

Estimated cost of not recycling

A report for Container Exchange

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1 Introduction

1. Container Exchange (COEX) has requested CEG to prepare a report on the cost of not recycling (CONR):

COEX is requesting that CEG prepare a report on the cost of not recycling (CONR) beverage containers in Queensland. This estimate will inform COEX's consideration and application of a CONR parameter within its scheme pricing framework (wherein prices by material will reflect a weighted average of COEX's costs for containers that are recycled and the CONR for containers that are not recycled, so that pricing does not unintentionally favour materials with lower recovery rates).

CEG's report should set out an estimate of a reasonable range of the average CONR for beverage containers in Queensland for the purpose of informing the CONR parameter within COEX's pricing formula. This CONR parameter is expressed as cent per container and does not distinguish between the material type of the container.

CEG's estimated range should have regard to:

- a) publicly available cost benefit analysis of beverage container recycling programs; and*
- b) any other relevant evidence.*

We also supply outputs from FY24 financial data that can be used to estimate COEX's cost of recycling to the extent that is relevant to estimating the CONR. These outputs include the payment of a 10-cent refund (GST inclusive) which represents around 43.2% of COEX's costs.

COEX's average cost of recycling for all material types in FY24 was approximately 21.0 cents per container. This can be further broken into an average cost (on a cents per container basis) of 26.8 for liquid paper board, 23.7 for steel, 23.4 for glass, 22.5 for PET, 22.4 for HDPE, 22.1 for other materials and 19.0 for aluminium.

The recycling rate achieved in FY24 was around 67.3% and COEX has a legislated 85% recycling-rate target and estimates that the marginal cost of expanding recovery to achieve that target to be at least 32.0 cents per additional container recovered.

2. This report has been prepared independently by CEG for COEX. The analysis, assumptions, opinions and conclusions expressed in this report are those of CEG. COEX supplied the information identified in the report but did not determine CEG's findings or conclusions.

1.1 Summary of opinion

3. The CONR encompasses factors such as the:
 - a. Costs of landfill that are directly incurred and the environmental costs of landfill;
 - b. Costs of litter in terrestrial and marine environments;
 - c. Costs of additional extraction of virgin resources;
 - d. The foregone employment and innovation benefits of recycling; and
 - e. The foregone value of resources which are unrecovered.
4. The CONR is not directly observable as it represents an aggregation of the economic and environmental costs of not recycling which are spread across society in the present day, plus costs which are transferred to future generations. For example, an exhausted landfill site or marine plastic pollution represents a foregone opportunity and/or a deferred clean-up cost for future generations.

5. Under the proposed pricing approach COEX's prices per container produced would reflect a weighted average of both:
 - a. The costs COEX incurs when containers are recycled; and
 - b. The CONR applied to containers that are not recycled.
6. For example, if the CONR were set at a very high level, prices would be driven almost entirely by the number of containers that are not recovered. In that case, the prices to recover COEX's costs would be the highest for the beverage material types with the lowest recovery rates.¹
7. Recycling provides society a benefit precisely because the cost of recycling is less than the CONR. It follows that, assuming recycling is efficient, the lower bound value of the CONR can be inferred based on the costs of recycling. How much the CONR is above this floor value must be estimated by quantifying the economic and environmental cost components of the CONR.
8. The results of our analysis are summarised below.

Table 1-1: Estimates of CONR (cents per container)

Approach	Range of CONR
Upper bound	
Cost benefit analysis high BCR (2.0) applied to the average cost of recycling all materials (16.5 to 21.0)	32.9 to 42.0
Central estimates	
Marginal cost of recycling	27.5 to 32.0
Cost benefit analysis central BCR (1.4) applied to the average cost of recycling all materials (16.5 to 21.0)	23.0 to 29.4
Highest average cost of recycling by material (LPB)	22.3 to 26.8
Lower bound	
Average cost of recycling all materials	16.5 to 21.0

1.2 Structure of the report

9. The remainder of this report is structured as follows:
 - a. Section 2 explains what the CONR relates to and how the CONR is relevant to COEX's scheme pricing;
 - b. Section 3 describes two approaches to estimate the CONR and estimates a reasonable range of the CONR for beverage containers in Queensland; and
 - c. Section 4 provides a summary of our estimates of the range of the CONR for beverage containers in Queensland.

¹ That is, the level of the CONR determines how much weight is given to containers produced but not recycled, compared with the costs COEX incurs for recycled containers

2 Background of the cost of not recycling

2.1 What are the costs of not recycling

10. The CONR is not a single, easily observed price and is broader than the amount paid to dispose of an empty container. The CONR represents an aggregation of the economic and environmental costs that arise whenever a beverage container is produced but not returned for recycling.² These costs include those which are spread across society in the present day, plus costs which are transferred to future generations. For example, disposing of containers in landfill uses up scarce landfill capacity that would otherwise remain available to future generations, while plastic pollution may impose clean-up and environmental costs either immediately or in future years.
11. Some of these costs are borne directly by government and industry, such as the cost of landfill and litter clean-up. Others are borne more diffusely by the community and the environment, such as the loss of amenity caused by litter, the additional emissions associated with sourcing virgin materials, and any employment, innovation and community benefits that a larger recycling sector would otherwise generate.
12. Australian (NSW, VIC, WA and ACT) and international (New Zealand, United Kingdom, Scotland) cost benefit analyses of container deposit schemes were reviewed for this report (see Table 3-1) and identify a broadly consistent set of costs avoided by recycling. For present purposes, those costs can be grouped as follows:
 - a. The costs of collecting, transporting, processing and disposing of containers as residual waste, including the opportunity cost and environmental externalities of landfill;
 - b. The costs of containers that become litter in terrestrial and marine environments;
 - c. The foregone value of the container material and the additional environmental costs of extracting and processing virgin materials to replace it;
 - d. System-wide costs within waste and recycling markets, including contamination, reduced material quality and the loss of scale, infrastructure, end-market development and innovation that would be supported by higher recycling rates; and
 - e. Foregone non-market and community benefits associated with recycling, including civic participation, social-enterprise opportunities and, in some circumstances, improved employment and social-inclusion outcomes.
13. Appendix A contains a further discussion of the components in these categories. Taken together, the evidence shows that the counterfactual to recycling involves several distinct and material costs. Some of these costs are observed in waste-management expenditure or material prices, while others are externalities borne through reduced amenity, ecosystem damage, emissions, depleted landfill capacity, lost future recycling opportunities and non-market or community effects. No single category needs to account for the whole CONR. The aggregate benefit of recycling is the combined value of avoiding these effects, subject to adjustments for overlap and double counting.

