Digital Deposit Return Scheme

High-level economic impact assessment

Digital Deposit Return Scheme Industry Working Group

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resourcefutures

Document prepared for

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Executive Summary

The Industry Working Group (IWG) on a digital deposit return scheme (DDRS) commissioned this study to undertake an economic impact assessment of a DDRS. The intention is to support discussion around deposit return schemes (DRS) and the best means of implementation, and to provide high-level indicative analysis of costs and benefits so that a DDRS may be compared to other DRS designs.

The DDRS design presented in this study takes advantage of existing kerbside recycling collections in the UK, making this the main point for collecting DRS containers and allowing the consumer to redeem their deposit via a smartphone app. This DDRS was compared to other DRS designs that do not use a smartphone app to redeem deposits or kerbside waste collections, and instead rely on a greater number of reverse vending machines (RVMs). These DRS are referred to in this report using the shorthand of RVM-DRS. It should be noted that the DDRS also uses RVMs but far fewer are required.

The approach for the economic impact assessment (IA) of DDRS is as closely aligned with the Government IA for RVM-DRS as could be made given the available information. The methodology and assumptions used to estimate costs and benefits for a DDRS are described in detail, and are drawn from engaging relevant stakeholders from the packaging, waste, and IT industries. The economic modelling is designed to present high-level indicative results, suitable for exploring the economic case for implementing DRS in the UK via DDRS. More detailed estimates of costs and benefits could be derived through further research, and by exploring different system designs. The study draws upon the central estimate values from the Government IA. It must be recognised that these are high-level estimates and there is a degree of uncertainty in both economic impact assessments which is not reflected in these central estimates. This study focusses on whole system costs and benefits. It does not take a position on the administrative, financial and legal structures for a DRS currently under consultation, nor does it investigate the associated distribution of costs and benefits to different entities and the potential compensation mechanisms.

Opinions differ on whether a DDRS could be introduced in a shorter timescale than RVM-DRS or would require longer to set up, and so for ease of comparison in the results the same timeframes for implementation were used as in the Government IA. Similarly, the parameters of economic analysis from the Government IA are adopted, such as price base year, present value (PV) base year, and discount rate.

A summary of the economic impact assessment is presented in the first results column in Table ES1, alongside results from the Government IA for other DRS designs presented in the other columns. The most direct comparison can be made between the results for an ‘All-In DDRS’ in the first column of results and an ‘All-In RVM-DRS’ in the second column. ‘All-In’ indicates that all drinks containers will bear a deposit. Other RVM-DRS options limit the product scope to just those drinks containers which are commonly consumed ‘on-the-go’ or ‘no glass’. The results indicate that the total cost of an All-In DDRS is lower than the comparable All-In RVM-DRS system, the present value of the All-In DDRS costs is estimated to be £3,002m over the 11 year period compared to £6,346m for All-In RVM-DRS. The net present value (NPV)[1] and benefit to cost ratio (BCR)[2] are higher for an All-In DDRS.

Table ES1: Summary of NPV, cost, BCR, £m (2022-32)[3]

	'All-In' DDRS	'All-In' RVM-DRS (Option 2)	'On the Go' RVM-DRS (Option 3)	'No Glass' RVM-DRS (Option 4)
NPV	8,891.0	5,884.5	282	3,582.30
Total cost PV	3,002	6,346	3,503	5,491
BCR	3.962	1.927	1.081	1.65

Comparing these two options directly, i.e. All-In RVM-DRS and All-In DDRS, illustrates the differences in costs and benefits. This is shown in more detail in Figure ES1 where negative values indicate the degree to which costs and benefits are lower in the DDRS compared to All-In RVM-DRS, and positive values indicate higher impacts. Costs associated with RVMs and manual take-back points are reduced in a DDRS as it uses a smaller network of these return points and cheaper RVM units. The greatest impact is a large reduction in the capital investment in RVMs when compared to an All-In RVM-DRS. The DDRS introduces new costs to support the digital function of the system. The largest of these lies in IT operational costs, and relates to the transaction fee associated with scanning the serialisation mark on the container and redeeming the deposit and a smaller cost for maintaining supporting IT infrastructure.

The benefits are also reduced, as the material collected at the kerbside is assumed to be of slightly lower quality and therefore fetch lower prices than that collected via RVMs and manual take-back (based on current kerbside performance). However, overall the All-In DDRS is thought to be more cost effective than the All-In RVM-DRS presented in the Government IA, as it delivers a similar level of benefits at a reduced cost. This is reflected in the higher net present value (NPV) and benefit to cost ratio (BCR) shown in ES1.

Whilst sorting of kerbside-collected materials can produce high-quality materials for recycling the sorting process would likely have a greater proportion of rejected materials than materials collected by RVMs and manual take-back points. To take this difference into account, benefits from greenhouse gas (GHG) emissions reductions from increased recycling in an RVM-DRS are assumed to be 5% less for a DDRS. However, this differential could be potentially reduced via changes currently under public consultation in England around consistency in recycling collections and extended producer responsibility for packaging, or

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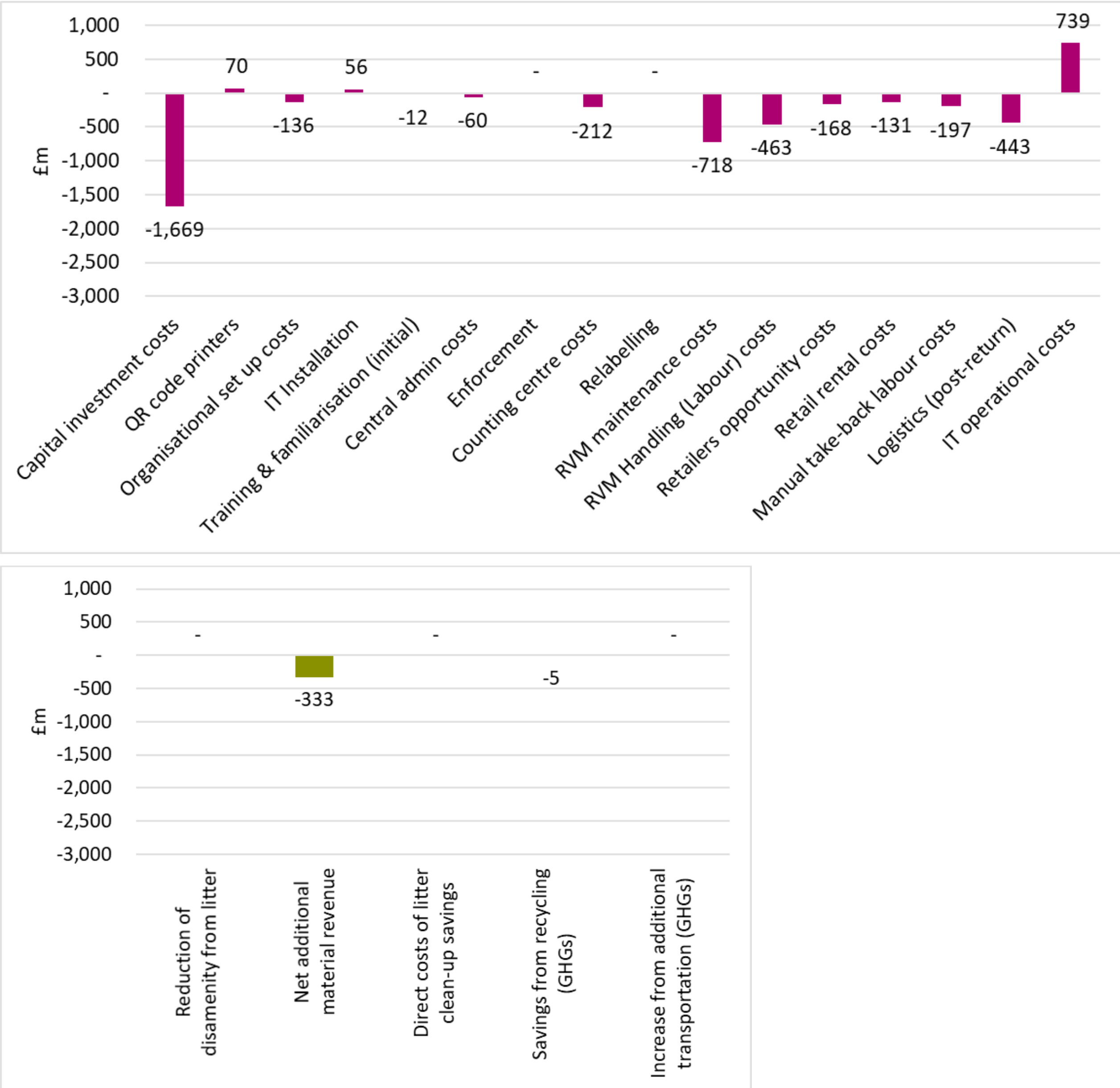
[1] Net present value (NPV) is the net benefit over the 11-year period of the economic appraisal, i.e. calculated as benefits minus costs. A positive NPV value indicates the value to which the estimated benefits outweigh the estimated costs. Present value is calculated using a discount rate of 3.5%.

[2] Benefit to cost ratio (BCR), calculated as the present value of benefits divided by the present value of costs. A BCR greater than 1 means that overall the estimated benefits outweigh the estimated costs. A BCR of 2 for example indicates the value of the estimated benefits is twice the value of the costs.

[3] Calculated on the basis of accrual costs. DDRS 'All-In' values are estimates from the research in this report. Other DRS options are presented in the last three columns using economic costs and benefits estimates presented in: Defra (2021), Introducing a Deposit Return Scheme on beverage containers – Impact assessment, https://consult.defra.gov.uk/environment/consultation-on-introducing-a-drs/supporting_documents/Impact%20Assessment.pdf

by investment and innovation in the recycling value chain. GHG emissions from transportation of DDRS material are assumed to be the same as previously estimated for RVM-DRS.

