, and label),
- baling the different materials before exporting them to a recycling facility.

The possibility to build such a facility in a land-scarce country like Singapore could be a challenge.

5. Workforce

In comparison to the single stream kerbside collection system, a deposit scheme is more labour intensive as it required infrastructures and a workforce dedicated to the management of a single stream of materials. For instance, we can estimate the required workforce for the collection of plastic bottles from the different points of collection at 45 full-time employees.[17]

In addition, technicians to maintain the RVMs, workers to operate the sorting facility will be also required. A deposit scheme would, therefore, represent a significant job creation opportunity.

[17] Estimation based on:

- 3,600 points of collection in Singapore
- Pickup time (including transport): 30 minutes per point of collection (so 16 pickups per day, 5 days per week)
- One pickup per week per point of collection

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4. Conclusion

Implemented over 20 years ago, the Norwegian deposit scheme has successfully resolved three of the main challenges faced in the recycling of plastic:

- High return rate through the mean of a deposit
- Easy segregation of materials through strict guidelines in the making of plastic bottles
- Low level of contamination through a dedicated system of management of the materials (RVM and sorting facilities)

The key driver for the success of the Norwegian scheme can be attributed to the environmental tax. This tax creates a compelling incentive for producers and importers to take responsibility for the management of the discards resulting in the consumption of their products. The more of their products are recovered, the less expensive is the tax.

This scheme has delivered substantial benefits in Norway such as:

- Maintaining high-quality materials from the recycling process to support the concept of bottle-to-bottle,
- Cost savings in waste management for councils,
- Job creation for the collection and processing of the empties,
- Reduction of carbon emissions,
- Reduction of the extraction of virgin resources,
- Reduction of littering.

Despite their differences, Singapore and Norway share many similarities such as the total population, the overall wealth, and a common ambition to promote sustainable practices. These similarities suggest that a deposit scheme similar to Norway could be successful in Singapore. However, Singapore will face different challenges such as land scarcity for the development of the necessary infrastructures and the implementation of an environmental tax.

Although a deposit scheme does not address the complete spectrum of plastic waste, it could be one of the solutions to address the low recycling rate of the plastic materials in Singapore and a first step before generalising the concept to other types of plastic packaging.

5. Zero Waste City introduction and author credentials

Zero Waste City is a consulting business specialised in waste reduction for commercial and industrial facilities. We help companies in implementing cost-saving Zero Waste practices. The services include waste auditing, process optimisation, project implementation and guidance for the TRUE Zero Waste Certification.

1. Remi Cesaro (Process Eng, CMVP, TRUE Advisor)

Remi Cesaro is a French Process Engineering with six years' experience in the sustainability field covering a wide range of applications such as stormwater management, energy efficiency for industrial and commercial facilities, and waste management. He lived and worked in several countries such as Norway, New Zealand, Australia, and Singapore. He was recently certified as a TRUE Advisor (Total Resource Use Efficiency) by the U.S. Green Building Council. This certification recognises his knowledge in Zero Waste programs and his ability to support businesses to achieve the TRUE Zero Waste certification.

CMVP directory: http://portal.aeecenter.org/custom/cpdirectory/index.cfm
TRUE Advisor directory: https://true.gbci.org/people-directory

Qualifications

- TRUE Advisor (Total Resource Use Efficiency) certification from the U.S. Green Building Council Inc, USA, 2018 (valid until 2021)
- Certified Measurement and Verification Professional (CMVP), by The Association of Energy Engineers, Australia, 2017 (valid until 2021)
- Professional Energy Manager (PEM), by the Institute of Energy Professionals, USA, 2014 (valid until 2021)
- Master Degree, by Phelma - Grenoble Institute of Technology, Grenoble, France, 2009 – 2012, Specialisation in Process Engineering and Electrochemistry for Energy and Environment (EPEE)

Relevant experience

Technical energy audits, Energy-Mass balance and Related services

Manufacturing

- Soda bottling factory
- Meat processing factory
- Brewery
- Milk processing factory
- Timber mill
- Agriculture (dairy farms, piggery, crop growing farm)

Commercial

- Aquatic Centre
- Casino and Resort

Utilities

- Water Treatment Plant
- Wastewater Treatment Plant

Strategic Advice - Industry guides

- Gas Measurement and Monitoring Guide (Australia, NSW, 2015)
- Metering and monitoring guide for aquatic centres (Australia, NSW, 2018, under development)
- Water heating technologies guide for aquatic centre (Australia, NSW, 2018, under development)