² For example, see Kinnaman, T. C. (2014). Determining the socially optimal recycling rate. *Resources, Conservation and Recycling*, 85, 5–10.

2.2 Why the cost of not recycling is relevant for COEX's scheme pricing

14. We understand that COEX incurs costs to collect, transport and recycle beverage containers in Queensland and sets prices to beverage manufacturers based on the material type used to recover the costs that it incurs.
15. The following simple example illustrates operation of a pricing scheme on the assumption that the cost for COEX to recycle each material type and the CONR is the same for each material type. These simplifying assumptions mean that only the differences by material are the recycling (recovery) rates of each material.
16. If COEX set its prices by material *per container produced* to recover the *cost per container recycled*, materials with higher recovery rates would attract higher prices, because COEX incurs more costs collecting and recycling them. In practical terms, this would make it cheaper for beverage manufacturers to use materials that are recycled less often.
17. Under COEX's proposed pricing approach COEX's prices per container produced would reflect a weighted average of both:
 - a. The costs COEX incurs when containers are recycled; and
 - b. The CONR applied to containers that are not recycled.
18. The higher the CONR relative to the cost of recycling then containers with low recycling rates will pay a higher price than containers with high recycling rates (other things equal). If the CONR were set at a very high level, say tens of dollars per unrecovered container, prices would be driven almost entirely by the number of containers that are not recovered.
19. By contrast, if the CONR were set equal to COEX's cost per recycled container, the resulting price would be the same for all beverage manufacturers, regardless of the material type they use (under the simplifying assumptions in this example). More generally, the relationship depends on how much higher the CONR is than COEX's cost per recycled container.
20. An illustrative example of the scheme pricing is presented in Appendix B.

3 Approaches to estimating the cost of not recycling

21. The CONR can be estimated by quantifying the economic and environmental cost components of the CONR. The individual cost components of the CONR are often quantified in cost benefit analysis studies.
22. Alternatively, the lower bound of the CONR can be inferred based on the efficiently incurred costs of recycling. This is because recycling provides society a benefit precisely because the cost of recycling is less than the CONR. Therefore, the efficient cost of recycling places a floor on the CONR. So long as recycling is efficient, the CONR must exceed the cost of recycling.

3.1 Estimating the cost of not recycling by quantifying the economic and environmental costs

23. Cost benefit analysis is a form of economic assessment that “provides an objective framework for weighing up different impacts and impacts that occur in different periods” through the valuation of “the gains and losses from a proposal in monetary terms”.³
24. The results of a cost benefit analysis study are often summarised using a benefit cost ratio (BCR) which is simply the total benefits divided by the total costs. Therefore, a BCR that is greater than 1 indicates that the benefits exceed the costs.
25. Cost benefit analysis studies of beverage container recycling schemes in other Australian states and internationally provide an estimate of the CONR because the benefits of recycling in these studies are, by definition, the avoided CONR.
26. The BCR of a study is a convenient way to summarise the results from these cost benefit analysis studies in a way that can be used to estimate the CONR for beverage containers in Queensland.
27. For example, if the BCR is 2.0, such that for each \$2 benefit of recycling there is a \$1 cost, it must follow that, in the context of that study, the CONR was 2.0 times the cost of recycling. If the cost of recycling is 20 cents per container, then a BCR of 2.0 implies that the CONR is 40 cents per container.
28. The following table summarises a review of Australian and international studies of container deposit schemes. This table reports the central estimate of the benefit to cost ratio from each study and the maximum benefit to cost ratio (if applicable).

³ The Office of Impact Analysis (2023), Cost Benefit Analysis, <https://oia.pmc.gov.au/sites/default/files/2023-08/cost-benefit-analysis.pdf>.

Table 3-1: Jurisdictional cost benefit studies for beverage container recycling schemes

Jurisdiction (year)	Study or analytical source	Central BCR	Upper bound BCR
Australian studies			
New South Wales (2017)⁴	NSW Environment Protection Authority, New South Wales Container Deposit Scheme - Decision Regulation Impact Statement	1.33	1.52
Victoria (2022)⁵	Victorian Department of Environment, Land, Water and Planning, Regulatory Impact Statement - Container Deposit Scheme	1.33	1.43
Western Australia (2018)⁶	Western Australian Department of Water and Environmental Regulation, Western Australian Container Deposit Scheme - Consultation Regulatory Impact Statement	1.37	1.48
Australian Capital Territory (2017)⁷	Transport Canberra and City Services Directorate, Container Deposit Scheme – Consultation Regulation Impact Statement	1.79	2.07
International studies			
New Zealand (2022)⁸	Sapere, A Container Return System for New Zealand: Cost-benefit Analysis Update	1.47	2.08 - 3.99
United Kingdom (2019)⁹	UK DEFRA, Consultation on introducing a Deposit Return Scheme in England, Wales and Northern Ireland	1.30	-
Scotland (2020)¹⁰	Scottish Government, A Deposit Return Scheme for Scotland: Full Business Case Stage 1 Addendum	1.21	-

29. This review supports a central estimate of the CONR at 40% higher than the costs of recycling. The upper bound estimate from the Australian studies is 107%. While the New Zealand study summarises

⁴ NSW EPA (2017), Decision Regulation Impact Statement, available at https://oia.pmc.gov.au/sites/default/files/posts/2018/03/final_decision_ris.pdf.

⁵ VIC Department of Environment, Land, Water and Planning (2022), Regulatory impact statement - Container deposit scheme, available at https://www.vic.gov.au/sites/default/files/2022-07/CDS-Regulatory-Impact-Statement_0.pdf.

⁶ WA Department of Water and Environmental Regulation (2018), Consultation Regulation Impact Statement, available at <https://www.wa.gov.au/system/files/2019-12/cris-wa-container-deposit-scheme.pdf>.