Figure ES1: Difference in economic costs (top) and benefits (bottom) of a DDRS compared to RVM-DRS, PV 2022-32



The period from 2022-24 reflects a staged adoption of a DRS, consistent with the Government IA. The total cost over this three-year transition period is shown in Table ES2, and the average annual cost after the transition period (2025-32) is also presented.

Table ES2: Transition costs and average annual cost, constant price, £m

	'All-In' DDRS	'All-In' RVM-DRS
Transition costs (3-year total, 2022-24)	806	2,430
Average annual cost (excl. transition)	363	651

The allocation of costs and benefits is yet to be decided and questions around this form part of the current public consultation on DRS. The Government IA explores one scenario wherein producer fees make up 50% of the net costs, the other 50% is covered by unredeemed deposits. If the scheme achieves an 85% return rate, as modelled, 15% of deposits will be unredeemed amounting to a considerable sum which can cover 50% of the net costs and still leave excess unredeemed deposits. The net cost (as equivalent annual cost) of the All-In DDRS is £323m lower than that presented in the Government IA for an All-In RVM-DRS – i.e. an annual cost saving of £323m over the 11-year period, including set up costs and material revenue. This results in an equivalent annual saving of £162m in producer fees (50% saving) and an additional £162m of excess unredeemed deposits (39% increase) when compared to the All-In RVM-DRS.

There are areas of a DDRS that require further research, particularly which technology to use for managing deposits and data systems. This economic impact assessment outlines one possible DDRS design and estimates the costs and benefits. A conservative approach has been taken so as to not underestimate costs or overestimate benefits where there is uncertainty in the system implementation or impacts, and the assumptions used have been clearly stated. Further work is recommended to determine if a DDRS can be implemented at scale and within the desired timescales. The design outlined here builds upon existing technology found in other contexts, such as blockchain and QR codes, and some pilots have already been undertaken in the UK. If such a system can be implemented, this economic impact assessment suggests that it could save considerable costs compared to an RVM-DRS with a relatively small impact on the benefits received.

Potential further developments were identified in the course of the research, such as smart on-the-go recycling bins and tracking of materials through the waste value chain. These features were not included in the basic economic impact assessment as they are not fundamental to an All-In DDRS and some of them could be implemented in either DDRS or RVM-DRS. These were described qualitatively to support further discussions, as they could provide additional value to either system.

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1 Introduction

Resource Futures was contracted to produce an economic impact assessment (IA) of a Digital Deposit Return Scheme (DDRS) by Bryson Recycling on behalf of the DDRS Industry Working Group (IWG). This will inform the IWG's submission to the Government's consultation which was opened on 24 March 2021.[4]

This research assesses the economic merits of a Deposit Return Scheme (DRS) system that does not feature in the economic assessment in the Government's latest IA (published 24 March 2021)[5].

A comparison is made between the Government Policy Option 2 – to introduce an 'all-in' deposit return scheme'[6] largely based on extensive use of Reverse Vending Machine (RVM) technology, i.e. an 'RVM-DRS' – and an alternative DDRS system largely based on kerbside collection of drinks containers on which a unique (to individual containers) serialisation code is printed. Under DDRS the deposit on a drinks container would be redeemed by the consumer scanning the serialisation code via a smartphone application ('app') which would also notify the supporting IT system that the deposit could not be redeemed again – a key security measure to prevent fraud. In addition to the kerbside return points, the DDRS system would be supplemented by a number of RVMs and manual take-back points, albeit fewer than the Government Policy Option 2 – to introduce an 'all-in' deposit return scheme.

The research approach is to assess key differences (described in Section 3) between the costs and benefits that a DDRS alternative would bring in comparison to RVM-DRS. The overall modelling approach for the DDRS alternative is as closely aligned with the Government's latest IA methodology for RVM-DRS as we could make it based on the transparency of method and applicability to DDRS. The study draws upon the central estimate values from the Government IA and errs on the side of caution when presenting new estimates for a DDRS so as to not to underestimate the costs or overestimate the benefits. It must also be recognised that these are high-level estimates and there is a potentially large degree of uncertainty in both economic impact assessments which is not reflected in these central estimates.

In the DDRS modelling, the timescales are kept consistent with the Government IA for purposes of comparability, i.e. starting implementation in 2023. However, other timescales have subsequently been proposed and the speed at which either system can be implemented requires further research. It is worth noting that DDRS technology providers and some other industry stakeholders consulted for this analysis indicated that DDRS has potential for being introduced sooner than RVM-DRS as it would build upon technology already used at scale in other contexts and trialled in the UK for DRS, and it would require fewer retail store-based RVMs and the associated planning permission issues to install them.[7] Other industry stakeholders expressed concern about the readiness of labelling technology and time needed for redesign.

The potential future DRS scheme will be implemented in England, Wales, and Northern Ireland. However, the Government's IA assesses the costs and benefits of a DRS across the UK as a whole. This DDRS IA takes the same approach so that a consistent comparison can be made.

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[4] https://consult.defra.gov.uk/environment/consultation-on-introducing-a-drs/

[5] Defra (2021), Introducing a Deposit Return Scheme on beverage containers, dated 24/02/21.

[6] Option 2 – Introduce an 'All-In' DRS to cover PET bottles, steel cans, aluminium cans and glass bottles, with no restriction of the size/format of drinks containers in-scope.

[7] The model assumes 23.8 bn containers per annum are placed on the market. To provide context, 35.3 billion consumer payments were made in 2019 (including cash and direct debits. (Source: UK Finance (2020); UK Payment Markets Summary 2020)

2 Government policy objectives

2.1 Analysis of DDRS against policy objectives and basic principles

The primary policy objectives of DRS are stated in the Government IA. In brief, these are:

1) Increase recycling rates of in-scope containers;
2) Increase the quality of recycled material to encourage closed-loop recycling and circularity to ensure materials remain in use for as long as possible;
3) Reduce littering of in-scope containers.

In addition, the IA states that a DRS would make it easier for consumers to recycle through clear labelling and consumer messaging.

The DDRS scheme proposed in Section 3 will meet primary objectives 1) and 3) because, as with an RVM-DRS, a deposit is used as an incentive to return in-scope containers thereby increasing recycling and reducing litter. On the question of whether in-scope materials collected at the kerbside would meet the same quality of recyclate from an RVM-DRS (objective 2), separate research (unpublished at the time of writing) into the quality question has concluded that based on current kerbside collection system performance the quality of material collected through kerbside services is unlikely to meet the quality of a well-managed RVM-DRS utilising high tech expensive RVM units. However, the research also evidenced that well run kerbside sort collections are operating with very low levels (single digit % values) of contamination of material presented at the kerbside. It was noted in the quality research that how the material is collected through an RVM-DRS system will also influence quality as any mixing of material either at the point of collection or through the handling process will require subsequent sorting on a par with current mixed materials in kerbside collection. The main issue on kerbside quality relates to the fact that the system is collecting other materials as well as in-scope DRS items. In regard to whether kerbside collected material can be used in high quality closed loop recycling, the quality research confirmed that this is possible and indeed currently happens, however, the reprocessing sector has additional costs in order to 'clean-up' the material before processing. When assessing which DRS system is more economically advantageous, the value of collected in-scope materials (benefits) should be balanced against the different costs of the two systems.

The Government IA states that, "English, Scottish and Welsh ministers agreed on the below principles for co-operation on a deposit return scheme, should one be introduced:[8]

- DRS should form part of a coherent system for improving recycling and reducing use of virgin materials, alongside producer responsibility obligations, kerbside collection and consideration of other appropriate fiscal measures. These measures should work effectively together in a way that is understandable and fair for consumers and industry.
- Schemes should be underpinned by legislation in order to maximise their effectiveness.
- The system should be clear and understandable for consumers, and provide convenient means of returning drinks containers and reclaiming deposits.
- There should be a clear definition of materials to be included within the schemes.

[8] Defra (2021), Introducing a Deposit Return Scheme on beverage containers, dated 24/02/21.

- The design of schemes should take into account the need to effectively serve both urban and remote and rural communities, and disabled people, and should also address other access challenges to make it as fair and equitable as possible.
- Schemes should ensure producers and retailers of products take responsibility for the material they put onto the market, while not creating unfair or unreasonable costs of compliance.
- Schemes should be underpinned by strong measures to promote compliance and limit the opportunities for fraud."

A DDRS system presents no significant barriers to the existing principles for co-operation, as described above. For example, deposit return locations would be convenient because they would be highly accessible to all – primarily utilising existing kerbside recycling collection schemes but supplemented by alternative take back locations to include those that would not use its kerbside deposit return technology. On the aspect of the opportunities for fraud, a DDRS would manage deposits on an individual container basis making it difficult to fake valid serialisation codes bearing deposits in order to fraudulently claim deposits. Furthermore, such attempts at fraud will be easier to track.

The Government IA lists "DRS principles which industry stakeholders have suggested and the UK and Welsh Governments and DAERA support: [9]

- Schemes should be transparent in reporting on performance.
- Schemes should be incentivised to manage costs and efficiencies.
- The organisation managing the operation of the DRS should be not-for-profit.
- Schemes should be operationally workable for those running return points".

A DDRS system presents no significant barriers to the existing DRS principles which industry stakeholders have suggested and the UK and Welsh Governments and DAERA supports for co-operation, as described above.