Appendix

Technical specifications for PET bottles for the Norwegian deposit scheme

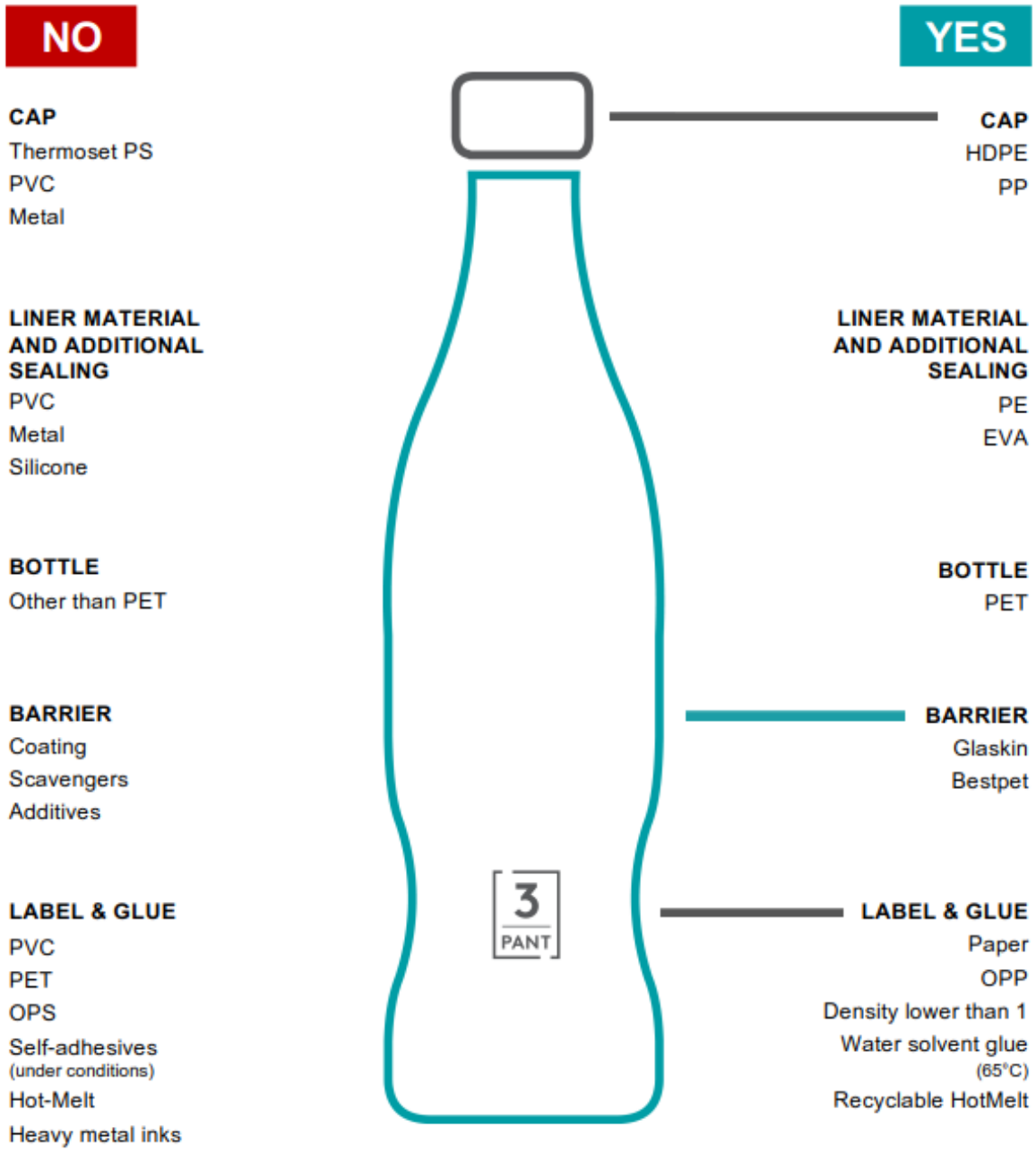

Figure 8 - Technical specifications for PET bottles (none of the NO materials is approved on any part of the bottle)[18]

[18] Technical Data Sheet for PET-bottles entering the Infinitum-system, last accessed on 20th February 2019, https://infinitum.no/file/10/d76f5cbeb26620a83c7cb0293f81bf23/161115_Ny_Tech_Spec.pdf

ZERO WASTE CITY

Glossary

CDR	Container Deposit Return
HDPE	High-density polyethylene
LCA	Life Cycle Analysis
NOK	Norwegian Krone
PET	Polyethylene terephthalate
vPET	Virgin PET
rPET	Recycled PET
RVM	Reverse Vending Machine
SEK	Swedish Krona
SGD	Singapore Dollar