⁷ ACT Government (2017), Container Deposit Scheme – Consultation Regulation Impact Statement, available at https://www.cityservices.act.gov.au/_data/assets/pdf_file/0004/1182568/ACT-CDS-Consultation-Regulatory-Impact-Statement.pdf.

⁸ Sapere (2022), A Container Return Scheme for New Zealand, available at <https://environment.govt.nz/assets/updated-crs-cost-benefit-analysis.pdf>.

⁹ UK Department for Environment Food & Rural Affairs (2019), Consultation on introducing a Deposit Return Scheme in England, Wales and Northern Ireland, available at https://consult.defra.gov.uk/environment/introducing-a-deposit-return-scheme/supporting_documents/depositreturnconsultdoc.pdf.

¹⁰ Scottish Government, (2020), Deposit return scheme for Scotland: Full business case addendum, available at <https://www.gov.scot/publications/deposit-return-scheme-scotland-full-business-case-addendum/documents/>.

the upper bound estimate to be 108%, the same study presents a sensitivity as high as 299%. For the purpose of this report, we use an upper bound of 100% higher than the costs of recycling.

30. To calibrate this estimated range to beverage container recycling in Queensland, we need an estimate of the cost of beverage container recycling in Queensland. The most obvious candidate is to adopt COEX's average unit costs of recycling, which we discuss in section 3.2.3.1 below, which is around 21.0 cents per container (we also present results that use a lower bound sensitivity of 16.5 cents per container).
31. Uplifting COEX's average costs of 21.0 cents per container by 40% to 100% produces an estimate of the CONR between 29.4 and 42.0 cents per container. Applied to our lower bound sensitivity for the cost of recycling (16.5 cents per container) results in a CONR range between 23.0 and 32.9 cents per container. Of course, there remains an unavoidable level of uncertainty around this estimated range of the CONR.

3.2 Estimating the cost of not recycling based on COEX's costs of recycling

32. The cost of recycling can be measured using the average cost of recycling or the marginal cost of recycling. While the average cost of recycling is easier to quantify, the marginal cost of recycling aligns with the economic principles of efficient resource allocation.
33. We expect that the marginal costs of recycling will be higher than the average cost. This is because the least cost efforts to increase recycling are sensibly undertaken first and higher rates of recycling are only achieved by relying on more costly efforts at the margin. At this point, it would become inefficient to continue to expand recycling because the marginal cost of recycling would exceed the CONR. The efficient level of recycling would be expected to increase over time as advances in technology reduce the costs of recycling and/or if social preferences for recycling, or equivalently the dissatisfaction of not recycling, change.

3.2.1 Efficient recycling and the optimal recycling rate

34. This section explains the economics of efficient and optimal recycling which can explain why an optimal recycling rate is likely to be below 100%. These concepts are explained using illustrative examples of:
 - a. Multiple recycling efforts, some of which are not efficient, with the key point being that a 100% recycling rate is unlikely to be an optimal recycling target; and
 - b. A general economic model which describes efficient and optimal recycling in a graph.
35. Imagine that there are 100 beverage containers disposed of each day at a beach. Of those 100 containers, 80 containers are disposed of into council rubbish bins, while 18 containers are littered across the sand and 2 containers are littered by being accidentally buried in the sand.
36. Assume the following costs to instead recycle these 100 containers:
 - a. It costs 5 cents per container to transport, clean and sort the containers which is net of the scrap value of the container;
 - b. A recycling bin can be added next to the rubbish bin for 5 cents per container, which would divert all 80 containers that were previously going into landfill;
 - c. Someone could be employed to walk across the beach to pick up surface litter for 7 cents per container; and
 - d. Someone could also be employed to drive a tractor towing a plough across the beach to unearth buried litter for 5,000 cents per container.
37. If the CONR is 20 cents per container, there is a 10 cent per container surplus for the first 80 beverage containers recycled, a 3 cent per container surplus for the next 18 beverage containers recycled¹¹ and an unjustifiable cost to recover and recycle the last 2 beverage containers. Therefore, in this example it would be efficient to recycle 98 of the 100 containers sold.
38. In the above example, the marginal costs are the recycling costs, and the marginal benefit is the 20 cents per container CONR that is avoided when a container is instead recycled.
39. More generally, the welfare maximising decision for society is to expand recycling until the marginal costs of recycling equal the marginal benefits of recycling.¹² While recycling at a cost that is precisely

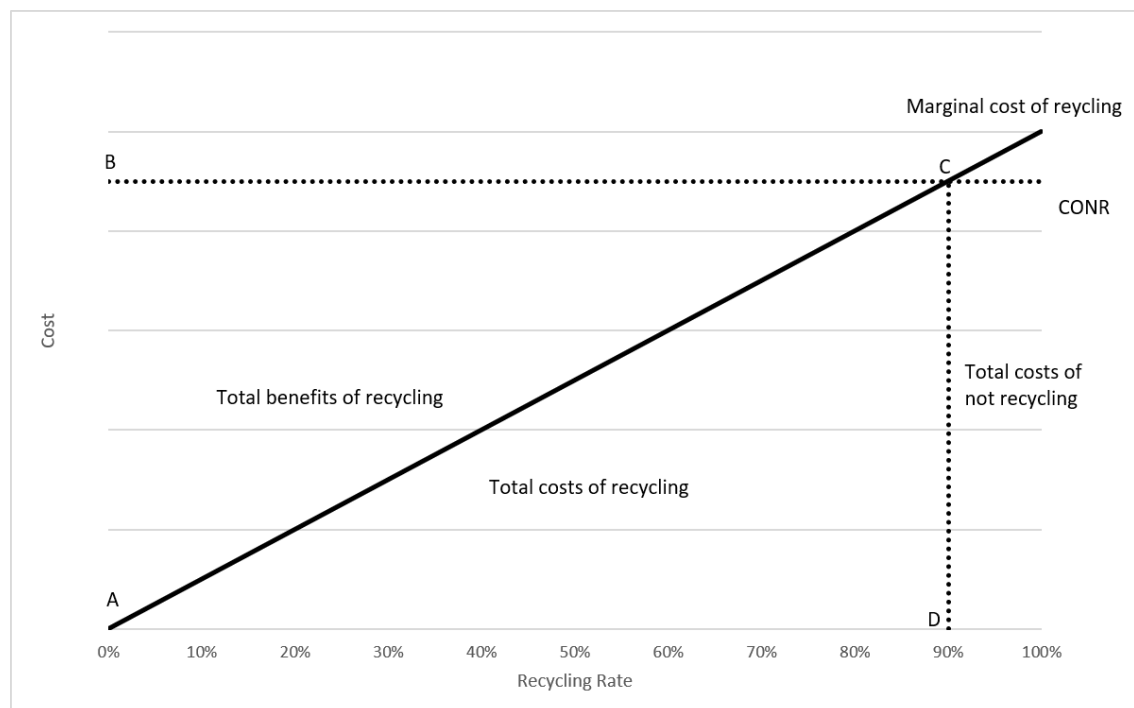
¹¹ The surplus of 3 cents being 20 cents less 7 cents to pick up the surface litter, 5 cents to dispose of the litter in the recycling bin and 5 cents to transport, clean and sort the containers for recycling.