2.2 Addressing risks identified in an RVM-DRS

The previous Government IA (2019) identified the following risks associated with an 'all-in' DRS option:[10]

- valuable material would be removed from kerbside collections.
- disproportionate impacts - some consumers might find it more difficult to access a DRS to claim back their deposits and therefore have the potential to be disproportionately impacted by a scheme. This is considered in the DRS consultation in order to gain more evidence on this distributional aspect.

These risks have not been included in the most recent Government IA (2021). However, the DDRS system analysed in this report would mean that:

- the in-scope material would not be removed from kerbside collections, and local authorities could be paid by the Deposit Management Organisation (DMO)[11] to collect and supply reprocessors with in-scope materials; and,

[9] Defra (2021), Introducing a Deposit Return Scheme on beverage containers, dated 24/02/21.
[10] Defra (2019), Introducing a Deposit Return Scheme on beverage containers, Date: 15/02/2019
[11] The Deposit Management Organisation (DMO) is the central body whose role is to set up and manage the operation of the DRS.

- the DDRS system can be accessed in four ways:
    1. use of householder’s existing kerbside recycling collection system (via a scan of the drinks container via a smartphone)
    2. use of RVMs
    3. use of manual take-back points
    4. use of on-the-go recycling bins (via a scan of the drinks container via a smartphone)

The Office for National Statistics (ONS) provides data that 84% of the population uses a smartphone for private use.[12] It is plausible that an even greater percentage of households as a whole use a smartphone, if for example, smartphone users live with others who do not have a smartphone.[13] Recent, initial and unpublished research results by Queen’s University Belfast has revealed that 70.54% of respondents either ‘strongly agreed’ or ‘agreed’ with the statement, “I would prefer to recycle my plastic waste at home rather than take it to a RVM at a central point”, and 88.49% of respondents either ‘strongly agreed’ or ‘agreed’ with the statement, “I have no difficulty downloading an app to my phone and using it”.

3 Systems overview

The approach to the economic modelling has been to identify what elements of the latest Government IA would be similar in a DDRS and what would significantly differ, so that the focus of a submission by the IWG in response to the new consultation is concentrated on key differences between the two systems. In other words, the analysis does not attempt to duplicate or refine the aspects of the Government’s modelling which will largely be common between the two systems. This has allowed the quantitative modelling efforts to focus on what is important and to provide outputs that are a fair and consistent comparison.

As stated previously, the baseline DRS for comparison will be Option 2 in the Government IA: an All-In RVM-DRS.

Section 3.1 provides and overview of the RVM-DRS discussed in the Governments latest IA. Section 3.2 provides an overview of the DDRS design developed for this economic impact assessment, and Section 3.3 provides a headline qualitative comparison of the two systems.

3.1 Reverse vending machine-based Deposit Return Scheme (RVM-DRS)

With the introduction of a DRS, consumers would be financially incentivised to return drinks containers to a recycling point in order to redeem a small deposit they have paid on the item. This has the potential to reduce littering and boost recycling of the relevant material. A common form of DRS found in Europe and the USA requires consumers to return containers via reverse vending machines (RVMs) or manual take back points (such as convenience stores).

Figure 1 provides an overview of the Government’s proposed RVM-DRS. Acquisition of recyclate from consumers is mainly via RVMs (plus some additional material via ‘manual’ takeback points in smaller

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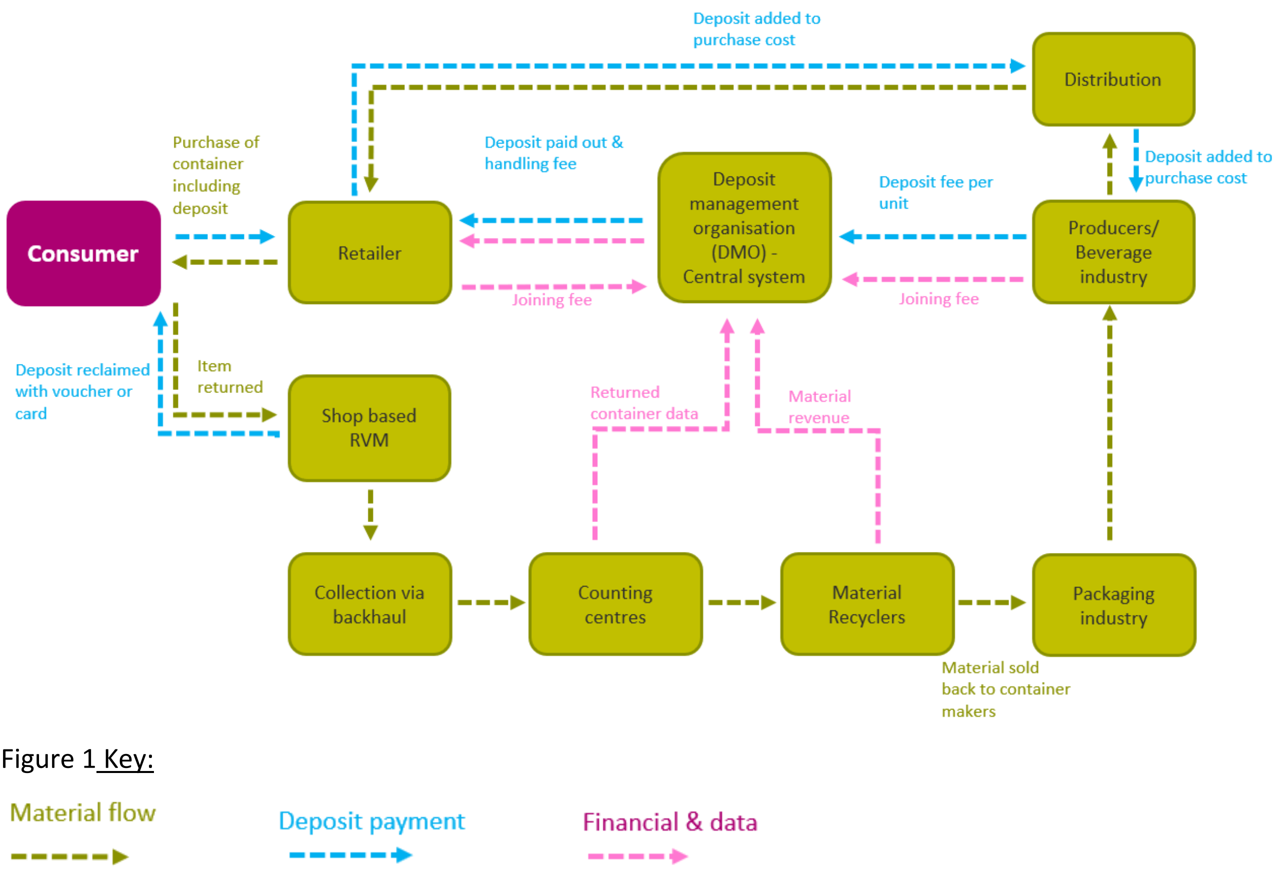
[12] Internet access - households and individuals, 2020: published 7th August 2020, Table 22: smartphone security, by age group, sex and disability status, 2020

[13] For context, the percentage of households with at least one car / van is 78%.[Source: Office for National Statistics, Table A47; Percentage of households with cars by income group, tenure and household composition; UK, financial year ending 2018]

retailers). There is a dedicated return route to material recyclers via the scheme's own bulking and counting centres.

Figure 1: Conceptual model of the Government's proposed RVM-DRS



3.2 Digital Deposit Return Scheme

The IWG hosted a workshop on 24 February 2021 to discuss and agree a high-level conceptual model for a DDRS system. Out of three options presented by Resource Futures, one option was selected as the system to be modelled for the purposes of this economic impact assessment (see Figure 2).

3.2.1 Description

For the purposes of this research, we have interpreted a DDRS as a scheme which is integrated into the existing kerbside collection recycling system. As described above, each in-scope drinks container has marker on it with a unique serialisation code (e.g. QR code[14]) which is scanned by the consumer and placed in their existing household kerbside recycling collection or a recycling on-the-go bin.

Kerbside recycling bins will also have a unique scannable code attached to it, e.g. a sticker or printed onto the recycling bin in future years. Each household must register their recycling bin as a certified recycling

[14] The specific type of unique marker that would be used in a DDRS is not confirmed. There are various suitable labelling technologies. In this report 'QR code' is used throughout this report because QR code is a commonly recognised term and therefore most readers will be familiar with its aims.

point in order to redeem the deposit[15]. The deposit return system is accessed by the consumer through a smartphone app which is linked to a digital wallet for the redeemed deposits. When the consumer wishes to discard their drinks container, they will scan the serialisation code on the drinks container and another unique code on the bin before placing for collection as part of their normal local authority kerbside recycling service. The smartphone app will connect to the DDRS's IT system to inform it to return the deposit to the consumer (e.g. to their bank account) and note that the deposit has been paid, thereby reducing the risk of fraud, e.g. from redeeming a deposit more than once using the same container and making it much more difficult to fake DRS marks to redeem deposits. Once placed in the kerbside recycling bin the material would be collected as normal by recycling collection crews (it is envisaged that the DMO will contract local authorities to provide this service).

It is recognised that not all consumers will be able or wish to use smartphone apps. The DDRS system analysed includes two alternatives that do not require a smartphone:

i. use of RVMs, albeit a reduced number than proposed for the Government's RVM-DRS; and
ii. use of manual take-back points at retailers, using shop-owned handheld serialisation code scanners.

In addition, the DDRS will comprise on-the-go bins with a scannable unique code on them e.g. in town centres, shopping malls, public parks and beaches. The potential for use of more sophisticated on-the-go recycling bins is outlined in Section 6.

[15] The system will have flexibility to allow more than one consumer to register against a kerbside recycling bin, for example: shared households, lodgers and those living in accommodation such as flats which will have communal recycling bins.