¹² Kinnaman, T. C. (2014). Determining the socially optimal recycling rate. *Resources, Conservation and Recycling*, 85, 5–10.

equal to the CONR will not generate a surplus, all other containers that are recycled at a cost below the CONR will provide a net benefit. Recycling up until this point ensures that all surpluses from recycling can be captured. The totality of this benefit is the difference between the avoided CONR and the total cost of recycling.

40. This concept is illustrated graphically in Figure 3-1 below. This figure illustrates an optimal recycling rate of 90%, which occurs at the intersection of the CONR and the marginal cost of recycling.
41. In this figure, the y-axis measures the costs or benefits as a cent per container while the x-axis corresponds with the percentage of materials that are recycled (the recycling rate). The horizontal dotted line reflects the CONR, while the upward sloping linear line reflects the marginal costs of recycling. This cost of recycling is upward sloping on the basis that it would be expected that achieving each 1% increase in the recycling rate will cost slightly more than the last. For example, this would be expected as the scheme would need to attract increasingly reluctant recyclers (e.g., by deploying an increasingly concentrated network of container drop off locations) or as discussed in the beach example above, would need to pursue increasingly costly methods of recovering additional volumes.

Figure 3-1: Illustrative example of optimal recycling at 90% recycling rate



42. The concepts of efficient and optimal recycling are fundamentally a question of cost minimisation:¹³
 - a. Efficient recycling occurs when the cost of recycling is below the CONR; and
 - b. The optimal recycling rate occurs when total costs are minimised, being the costs of recycling plus the costs of not recycling.

¹³ It should be noted that in practice there is an unavoidable level of uncertainty around the level and shape of the CONR and marginal cost of recycling (and therefore, the optimal level of recycling). The purpose of this stylised example is to provide a simple illustration of this theoretical framework.

43. It can be seen in the above figure that recycling is efficient between points A to C along the marginal cost of recycling curve, where the cost of recycling is below the CONR (or equal at 90%). However, recycling beyond a 90% recycling rate becomes inefficient as the marginal cost of recycling curve extends above the CONR. This is inefficient as recycling at a cost above the CONR does not minimise disposal costs.
44. At a recycling rate of 90%, the gross benefits of recycling can be quantified as the area of the square labelled ABCD (the net benefits of recycling plus the total costs of recycling). This is equal to the CONR multiplied by the total number of containers recovered at a recycling rate of 90%. The total cost of recycling is the area of this square that is under the marginal cost of recycling line, which is quantified by the area of the triangle labelled ACD.
45. In the context of the cost benefit analysis studies reviewed in section 3.1, the BCR in this graphical illustration is equal to the gross benefits of recycling, the area of the square (ABCD), divided by the total costs of recycling, the area of the triangle (ACD). As the area of the triangle is half the size of the area of the square, this illustration corresponds to a BCR of 2.0. Furthermore, the CONR is also twice as high as the average cost of recycling¹⁴ but equal to the marginal cost of recycling.

3.2.2 The average cost of recycling as a floor value

46. As discussed in section 3.2.1 above, optimal recycling is defined in economics as when the marginal costs of recycling equal the marginal benefits of recycling. If the marginal cost of recycling increases as recycling expands, which would be expected, the average cost of recycling will be less than the marginal cost of recycling (for example, at any recycling rate in Figure 3-1 above, the marginal cost of recycling is double the average cost of recycling).
47. Therefore, if recycling is efficient the average cost of recycling would be expected to underestimate the CONR (i.e., to be a floor for the CONR).
48. It is notable that a CONR that is equal to this floor value implies that there are no net benefits from recycling, which in the context of the cost benefit analysis studies reviewed in section 3.1, would be consistent with a BCR of 1.0.
49. It is also relevant to note that if some materials are more expensive to recycle than others, it is only efficient to recycle containers if the CONR exceeds their material specific cost of recycling. It follows that the cost of recycling the highest cost to recycle material can be treated as a floor for the CONR.

3.2.3 COEX's costs of recycling

50. COEX's cost of recycling estimates from its FY24 financial data include costs in the form of payments of a 10-cent refund (which includes GST). The cost to COEX of these refund payments arguably represents a transfer, rather than the cost of recycling.
51. However, the costs of recycling extend beyond the costs that are directly incurred by COEX as the refund payments compensate households and businesses for real resource costs of participating in the scheme. For example, scheme participation costs include households' time to clean, sort and transport empty beverage containers to collection points and the transportation costs themselves, such as fuel if someone drives to a collection point.
52. Adopting COEX's costs as an estimate of the cost of recycling effectively assumes that 100% of the refunds that are paid are reimbursing households and businesses for these participation costs. At the

¹⁴ This is because the marginal cost of recycling curve that is illustrated above is linear and has no intercept. That is, the average cost of recycling is indicated by the height of the marginal cost of recycling curve at half of the recycling rate (45%).

margin, households and businesses will rationally incur costs to participate in the scheme up to the cost of the refund. Therefore, including 100% of the refunds is a reasonable proxy for marginal scheme participation costs.

53. Refund payments comprised approximately 43.2% of COEX's costs in FY24. If 100% of the refunds are considered to reflect participation costs, it would follow that participation costs are 43.2% of COEX's total costs of recycling. The studies relied on for this report support average participation costs of up to 35% which is equivalent to 72% of COEX's refund payments.¹⁵ We note that these studies identify further costs of recycling that are not captured in COEX's costs and go beyond participation costs, such as costs incurred by the government and compliance costs for the beverage industry.
54. Therefore, in this report we present estimates of the CONR which assume that either 50% or 100% of refund payments made by COEX represent resource costs that are not incurred by COEX. When it is assumed that 50% of the refund payments by COEX represent a resource cost of recycling, we have reduced COEX's cost of recycling by 4.5 cents per container.¹⁶
55. The following table summarises COEX's average cost of recycling in FY24 for all material types combined, and each individual material type.¹⁷ We note that these estimates are conservative to the extent that they fail to include any return on COEX's investments in establishing a network of recycling assets.

Table 3-2: COEX's average cost to recycle in FY24 by material type (cents per container)

Material type	Average cost of recycling (100% refund)	Average cost of recycling (50% refund)
Total (all materials)	21.0	16.5
Aluminium	19.0	14.5
PET	22.5	18.0
Glass	23.4	18.9
LPB	26.8	22.3
HDPE	22.4	17.9
Steel	23.7	19.2
Other materials	22.1	17.6

3.2.3.1 Estimating the cost of not recycling based on the average cost of recycling all materials

56. Table 3-2 above indicates that COEX's weighted average cost of recycling all material types is 21.0 cents per container, which includes the full refund that is paid by COEX for the containers that are

¹⁵ Sapere, in its report for the New Zealand Ministry for the Environment, estimated participation costs that were around 35% of total costs, which if applied to COEX's costs, would imply that 72% of the refund payments are participation costs. As for the Australian studies, the NSW study implies around 38% of the refund payments are participation costs, while the VIC and WA studies imply around 32% and the ACT study implies around 15%.

¹⁶ $4.5 = 10 / 1.1 \times 50\%$.

¹⁷ We have not applied inflation to the FY24 figures provided by COEX. Adding inflation would increase these numbers.

recovered by COEX. When it is assumed that only 50% of these refund payments relate to resource costs of recycling, the implied cost of recycling falls to 16.5 cents per container.

57. Therefore, we estimate that the floor value of the CONR ranges from 16.5 to 21.0 cents per container.

3.2.3.2 Estimating the cost of not recycling based on the average cost of recycling the highest cost material

58. The material that COEX recycles at the highest average cost is liquid paper board (LPB) at 26.8 cents per container. The lowest cost material for COEX to recycle is aluminium, at 19.0 cents per container, which is 29% lower than the cost of recycling LPB (which implies a BCR of 1.4 for aluminium recycling). When it is assumed that only 50% of these refund payments relate to resource costs of recycling, the implied cost of recycling falls to 22.3 cents per container.

59. Therefore, when assuming that the CONR is equal to the average cost to recycle the most expensive material type that COEX recycles (LPB), we estimate a range of the CONR of 22.3 to 26.8 cents per container.

3.2.3.3 Estimating the cost of not recycling based on the marginal cost of recycling

60. We have been instructed that COEX has a legislated recycling rate target of 85% and that COEX anticipates that it could achieve this target at a marginal cost of at least 32.0 cents per container.
61. If we assume that this recycling rate target of 85% is efficient, it follows from this assumption that the optimal level of recycling must be greater than or equal to 85%. In this instance, it is unclear how much higher than 85% the optimal rate of recycling may be or the marginal cost of recycling to achieve a higher recycling rate.
62. Therefore, for the purpose of estimating the CONR, the expected marginal cost to achieve the 85% target implies a CONR of at least 32.0 cents per container (or 27.5 cents per container if only half of the refund is assumed to reflect the resource costs of recycling).

4 Summary of estimates of the cost of not recycling

63. Based on the review of cost benefit studies for beverage container recycling schemes in section 3.1, we estimate a central and high BCR for container recycling of 1.4 and 2.0 respectively. Based on the analysis in section 3.2.3.1 we estimate that COEX's average cost of beverage container recycling across all material types to be 16.5 to 21.0 cents per container. This represents the range for the CONR floor. Applying a 1.4 and 2.0 BCR to these costs results in an estimated:
- a. Upper bound CONR range of 32.9 to 42.0 cents per container; and
 - b. Central estimate CONR range of 23.0 to 29.4 cents per container.
64. These values are reported in Table 4-1 below. Also included in this table are estimates of the CONR based on the:
- a. Highest cost to recycle material (22.3 to 26.8 as explained in section 3.2.3.2); and
 - b. Marginal cost of recycling (27.5 to 32.0 as explained in section 3.2.3.3).

Table 4-1: Estimates of CONR (cents per container)

Approach	Range of CONR
Upper bound	
Cost benefit analysis high BCR (2.0) applied to the average cost of recycling all materials (16.5 to 21.0)	32.9 to 42.0
Central estimates	
Marginal cost of recycling	27.5 to 32.0
Cost benefit analysis central BCR (1.4) applied to the average cost of recycling all materials (16.5 to 21.0)	23.0 to 29.4
Highest average cost of recycling by material (LPB)	22.3 to 26.8
Lower bound	
Average cost of recycling all materials	16.5 to 21.0

Appendix A Components of the cost of not recycling from cost benefit analysis studies