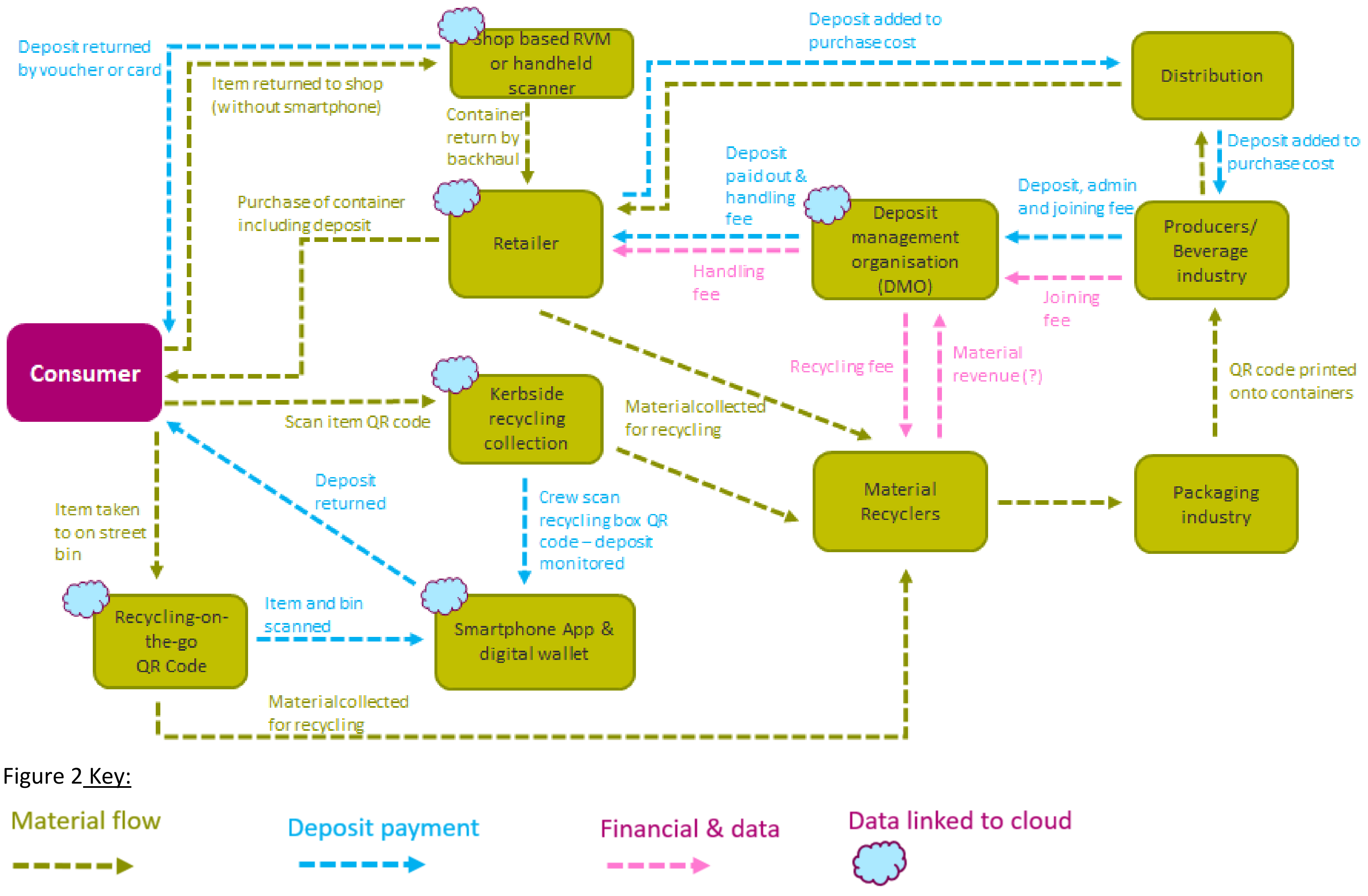


Figure 2: Conceptual model of the DDRS for the economic impact assessment

3.2.2 Key aspects

The key aspects of this DDRS system are:

Strengths / opportunities

- Utilises existing, established kerbside recycling infrastructure which largely negates the establishment of new and dedicated infrastructure.
- Low fraud risk via serialisation codes each digitally linked to a deposit value, making it harder to falsify a valid DRS code and fraudulently claim a deposit
- Fraud risk further reduced by digital checks or use of Blockchain
- Limited use of expensive RVMs
- App development cost is relatively inexpensive
- Promotion of positive behaviour change though the app, supported by the ability to have loyalty rewards, competitions and giveaways
- Individual container identification would allow for variable deposits, as well as differentiation of deposits by devolved governments, and changes to the amount of deposit over time (because the amount of deposit is assigned to individual drinks containers, the consumer would always receive the correct amount of deposit back on redemption),
- Valuable data collected due to the system's ability to track individual containers. For example:
    - Insight on distribution of products and materials after sale, insight on consumption patterns and locations. Insight on any problem container types or formats – e.g. low collection and recycling rates (not quantified in this assessment).
    - Supporting wider waste data, reporting and analysis agenda such as mandatory digitisation of waste transfer notes (Defra waste tracking project[16]), and a the potential ONS DSC-69 National Materials Datahub.[17]
- Opportunities for greater co-benefits between DDRS, EPR and collections consistency, e.g. highly detailed data on recycling collections could be used to inform EPR mechanisms, such as eco-modulated fees.
- Potential for good integration with online retail. Some consumers use online grocery deliveries because it is difficult or otherwise inconvenient to travel to the shops. For consumers that are not visiting the shops it may be more accessible for them to engage with a DDRS system that allows them reclaim deposits and return containers from their home using their existing kerbside waste service.
- Potential for widening the scope of DRS to include non-drinks containers with currently low recycling rates (e.g. shampoo bottles, cleaning bottles, etc.) or high litter risk.

Weaknesses and challenges

- Overall material quality from existing kerbside recycling bins (i.e. non-DRS specific) is likely to be lower quality based on current systems than materials collected through a dedicated DRS channel, i.e. RVMs and manual take back points, although this varies by material type and kerbside collection system. Separate research into the quality of material collected through kerbside

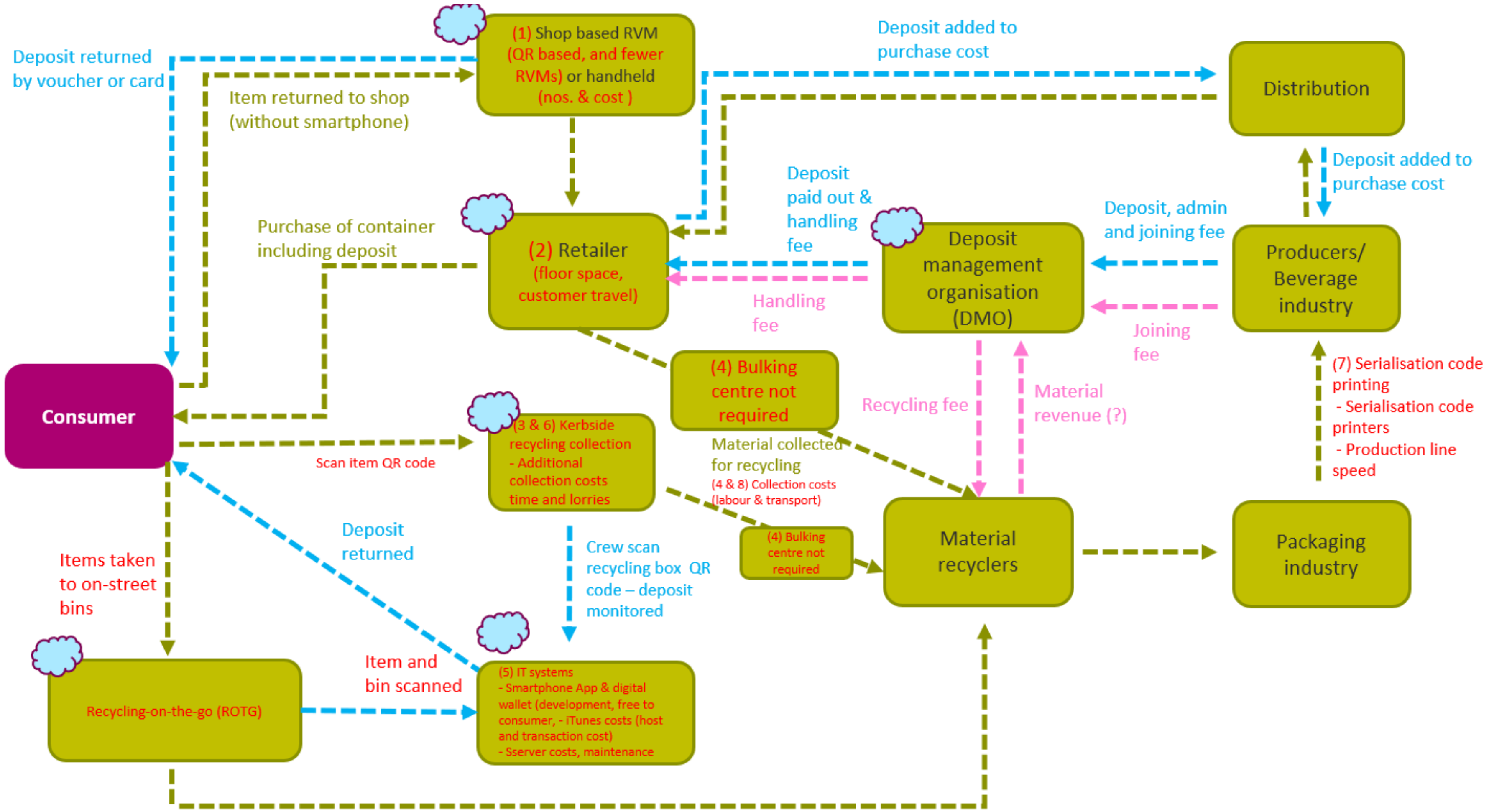
[16] https://www.gov.uk/government/news/1-million-boost-for-uk-smart-waste-tracking
[17] https://datasciencecampus.github.io/projects/DSC-69-National-Materials-Datahub/

collections compared to material collected through an RVM-DRS has found that a well-run kerbside sort collection system is able to produce consistently high-quality material suitable for closed loop recycling.