65. This appendix contains a discussion of the components of the CONR based on a review of Australian (NSW, VIC, WA and ACT) and international (New Zealand, United Kingdom, Scotland) cost benefit analysis studies.
66. The NSW and Victorian analyses included avoided collection, processing and landfill costs, landfill externalities, litter costs and the value of recovered resources.¹⁸ The New Zealand analysis separately quantified gains from increased recycling and reduced litter, material recovery, litter clean-up and volunteer effort, avoided landfill and kerbside costs, reduced contamination and lower emissions.¹⁹ The Western Australian analysis used substantially the same framework and also recognised possible social-enterprise employment benefits.²⁰
67. There may be some overlap in these categories. For example, willingness to pay for more recycling may partly reflect concern about landfill, litter or resource depletion, while the market price of recovered material may already reflect some savings from avoiding virgin inputs. Caution is therefore required to avoid double counting. This section does not assign a separate per-container value to every component, but rather, it explains why the combined social cost of non-recovery may be material even where some effects are difficult to observe or monetise.
68. Where a container enters the residual-waste stream, the immediate costs include collection vehicles and fuel, labour, transfer and sorting, transport to landfill, landfill operation and the capital cost of developing and maintaining disposal capacity. Those resources remain economic costs whether they are funded through council rates, commercial gate fees or a waste levy. While charging determines who pays, it does not necessarily cover the land, labour, vehicles and infrastructure used.
69. Landfill airspace also has an opportunity cost. Disposal brings forward the need to expand an existing facility or develop a replacement site, particularly near population centres where suitable land is scarce and planning and construction periods are long. The value of landfill capacity is also unlikely to remain constant over time. Landfill airspace is a finite and increasingly scarce resource, and several Australian jurisdictions have progressively increased their landfill levies in recent years,²¹ reflecting both policy settings and the rising cost of developing new landfill capacity. A landfill-based estimate of the CONR that is calculated by reference to today's levies is therefore likely to understate the forward-looking cost of landfilling a container, because it does not reflect the higher costs that can be expected to apply as existing landfill capacity is exhausted.
70. For the principal Victorian option, the analysis estimated present-value benefits of \$40.5 million from avoided collection and transport to landfill and \$35.7 million from avoided landfill operation and development.²² Those figures are not directly transferable to an individual container but nonetheless illustrate that the relevant cost is not confined to the current gate fee.

¹⁸ NSW EPA (2017), New South Wales Container Deposit Scheme - Decision Regulation Impact Statement, pp. 16-18 and 44-55; Victorian DELWP, Regulatory Impact Statement - Container Deposit Scheme (2022), pp. 38-49.

¹⁹ Sapere (2022), A Container Return System for New Zealand: Cost-benefit Analysis Update, pp. 27-33.

²⁰ WA DWER (2018), Western Australian Container Deposit Scheme - Consultation Regulatory Impact Statement, pp. 48-62.

²¹ See, for example, Waste Levy Rates by State, Bundle Waste (2026), <https://bundlewaste.com.au/resources/waste-levy-rates-australia-by-state>; NSW Waste Levy Rises from 1 July 2025, <https://wanless.com.au/nsw-waste-levy-rises/>; and QLD Waste Levy Rises by \$10 a tonne in metropolitan zones since 2022, <https://www.qld.gov.au/environment/waste-reduction-recycling/disposal-levy/about/levy-rates>.

²² VIC Department of Environment, Land, Water and Planning (2022), Regulatory impact statement - Container deposit scheme, Section 5.3, available at https://www.vic.gov.au/sites/default/files/2022-07/CDS-Regulatory-Impact-Statement_0.pdf.

71. Landfill also gives rise to costs not fully reflected in market prices, including greenhouse-gas and other air emissions, leachate risk, odour, noise, dust, vermin, truck movements and local disamenity. Some effects will differ by material. For example, fibre in liquid paperboard can decompose anaerobically and generate methane (as can the residual contents of the beverage container), while glass, metal and most plastics are largely inert but occupy capacity for very long periods. A waste levy may indicate that the government regards these effects and landfill scarcity as being material, which are the underlying costs that the levy is intended to address.²³
72. Some landfill costs are deferred to future generations. This is because waste that is disposed in the present can require later expenditure on replacement capacity, monitoring of closed sites or remediation of environmental problems. This intergenerational feature matters because the people bearing those future costs receive none of the benefit from the beverage that was packaged in the disposed container.
73. The costs can be much greater when a container becomes litter. Beverage containers are a persistent and disproportionately visible component of litter in Australia. National litter audits conducted by Clean Up Australia recorded beverage containers as accounting for around 13.8% of all litter items in Queensland in the 2025 financial year.²⁴ It must be noted that the proportion would be materially higher but for the existence of the COEX operations. For example, it was reported that the Tasmanian environment minister said the proposed beverage container deposit scheme was expected to reduce beverage container litter (which is 45% of Tasmania's litter) by almost 50%.²⁵
74. Litter imposes a direct cost on the community through the resources that state and local governments and other land managers spend on collection and clean-up. One recent study estimated the direct damage caused by marine litter to fisheries, aquaculture, shipping and tourism at approximately US\$10.8 billion a year across Asia-Pacific (APEC).²⁶
75. Litter is dispersed and may be difficult or dangerous to access, so its collection can require far more labour and equipment than ordinary household waste. Litter reaching drains, waterways, beaches or the ocean can be especially expensive to remove, and some will never be recovered. The burden is spread across governments, land managers, businesses, community organisations and volunteers.
76. Direct clean-up expenditure demonstrates the potential scale. The NSW Decision RIS cited a survey finding that more than \$162 million per year was then spent by NSW local government, state agencies, private land managers and community groups on managing litter.²⁷ The Victorian analysis developed an alternative clean-up-cost value of \$29,110 per tonne of beverage-container litter, with costs varying sharply by location and reaching an estimated \$254,103 per tonne for ocean litter.²⁸ These estimates show why the destination and dispersal of litter matter. In the context of

²³ Covec, Recycling: Cost Benefit Analysis, report for the New Zealand Ministry for the Environment (2007), pp. 9-14 and 19-28: <https://environment.govt.nz/assets/Publications/Files/recycling-cost-benefit-analysis-apr07.pdf>.

²⁴ Clean Up Australia, FY25 Annual Litter Report, <https://www.cleanup.org.au/wp-content/uploads/2026/02/Clean-Up-Australia-Litter-Report-FY25-QLD-Fact-Sheet.pdf>

²⁵ Pulse Tasmania (2024), Tasmania's long-awaited container refund scheme to launch in mid-2025, <https://pulsetasmania.com.au/news/tasmanias-long-awaited-container-refund-scheme-to-launch-in-mid-2025/>.

²⁶ McIlgorm, A., Raubenheimer, K., McIlgorm, D.E. and Nichols, R. (2021), 'The cost of marine litter damage to the global marine economy: Insights from the Asia-Pacific into prevention and the cost of inaction', Marine Pollution Bulletin, <https://doi.org/10.1016/j.marpolbul.2021.113167>.

²⁷ NSW EPA (2017), Decision Regulation Impact Statement, page 1, available at https://oia.pmc.gov.au/sites/default/files/posts/2018/03/final_decision_ris.pdf.

²⁸ VIC Department of Environment, Land, Water and Planning (2022), Regulatory impact statement - Container deposit scheme, page 49, available at https://www.vic.gov.au/sites/default/files/2022-07/CDS-Regulatory-Impact-Statement_0.pdf.

Queensland, it would be expected that litter would impose significant costs in sensitive ecosystems such as the Great Barrier Reef.

77. Clean-up expenditure is also incomplete. Litter reduces visual amenity and enjoyment of public places. Litter can injure people (e.g., broken glass), harm terrestrial and marine wildlife, contribute to plastic leakage and fragmentation and may affect tourism, recreation and perceptions that an area is safe and well cared for. Clean-up spending does not capture damage that remains after collection or litter that is never removed.
78. The principal scheme studies therefore use or test non-market valuation evidence. NSW adopted a willingness-to-pay estimate of \$17,584 per tonne of reduced public-space litter in 2015 dollars.²⁹ Victoria used \$26,683 per tonne in 2021-22 in its central analysis, while also testing direct clean-up costs.³⁰ The New Zealand study estimated a present-value welfare gain from reduced litter of about NZ\$1.04 billion over 30 years, separate from clean-up and volunteer-time savings.³¹ These values are uncertain and sensitive to survey design, but their scale indicates that amenity and environmental damage can be a major part of the aggregate benefit of recycling.
79. Volunteer effort is a real input even where it does not appear in government accounts. Time devoted to community clean-ups could otherwise be used for work, caring, recreation or other community activity. The New Zealand analysis accordingly valued both avoided clean-up expenditure and avoided volunteer time.
80. A container disposed of in landfill or littered also represents a loss of a valuable material. For example, glass, aluminium, steel, PET, HDPE and liquid paperboard can be inputs into new products, although their value varies with material, quality and market conditions. The foregone value of recycling is therefore an opportunity cost of non-recovery even before wider environmental effects are considered.
81. Where recycled feedstock displaces virgin production, it can also avoid environmentally destructive activities such as mining, quarrying, forestry, refining and manufacturing. Relevant effects include avoided energy use and greenhouse-gas emissions, air and water pollution, land disturbance, habitat loss, water use and depletion of finite or slowly renewable resources. The scale is material-specific and depends on production technology, the electricity mix, transport distances and whether recovered material actually displaces virgin material inputs.
82. Recovered aluminium provides the clearest illustration of this effect. For example, producing aluminium from recycled scrap requires approximately 5% of the energy needed to produce the same quantity of aluminium from virgin bauxite ore, representing an energy saving, and an associated reduction in greenhouse gas emissions, of around 95%.³² Every aluminium container that is not recycled therefore represents a foregone opportunity to avoid this energy and emissions cost in future production (not to mention environmental damage associated with the actual mining site).
83. Other materials give rise to similar, if less extreme, effects. Glass production from virgin sand and other raw materials, and PET production from virgin petrochemical feedstocks, are both energy-intensive processes for which recycled material can substitute. Fibre-based packaging draws on

²⁹ NSW EPA (2017), Decision Regulation Impact Statement, page 22, available at https://oia.pmc.gov.au/sites/default/files/posts/2018/03/final_decision_ris.pdf.

³⁰ VIC Department of Environment, Land, Water and Planning (2022), Regulatory impact statement - Container deposit scheme, page 48, available at https://www.vic.gov.au/sites/default/files/2022-07/CDS-Regulatory-Impact-Statement_0.pdf.

³¹ Sapere (2022), A Container Return Scheme for New Zealand, Table 34, available at <https://environment.govt.nz/assets/updated-crs-cost-benefit-analysis.pdf>.

³² International Aluminium Institute, <https://international-aluminium.org/landing/aluminium-recycling-saves-95-of-the-energy-needed-for-primary-aluminium-production/>.

virgin timber, and its production is associated with the land-use and biodiversity impacts of forestry, in addition to the energy used in pulping and processing. In each case, the environmental cost of virgin production is a cost that recycling avoids, and that the CONR should, in principle, reflect.

84. By way of illustration of the scale of these effects, greenhouse gas abatement in Australia is currently priced at around A\$36 to A\$83 per tonne of CO₂-e in the market for Australian Carbon Credit Units under the Safeguard Mechanism,³³ indicating that a functioning market exists for valuing these emissions. That price, however, captures only the greenhouse gas component of the negative externality of virgin production. It does not capture other environmental costs associated with resource extraction, such as land disturbance, water use and biodiversity loss, which are real but more difficult to value in dollar terms.
85. The New Zealand container-return analysis estimated a present-value emissions benefit of about NZ\$137 million after allowing for additional transport.³⁴ The US EPA's Waste Reduction Model likewise compares life-cycle greenhouse-gas and energy effects of recycling and landfilling aluminium, steel, glass, PET, HDPE and paper products. Such estimates demonstrate the category's relevance.³⁵
86. Measurement must respect the boundary between private and external benefits. Private savings from using secondary inputs may already be reflected in the price of recycled materials and should not be counted twice. By contrast, emissions, ecosystem damage and other effects not fully priced remain additional external costs. Existing carbon or pollution policies may internalise part of those costs, but do not negate the basic point that non-recovery can require additional virgin production and impose costs beyond the disposal system.
87. Non-recovery can impose costs elsewhere in the recycling system. Containers in commingled streams may need to be identified and sorted even if ultimately rejected. Difficult materials can contaminate otherwise valuable bales, lower sale prices, increase residue, damage equipment or create downtime. New Zealand estimated a present-value benefit of NZ\$30 million from reduced contamination.³⁶ Conversely, clean and separately collected material can support higher-value and potentially closed-loop uses.
88. Recovery rates can also influence market development over time. Larger and more predictable volumes can support investment in collection and processing infrastructure, specialised skills and domestic end markets, while repeated operation can generate learning, innovation and economies of scale. If recovery remains low, some investments may not become viable, leaving a smaller and less resilient sector and making future increases in recovery more costly. These dynamic effects are difficult to attribute to one container and are not fully quantified in the reviewed studies, but they are, nonetheless, relevant components of the CONR.
89. Recycling can also produce community and social benefits. Access Economics, in analysis prepared for the Australian government, estimated direct employment of approximately 9.2 full-time equivalent (FTE) jobs per 10,000 tonnes of material recycled, compared with 2.8 FTE jobs per 10,000 tonnes of material landfilled. That is, recycling creates more than three times as many direct jobs, with a broadly similar multiplier applying to indirect employment supported through industry

³³ EY, Australian carbon market outlook 2026, https://www.ey.com/en_au/insights/sustainability/a-time-for-clarity-and-confidence.