- To date, DDRS technology, including software and container marking, has been trialled in the UK at a relatively small scale only. There is still uncertainty about the outcome of scaling up systems to a national level, and large-scale trials may be required.
- This economic impact assessment is relatively high level and looks at one possible DDRS design. At a more detailed level, there are many options for the scheme's various aspects, e.g.:
  - the precise type of serialisation code technology;
  - defining and controlling the legal ownership of materials collected for later reprocessing; and,
  - the type of contracts the DMO would commission from service providers such as logistics providers.
- Ownership / access to scheme data.
- Potential for fraud by claiming deposits before purchase or just after purchase using a copy of a bin unique code. However, GPS could be part of the smartphone app and AI technology has the potential to identify patterns of fraudulent use and could restrict individuals' ability to commit further fraud. (It will be accepted that no DRS system is likely to be 100% fraud free).
- Some local authorities have signed long-term contracts with third-part waste management companies which may invoke a substantial cost to change arrangements mid-contract. However, it is common for local authorities to attempt to maximise recycling rates and a change of contract may not be required. In comparison to the implementation of an RVM-DRS, change is likely to be less. The required legislation for any type of DRS would likely address structural changes to kerbside collection, potentially through a staged rollout.

3.3 Comparison of reverse vending machine-based DRS and a DDRS

Figure 3 illustrates the key differences between the RVM-DRS (Option 2 in the Government IA) and a DDRS.



<u>Figure 3 Key:</u>

- Red text: potential difference of DDRS with RVM-DRS
- (no.) = paragraph no. on next page.

Material flow | Deposit payment | Financial & data | Data linked to cloud

Figure 3: High-level comparison of potential differences between the systems

The key differences identified between the modelled DDRS and the Government's proposed 'all in' RVM-DRS and are as follows (bullet numbers correspond to numbers in Figure 3):

1. The introduction and high reliance on technology that **does not require as many costly RVMs and their associated costs**, such as retailer operation (labour), maintenance, value of retailer floor space (rental and opportunity cost).[18] The main tonnage of materials will be collected at the kerbside as part of existing local authority kerbside collection of recyclate, thus saving scheme infrastructure costs of a large number of RVMs.
2. In addition to a lower number of RVMs, manual take back points will be available (as with the RVM-DRS system). It is envisaged these **will require a QR scanner operated by the retailer**
3. **Potential change in kerbside collection costs** delivered by local authorities (LAs) collecting additional materials of in-scope containers (compared to current collection costs). The distribution and responsibility of costs and benefits forms part of the current Government consultation.
4. Reduced costs by there **not being a requirement for bulking and counting centres**. In the Government IA for an RVM-DRS, counting centres are required to minimise fraud by comparing container numbers returned with those registered at RVMs and other return points. Counting centres would not be required under a DDRS because the system would be able to track individual containers returned and a deposit cannot be redeemed from the same serialisation code more than once. To verify that containers are in fact entering the recycling stream, it is feasible that spot checks could be made at materials recovery facilities (MRFs) and checked against DDRS data on quantities and weight (see section 6.2 for details). For a DDRS system, local authorities (including their third-party kerbside waste contractors) use their existing bulking centres, e.g. waste transfer stations and material recovery facilities (MRFs).
5. **A DDRS's IT systems would be more complex than that required for an RVM-DRS, and this is likely to carry additional costs**. It would need to be capable of handling billions of unique container identification codes, millions of app users, and act in (near) real time in order for the system to avoid duplicate deposit returns on the same container and provide the consumer with a convenient delay-free experience. Additional costs to a DDRS system would include the development of a smartphone app and backend software technology; supporting IT infrastructure (e.g. backend server hosting or blockchain nodes), and transaction processing costs (examples have already been developed by at least three technology providers). These costs are described in more detail in section 4.3.7. RVMs would also need integration into the digital system, as would the handheld-scanner take back points.
6. Depending on the level of fraud prevention and data acquisition required, a **unique code may be required for kerbside recycling bins**, e.g. a sticker or printed mark on a recycling bin. (This would be an additional cost but it is considered to be negligible against the overall costs of DDRS and has not been modelled.)
7. The unique serialisation container codes will require purchasing **equipment to print or etch these codes on aluminium cans**. The printing equipment will have one off purchase costs as well as on-going maintenance costs. A potential cost impact for aluminium container manufacturers and / or the beverage sector is the **speed at which production lines can run with these printers**, however these issues and potential solutions are further explored in Section 4.3.1.

[18] 5,000 RVMs for a DDRS vs. 36,749 for an RVM-DRS.

8. In the Government’s IA, the arrangements for transporting recyclate to the material reprocessors via bulking / counting centre are not confirmed. It would be left to the DMO to organise, though the IA mentions that backhaul from retailers could be employed. For the DDRS modelling **it is assumed that the DMO will contract local authorities to collect materials placed at the kerbside as part of their regular recycling kerbside schemes** rather than a dedicated logistics exercise.

4 DDRS economic modelling

4.1 DDRS economic modelling – comparison with reverse vending machine-based DRS

The economic costs and benefits are presented below for a DDRS (Figure 4, as calculated in this report), RVM-DRS (Figure 5, based on previous Government IA) and the difference between the two (Figure 6).

Figure 4: Digital DRS - Economic costs (left) and benefits (right), PV 2022-32

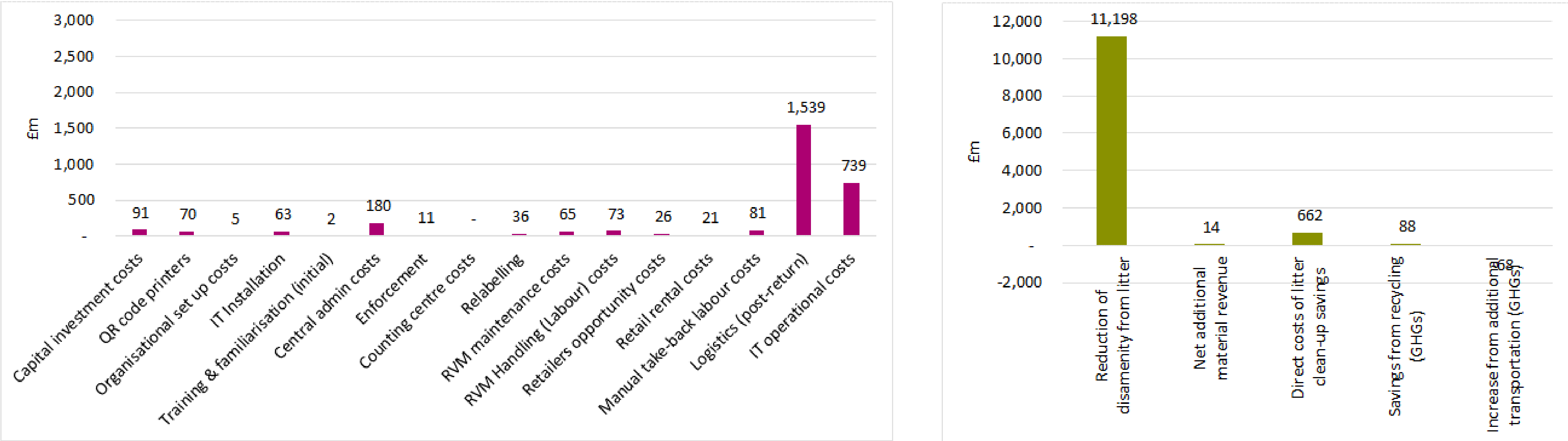
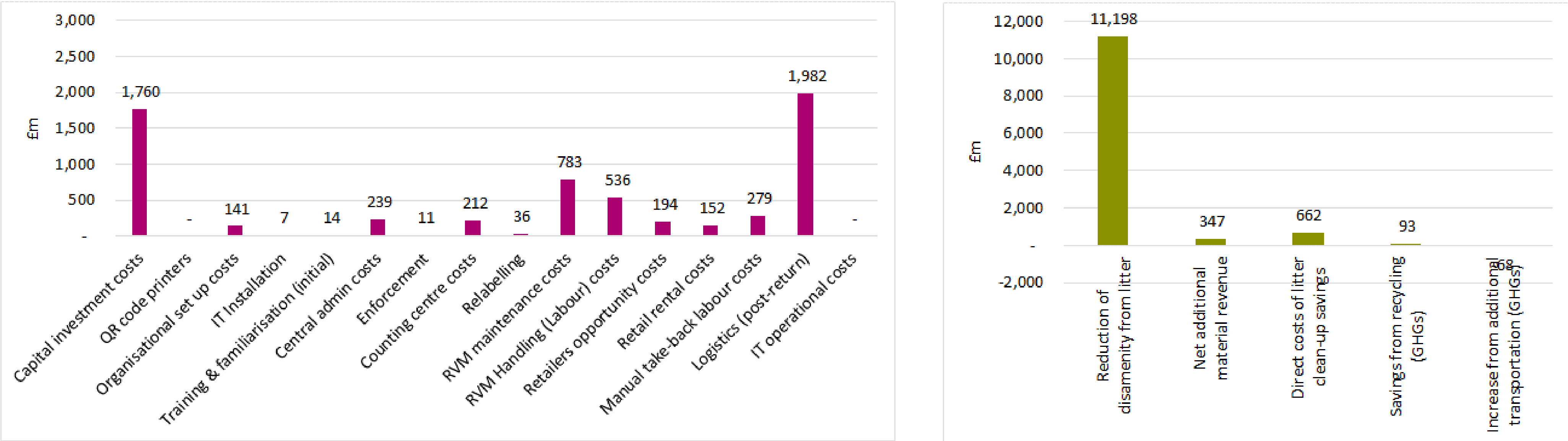
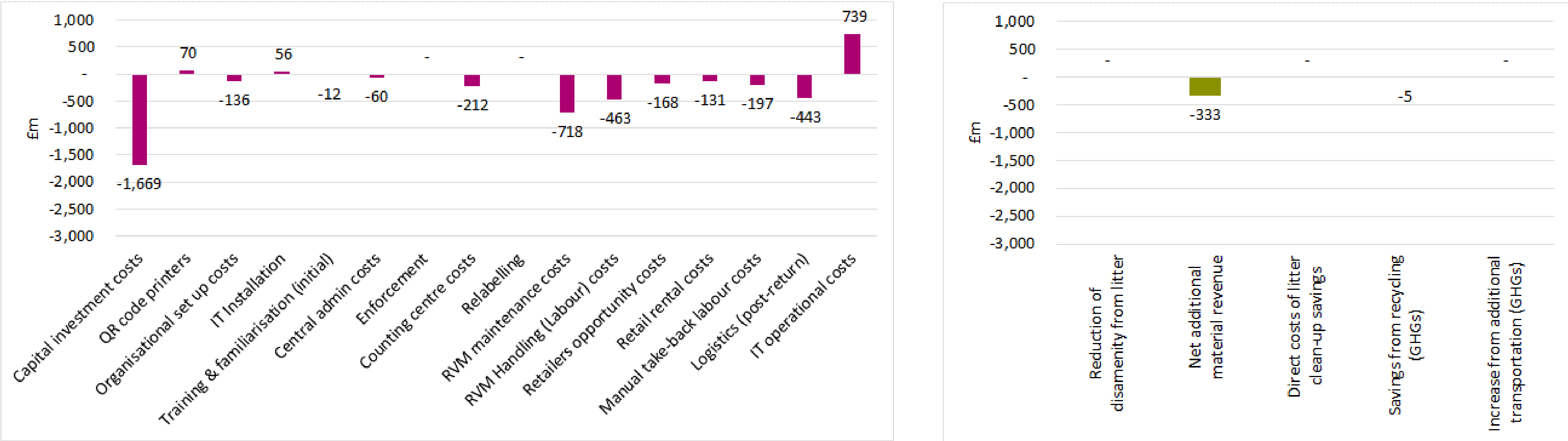