³⁴ Sapere (2022), A Container Return Scheme for New Zealand, Table 22, available at <https://environment.govt.nz/assets/updated-crs-cost-benefit-analysis.pdf>.

³⁵ US Environmental Protection Agency, Waste Reduction Model (WARM): <https://www.epa.gov/waste-reduction-model>.

³⁶ Sapere (2022), A Container Return Scheme for New Zealand, Table 16, available at <https://environment.govt.nz/assets/updated-crs-cost-benefit-analysis.pdf>.

supply chains.³⁷ Queensland's scheme objectives include opportunities for social enterprise and benefits for community organisations. COEX reports that, by 2025, the scheme had supported more than 1,500 local jobs across more than 380 refund points and facilitated \$17.9 million in donations to charities and community groups. These figures describe the scheme's reach, not amounts that can simply be added to the CONR. Gross employment is not automatically a net social benefit because labour has an opportunity cost.³⁸

90. Nevertheless, some community effects can have additional social value. Social enterprises may provide employment and skills to people who otherwise face barriers to work, for whom the opportunity cost of labour may be below the wage paid. Fundraising can strengthen community organisations and regular participation can reinforce recycling behaviour. The Western Australian RIS recognised likely opportunities for long-term involuntarily unemployed people through social-enterprise redemption points. Other studies identify non-market value from recycling itself, including civic duty, communal responsibility and the satisfaction obtained from participating.

³⁷ Access Economics (2009), *Employment in Waste Management and Recycling*, prepared for the former Department of the Environment, Water, Heritage and the Arts, summarised at <https://www.dcceew.gov.au/environment/protection/waste/publications/employment-waste-management-and-recycling>.

³⁸ Queensland Government, *Expanding Queensland's Container Refund Scheme to Include Wine and Spirit Bottles: Cost-benefit Analysis - Summary Report*, p. 3; Container Exchange, *Annual Report 2024-25*, pp. 6-7.

Appendix B Example of scheme pricing with an illustrative cost of not recycling

91. This appendix provides an illustrative example of COEX's proposed scheme pricing that is determined by (a) the costs COEX incurs when containers are recycled and (b) the CONR applied to containers that are not recycled.
92. The following table presents two illustrative examples where material type A is entirely recycled, while material type B is not recycled at all. In these examples, COEX is assumed to have a cost of \$10 in recycling 100 containers of material type A. This is a cost of 10 cents per container recycled. In the first example we set the CONR at 10 cents per container and in the second example we set the CONR at 30 cents per container (each example adopts the same CONR for each material type).

Table 4-2: Illustration of cost-based pricing methods with 10 or 30 cent CONR

Row	Description	1: CONR is equal to the cost of recycling		2: CONR is three times the cost of recycling	
		Material type A	Material type B	Material type A	Material type B
A	Beverages sold	100	100	Unchanged	
B	Containers recycled by COEX	100	0	Unchanged	
C	COEX costs per container	\$0.10		Unchanged	
D	CONR per container	\$0.10		\$0.30	
E	Total cost to COEX $= B \times C$	\$10.00	\$0.00	Unchanged	
F	Total CONR $= (A - B) \times D$	\$0.00	\$10.00	\$0.00	\$30.00
G	COEX costs plus CONR $= E + F$	\$10.00	\$10.00	\$10.00	\$30.00
H	Scale up/down CONR $= F \times [(E_A + E_B) / (F_A + F_B)]$	\$0.00	\$10.00	Unchanged	
I	Scale down COEX costs plus CONR $= G \times [(E_A + E_B) / (G_A + G_B)]$	\$5.00	\$5.00	\$2.50	\$7.50
J	Price based on COEX costs $= E / A$	\$0.100	\$0.000	Unchanged	
K	Price based on CONR $= H / A$	\$0.000	\$0.100	Unchanged	
L	Price based on all costs $= I / A$	\$0.050	\$0.050	\$0.025	\$0.075

93. In each of the above examples, COEX needs to set prices to recover its total costs of \$10. This must be recovered over 200 containers produced (100 beverages that are sold in containers from material type A and another 100 beverages in containers from material type B). In each of these examples, if prices only have regard to COEX's costs, then material type A funds COEX entirely at a price of 10 cents per container and if prices only have regard to the CONR, material type A will cover none of COEX's costs as it is entirely recycled.
94. However, if prices have regard to both the CONR and COEX's costs, the level of the CONR relative to COEX's costs of recycling impacts the relative price for each material.
95. If the CONR is assumed to be equal to COEX's costs at an assumed 10 cents per container, COEX can recover its costs of \$10 over all 200 beverages sold where material type A and B each pay 5 cents per container produced.
96. If the CONR was instead assumed to be three times COEX's costs, so 30 cents per container, COEX can recover its costs of \$10 over all 200 beverages sold where material type A pays a price of 2.5 cents per container produced (recovering \$2.5 in total) and material type B pays a price of 7.5 cents per container produced (recovering \$7.5 in total). While COEX is still incurring \$10 in costs, because the CONR is assumed to be three times COEX's costs of recycling (resulting in social costs of \$30), the CONR has a 75% weight when the total costs of \$40 are rescaled to cover COEX's costs of \$10.³⁹

³⁹ 75% = $\$30 / (\$30 + \$10)$.