Figure 5: RVM-DRS - Economic costs (left) and benefits (right), PV 2022-32[19]



[19] Using economic cost and benefits estimates presented in: Defra (2021), Introducing a Deposit Return Scheme on beverage containers – Impact assessment, https://consult.defra.gov.uk/environment/consultation-on-introducing-a-drs/supporting_documents/Impact%20Assessment.pdf

Figure 6: Difference in economic costs (left) and benefits (right) of a DDRS compared to RVM-DRS, PV 2022-32



The figures above show that a DDRS is expected to be significantly cheaper to set up and operate than an RVM-DRS. This is largely due to a much smaller outlay in capital investment costs, as shown in the figures above. The RVM-DRS proposed in the Government IA requires £1.8 billion in infrastructure, PV 2022-32. The figures quantify the savings (previously mentioned) that are associated with DDRS requiring fewer RVMs. The logistics costs of transporting material from RVMs and convenience stores is also reduced, and although collection costs increase at the kerbside the net result is a cost saving when compared to RVM-DRS.

The DDRS introduces new costs such as the need for unique serialisation code printers for aluminium cans, and additional IT costs such as app development, servers or blockchain nodes, and digital transaction costs. However, these new costs are less than the savings in other areas, and so overall DDRS costs are lower than those presented in the Government IA for an RVM-DRS.

The net additional material revenue however is expected to be lower. The DDRS predominantly collects containers at the kerbside where the material quality based on current collection systems is, on the whole, lower due to mixing of materials. The financial value of material is therefore likely to be lower also, and this is reflected in the economic modelling. Litter reduction benefits and greenhouse gas (GHG) emissions from transportation are assumed to be the same as previously estimated for RVM-DRS. Greenhouse gas (GHG) emission benefits from increased recycling in an RVM-DRS are assumed to be 5% less for a DDRS because of the higher rate of rejected materials to make kerbside collected materials to a high quality recyclate stream for repressors. However, this differential could be reduced via changes currently under public consultation in England around consistency in recycling collections and extended producer responsibility for packaging, or by investment and innovation in the recycling value chain.

A summary of results is presented in Table 1. The first column of data presents the results from the economic impact assessment of the 'All-In' DDRS. The other three columns are reproduced from the Government IA for DRS and presented for comparison[20].

Table 1: Summary of NPV, cost, BCR, £m (2022-32) [21]

	'All-In' DDRS	'All-In' RVM-DRS (Option 2)	'On the Go' RVM-DRS (Option 3)	'No Glass' RVM-DRS (Option 4)
NPV	8,891.0	5,884.5	282	3,582.30
Total cost PV	3,002	6,346	3,503	5,491
BCR	3.962	1.927	1.081	1.65

The summary table shows that, taking the estimated costs and benefits into account, the NPV and benefit-cost ratio of an All-in DDRS are significantly higher than those estimated for an RVM-DRS. This is due to the much lower total cost of the DDRS system.

The modelling approach and assumptions used are detailed in the sections below, with a further breakdown of economic costs and benefits for each year of operation.

[20] Using economic cost and benefits estimates presented in: Defra (2021), Introducing a Deposit Return Scheme on beverage containers – Impact assessment, https://consult.defra.gov.uk/environment/consultation-on-introducing-a-drs/supporting_documents/Impact%20Assessment.pdf

[21] Calculated on the basis of accrual costs

4.2 Modelling approach

The overall modelling approach for the DDRS alternative is closely aligned with the Government's latest IA methodology for an RVM-DRS. As stated previously, the research approach was to assess key differences (described in Section 3) between the costs and benefits that a DDRS would bring in comparison to an RVM-DRS, and that is reflected in the economic modelling. Estimates of costs and benefits were calculated for a DDRS where they were considered to be likely to differ an RVM-DRS. If the cost or benefit area was deemed not to change significantly then the same values were used as those presented in the Government's IA for the RVM-DRS.

Number of return points

In the DDRS, consumers will be able to return DRS materials through their existing kerbside waste collection service, covering the 28 million households in the UK[22]. There will also be a network of public return points for consumers that cannot or do not want to engage with the digital-based system in their homes. These return points will not require the consumer to have a smartphone to reclaim their deposit, e.g. printing a voucher with the deposit value to be reclaimed at the till or working with a 'top-up' card which can be used to pay for goods in shops.

Public return points will be conveniently located to maximise access and inclusion. The minimum coverage may be around 11,600 return points – based on number of post offices in the UK which are located so that 99.7% of the population live within 3 miles of a post office.[23] However, we have modelled costs for 20,000 return points: 5,000 RVMs and 15,000 manual take-back points to further improve access and convenience. Manual take-back points are likely to suit rural communities and suburban highstreets where smaller shops have less space to accommodate RVMs, whilst RVMs can be installed in larger shops and supermarkets.

The network of public return points could be developed through engagement with retailers. Some retail outlets may prefer not to become a return point whereas others may welcome the opportunity for the additional handling fee and footfall. DRS legislation could require all supermarkets and convenience stores to take container returns if designated as a return point by the DMO. The resulting network should provide inclusion and ease of access for consumers.

Most of the DDRS material would be collected at the kerbside, with a smaller quantity going through the public return points. Assumptions on digital engagement are supported by survey results from the Whitehead DDRS trial, see section 2.2. With less material and fewer return points, we estimate that on average a broadly similar quantity of material will be handled per RVM and per convenience store under a DDRS as is handled in the RVM-DRS.

In addition, unique code marks on existing recycling on-the-go bins allow consumers with a smartphone to return containers and reclaim their deposit at these bins. This further supports the convenience of a DDRS system, particularly for drinks consumed on-the-go. This has the greatest potential to reduce litter which is associated with on-the-go materials. The quality of recyclate captured in recycling on-the-go bins is known to suffer from contamination issues. This issue could be addressed via smart bins, as described in section 6.1, although these have not been costed into the economic impact assessment at this point.

[22] https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families/datasets/familiesandhouseholdsfamiliesandhouseholds

[23] https://corporate.postoffice.co.uk/media/48108/networkreport2020_final.pdf

Return rates

The economic modelling assumes that 85% of containers are returned through the DDRS. This is the same return rate as used for an RVM-DRS in the Government IA. This is considered a conservative assumption because:

- The deposit level is the same and so the financial incentive for the consumer to return the container is the same.
- If the consumer engages with the DDRS system via a smartphone then they can return their containers in their existing kerbside recycling service, which will be more convenient for some than returning containers to an RVM or convenience store. The Government IA assumes that under an RVM-DRS 7%-10% of DRS containers will be returned at the kerbside rather than through a recognised return point, even though the consumer loses their deposit by doing so. It is likely that a DDRS will capture a proportion of this additional 7%-10% of containers, if sufficiently convenient for the consumer.
- If the consumer does not engage via a smartphone and kerbside recycling, then a suitable return point will be located within three miles of 99.7% of the population.

Further research into return rates and, in particular, the results from DDRS trials should inform future analysis and discussion.

Kerbside collections

The modelling of logistics costs and additional material revenue are based on the current kerbside waste collection services in the UK. Two proposed policy interventions could lead to significant changes in how these services are delivered: reform of EPR for packaging in the UK, and consistency in recycling collections in England. This DDRS economic impact assessment makes no assumptions about if, how and when such policy is introduced, nor the subsequent impacts upon kerbside collection services. These policies could help mitigate some of the impacts in both an RVM-DRS and DDRS if designed with this in mind.

Information technology

The costs associated with the IT to support the digital aspect of this system were derived primarily through stakeholder engagement. Resource Futures attended a workshop hosted by the IWG whereby a number of technology providers presented their current IT system for similar digital rewards-based recycling incentives. We engaged with a sample of these technology providers to understand the nuances of their different approaches and technologies. However, when engaging these stakeholders, it was made clear that the DDRS system described in section 3.2 was co-designed with the IWG and was not based on any specific technology or company offering. The engagement and support from the technology providers consulted in this research was primarily to understand and help estimate overall system costs, not costs related to any specific technology. However, we recognise that these cannot always be separated from a specific approach, and so have taken a conservative approach in the modelling and not used the lowest cost estimates provided. These costs are explained in further detail in section 4.3.7.

4.3 Costs

4.3.1 Labelling and impact on production line speed

A cost impact for container manufacturers and / or the beverage sector is a potential negative impact on the speed at which production lines can run, to accommodate the printers and activation cameras required to print unique codes. However, opinions differ on how serialisation will affect production line speed.

Most stakeholders consulted in this research agree that the issue of slowing down production lines is only currently an issue for aluminium cans, due to the filling and printing process. Whereas printers for traditional labelling on PET, carton and glass can support unique serialisation, etching printers on aluminium cans work in 'batches' that do not currently support unique serialisation.

One solution is to have the serialisation printed on the top rather than the body of the can, as this would solve the problem of separation and positioning of the can in the filling lines that would be required to consistently print a code on same part of the body of the can. However, as there is currently no printing on can ends, investment would be required to upgrade lines to include a printer. The question of which lines should be upgraded is an active area of research; there is currently no industry position as to where a printer would be most suited, i.e. either at the filling lines or the can end packaging production lines.

Placing the printers on can end production lines would require the printer to match the high production speeds (2,400-2,500 can ends per minute). Currently, high-speed serialisation printers compatible with aluminium cans print at about 2,000 cans per minute, so placing the printers at can end production lines would result in some slowing of production lines of about 400-500 cans per minute. Whether faster printers can be developed for this purpose should be explored in further research[24]. We estimate that there are 23 canning production lines in the UK making can bodies and can ends, however the split between the two was not able to be determined. At a unit cost of £425,000 for a high-speed printer and a conservative estimate of 23 production lines, the one-off labelling cost would be £9,775,000.

Another option is to place the printers on filling lines. This may be more straightforward, with little risk to slowing down production lines as the filling lines run at slower speeds and thus would be compatible with slower printers. However, we were unable to establish an accurate number of filling lines in the UK. One canning industry stakeholder estimated it to be between 100 and 500. At a unit cost of £212,500 for a printer that can run at approximately 840 cans per minute, on an average of 300 filling lines, the one-off labelling cost would be £62,750,000.

To reflect that this active area of research with currently no position as to the preferable placement of the printers, for the purposes of our modelling, we have taken an average of the two estimates, to arrive at a capital investment cost of **£36.76 million** for serialisation code printers and a replacement rate of five years.

For PET, carton and glass container production, most stakeholders believe that unique serialisation would not slow down production lines, as the codes can be printed offsite/at a pre-production stage using existing printers (e.g. at labelling phase), then placed onto the containers in the filling lines as usual[25]. Therefore, no additional printer infrastructure costs are applied for producers of PET, carton and glass for the printing of unique codes. Other costs associated with updating PET, carton and glass container labels are included in the relabelling cost below.

[24] According to tech providers, laser etching is beginning to be available to the canning industry as well.

[25] Note, costs for updating the current printers to support a digital element to print a serialisation code is covered in the £38.67 million one-off cost explained in the last paragraph of this section.

It is worth noting as well that printing technologies are advancing. In some cases, it may be possible to retrofit the commonly used continuous inkjet printers (CIJ) with thermal inkjet printers (TIJ). CIJ printers have typically always been able to print at faster speeds, but TIJ printer technology is progressing quickly and have various other benefits, such as clearer printing quality and resolution, lower maintenance, and better compatibility with printing on metals. The cost difference between a CIJ vs TIJ printer to support high speeds could not be identified at this time.

DRS bearing containers will require new label design and relabelling. The same cost is used as presented in the Government IA: **£38.67 million one-off cost** in 2023. This is a slight overestimate for DDRS costs as aluminium cans will have the serialisation printed on the can lid and therefore will not require changes to the label design (unless there is reason to also require a DRS scheme logo on the can and this cannot be printed through the same means as the serialisation code).

4.3.2 Reverse vending machines (RVMs)

Table 2: Summary of costs for simple RVMs. Note: all costs are on a per unit basis.

Location	Machine type	Unit cost (CAPEX)	Maintenance cost per year (OPEX)	Installation cost	Lifespan / depreciation period (years)	Floor space
Supermarkets	Simple RVM	£11,200	15% of CAPEX	£1,350	7	5 m^2

RVMs under a DDRS differ from those under an RVM-DRS in that the only technology required of the RVM is a serialisation code reader, and an aperture that opens accordingly to allow containers to enter. For this reason, the Tomra-style RVMs with advanced weighing and container identification functions were not used to model the economic impact of a DDRS.

The simplest RVM, such as the one in Figure 7, has 360-degree serialisation code reader and consolidates the collected products without major sorting and with limited compaction capabilities. It is dedicated for mid to large traffic areas such as supermarkets. They differ from a traditional RVM in that they do not have major conveyer belts, weighing or sorting capabilities. Other RVMs have greater sorting and compaction capabilities and our costs are based on the top end of such machines.

Connectivity (solar or connected to the shop's power source) is required in order to establish an internet connection to confirm in real-time that that the serialisation code bears a deposit. It can, however, be used without smartphones. The bin can transfer the deposit onto a user's gift-card type personal card.

Figure 7: Example simple RVM. Source: RLG

Unit costs

Unit costs for simple RVMs was estimated to be **£11,200**. This cost is the higher end of the price range provided by RLG Ltd, which ranged from £8,500 for single chamber and no compaction, to £11,200 for multi-chamber and compaction RVMs. To increase efficiency and remain conservative in our modelling, we have modelled the higher price estimate.

Installation costs

Installation costs were estimated to be £1,350 per unit. This was estimated based on assumptions by RLG that installation costs would be approximately half of a traditional RVM (estimated at £2,700 in the Government's IA). Installation costs will be linked to connecting the machine to a power source, installing it, and training supermarket staff.

This cost also includes the cost for an inbuilt communication module to enable connection to the wider data system in real time, but the software cost for the whole system is charged separately (see section 4.3.7 IT Costs).

Maintenance

Maintenance costs were estimated at 15% of unit costs per year. In this case, the annual maintenance costs would be approximately £1,680 per RVM.

Floor space and staff time

Tech providers have provided an estimated floor space of 1 m^2 for each simple RVM, but we have assumed the same floor space as in the Government's IA (5 m^2) as this is mostly space to store materials, and we assume the volume of materials going through each RVM will be roughly the same as per the RVM-DRS.

However, it is important to note that in our discussions with retailers, they have revealed that RVM floor space is often underestimated, and in fact is probably larger that the Government's estimate of 5 m^2.

Understanding an accurate floor space is critical when considering rental and opportunity costs to retailers from the lost space.

We have assumed the same staff time will be required for a simple RVM and a traditional RVM.

4.3.3 Recycling on-the-go bins

For the purposes of this research, we have considered recycling on-the-go to follow the same arrangement as the kerbside collections element of a DDRS. That is, existing on-the-go bins (e.g. general litter recycling bins, or other specialised litter bins for specific waste streams) would have a unique code attached to it, most likely in the form of a sticker. The user would then scan the sticker using their mobile phone app, scan the in-scope item, and then deposit the item in the bin as they would normally.

Under this system, capital costs are negligible when compared to the full cost of the system, as it relies on existing infrastructure and is supported by the software/mobile app, whose set up and operating costs are covered and discussed in section 4.3.7.

The on-the-go waste infrastructure is a topic of great interest as it has the potential to greatly influence litter and visual disamenity costs. Through a DDRS, it is expected that users will be incentivised to correctly dispose of their containers in a litter recycling bin in order to claim back their deposit. A DDRS has the added convenience of on-the-go locations rather than centrally located RVMs. However, under the current design there would be no way to verify that the item was deposited correctly, inside the bin, and not beside it or near it. Measures should be put in place to ensure on-the-go recycling bins are not left full in order to prevent side-waste and litter.

However, there are many innovative recycling on-the-go technologies under development and currently on the market that could be compatible with a digital app. While we have not included them in the economic appraisal, these technologies are discussed qualitatively as potential areas for further developments in section 6.1.

4.3.4 Manual Take-Back

Table 3: Summary of costs for handheld scanners. Note all costs are on a per unit basis.

Scenario	Machine type	Unit cost (CAPEX)	Maintenance cost per year (OPEX)	Installation cost	Lifespan / depreciation period (years)	Floor space
Convenience stores	Handheld scanner	£165	Replacement cost only	£35	7	n/a

For the purposes of the economic impact assessment, we envisage that manual take back will operate via a handheld scanner located in and operated by convenience stores and smaller chain outlets. This technology is readily available on the market, and while it is currently used in other contexts (e.g. parcel return points in convenience stores), the technology exists and can be adapted to suit the DDRS system. Technology providers engaged in this research have included handheld scanners in trials, internal research, and even for use in the home. Handheld scanners for use in the home are discussed in Section 6 Potential further developments.

<u>Handheld scanner unit price</u>

The unit price for a handheld scanner has been estimated at **£165**. This is based on an average of prices provided by various tech providers. Initial research into prices for handheld serialisation code scanner ranged from £30 to £430. After discussions with UK-based tech providers, the appropriate technology was identified to meet the requirements and this range was lowered slightly to £30-£300.

<u>Installation costs</u>

Installation costs have been estimated at **£35 per unit**. Handheld scanners will arrive at convenience stores with clear installation and training instructions on the package. RLG estimated between £20 - £50 for the costs of creating the training package.

This cost includes the cost for an inbuilt communication module to enable connection to the database in real time, but the software cost for the whole system is charged separately (see section 4.3.7 IT Costs).

<u>Maintenance</u>

According to RLG, handheld scanners have no running annual maintenance cost, barring electricity and data charges, which are minimal in the scale of economic costs modelled. Maintenance costs are considered only when replacement of the machine at the end of its life span is required, approximately 5-10 years.

<u>Floor space and staff time</u>

Floor space is not a consideration for handheld scanners, as they will be on a countertop within reach of the convenience shopkeeper, e.g. next to the cash register.

4.3.5 Logistics costs

Logistics costs are those that would be incurred by the DMO for the DRS in-scope materials and were calculated in two stages:

1) Kerbside collections (envisaged to be contracted to local authorities); and,
2) RVMs, manual take-back and recycling-on-the-go.

<u>Kerbside collection costs</u>

A weighted average cost per tonne for kerbside collection of recyclate was calculated at £90.82. This was derived from data for comingled, multi-stream and twin-stream collection profiles. Cost data was sourced from Resource Future’s specialist Waste Services Optimisation Team and its bespoke models.

Multiplying the average collection costs by the in-scope DDRS kerbside collection weight of 1,706,358 tonnes derived an average annual logistics cost of £155m.

<u>RVMs, manual take-back and recycling-on-the-go</u>

Average (mean) logistics costs per tonne were calculated from data included in research conducted for the Scottish DRS.[26] Costs from the report’s ‘Low Scenario’ (85% return rate) were used. These costs comprise:

- Transport costs - backhauling
- Transport costs - dedicated rounds
- Transport costs - hauling uncompacted manual containers from depots to counting centres
- Transport costs – pickup and unload (backhauling and dedicated rounds)
- Container costs

[26] Eunomia (2015); A Scottish Deposit Refund System, Final Report for Zero Waste Scotland.

The ratio between lower-cost per tonne backhauling and high-cost dedicated rounds was assumed to be the same as used in the Scottish DRS research.

The costs per tonnes were inflated to 2018 prices, as the price base used in the economic model. A further 20% was added to costs as a conservative modelling approach to reflect that the DDRS system largely relies on kerbside collections with less material collected at RVMs and manual takeback, and so collections from these return points may be less cost-efficient. The Scottish DRS, on which the cost per tonne is based, is relatively small tonnage and more spread out geographically per tonne, and so arguably it could balance out without the extra 20% adjustment, but the modelling errs on the side of caution. The cost per tonne of £80.80 was multiplied by the weight of in-scope materials to be collected (325,020 tonnes) to an average cost of £44m per annum.

Total logistics costs

Total logistics costs for in-scope DDRS materials is modelled to be **£200m per annum**.

4.3.6 Counting centres and central administration

No counting centres will be required under DDRS because the blockchain technology will largely negate fraud and tonnage errors by itself (see Section 3.3). Nor are counting and bulking centres needed to aggregate DRS material for sale. The DDRS system records exactly how many containers are collected and where they are collected, and so can infer which local authority is responsible for kerbside collections. Contracts can therefore be negotiated on this basis and indeed can be linked to exact quantities of material in the DDRS data system, if desired.

After subtracting the costs of counting centres, the Government's IA describes £30m of 'central administration costs' to be for:

- bulking centres
- cost of fraud
- communications
- staff employed directly by the system

Neither the IA nor its reference sources provide a breakdown of these four costs.

For a DDRS it is assumed that DMO-operated bulking centres will not be required. As a pragmatic modelling approach, it is assumed that each of the four costs are equal and, therefore, the non-requirement for bulking centres will result in a 25% reduction in costs. Consequently, the annual central administration cost under DDRS is assumed to be **£22.5m per annum**. The risk of fraud is expected to be reduced via DDRS serialisation and supporting technology such as blockchain distributed ledger, but it is not possible to quantify the impact at this point and so the costs of fraud have not been altered for this economic impact assessment.

4.3.7 Information technology

IT costs is one of the major cost differences between an RVM-DRS and a DDRS. Estimating the costs for such an IT system is complicated, largely due to the fact that this type of technology has not yet been employed for this purpose at scale and to the exact system design described in section 3.2. Nonetheless, the technology to support digital rewards-based recycling exists, and trials have been undertaken in the UK to investigate its economic impacts.

For this research, we have spoken with various technology providers to understand different cost structures and estimates for a national-scale DDRS. While cost structures vary greatly depending on the technology solution, we have been in close communication with these stakeholders to ensure that the final global figures and cost headings presented below are reasonable. Various technologies are available, and further research should compare their relative costs and benefits. The figures used are reflective of what a blockchain-based system for unique serialisation of in-scope DRS containers at UK-scale might look like.

Whilst great care was given to produce the most representative figures, these are based on best available data and assumptions and are thus indicative. Furthermore, various forms of serialisation (e.g. data matrix) and other digital platform options (other than blockchain) are available, and these are briefly discussed at the end of this section.

Development of a smartphone app & backend software: **£400k**

To support a national DDRS, a smartphone app and supporting backend software will need to be developed that can be used by several million people and record several billion transactions every year. The question of operating a technology solution at scale has been raised as a point of concern by some stakeholders. Several companies are building their solutions on existing IT infrastructure designed for high volume transactions and scalability. For example, one technology producer, Metrisk, has confirmed that that under current and planned schemes, their technology (which is closely aligned with the technology we are proposing in this IA) could be scaled to support a UK-wide DDRS, as it is built on Amazon Web Services (AWS), which is currently used to support over 200 million of Amazon's own customers.

The cost of producing such an app is dependent on the features required, and until these requirements are specified it is difficult to quantify. Initial conversations with tech providers revealed this could cost anywhere from £250,000 to £500,000. We have conservatively based the economic modelling on a one-off cost of £400,000, which would include costs to programme the software with all the code variations on different products.

Backend server hosting costs: **£65m one-off + annual maintenance of £15m**

The costs modelled are based on blockchain as the platform for secure data transaction. With this technology, another cost area under a DDRS will be the 'nodes' which effectively store and manage the blockchain data. One technology company estimated 200 nodes would be required for the expected transaction volumes, with a total capital cost of £65m with annual maintenance of £15m. This annual maintenance cost would include the activation of serialisation codes onto the system. These costs could potentially be reduced via use of virtualised servers and existing infrastructure such as AWS or Azure, and could be split across producers dependant on size. Furthermore, backend server hosting costs could be further reduced under a non-blockchain solution, discussed in more detail under 'Other options' below.

Recurring transaction/processing cost: **£0.004 per transaction**

These are costs related to processing the data through the system when a container is returned (i.e. connecting the user to the serialisation code, the serialisation code to the code ledger and the related deposit, and the deposit back to the user). At a return rate of 85%, 20 billion containers will be returned through the system each year and so this recurring transaction/processing costs will likely be a high cost area for the IT system (~**£81m per annum** estimate for a blockchain solution). However, this process is critical to securely handle the deposits being managed by the system.

Other options

While we have based our initial modelling on blockchain-based technology, it is important to note that there are other technology solutions available. While there are concerns around the associated carbon footprint of blockchain, particularly stemming from reported emissions of bitcoin applications, the blockchain technology option under a DDRS would not need to be as energy intensive. The benefit of blockchain is that it provides a very secure and decentralised platform. Nonetheless, other technology solutions exist besides blockchain, which offer a different balance of costs and benefits, including different approaches to security and fraud prevention measures (e.g. to avoid double counting a deposit or hacking the system to alter the deposit records). According to one stakeholder, fraud is an area often underestimated, and that has the potential of totalling upwards of £100m a year.

Different serialisation options exist as well. QR codes are just one option and whilst QR codes do offer suitable unique serialisation, they require a minimum resolution in the visual mark which in some cases may be limiting, particularly on smaller packaging with limited label space. Some manufacturers prefer smaller resolution codes, such as data matrix, or expanded batch codes to uniquely identify their products.

The technology provider that supports the technology behind DDRS should consult with the packaging sector on which serialisation option would be most suitable for their packaging. Flexibility on the codes accepted by the system is important, and many of the technology providers consulted in this research can support such flexibility.

4.3.8 Overall Costs

Table 4 sets out the estimated costs at the UK level over the appraisal period. The costs presented recognise that there will likely be a phased introductory period, with a staged adoption in the first three years. The economic impact assessment uses a price base of 2018, PV base 2022, time period 11 years, and discount rate 3.5%, consistent with the Government IA. Table 4 on page 36 can be compared to Table 2 in the Government IA, which outlines the economic costs of an All-In DRS in the same manner.[27]

Capital investment costs presented in Table 4 include the costs of purchasing RVMs and handheld scanners. RVMs and handheld scanners are assumed to have an average lifespan of seven years, and the high-speed serialisation code printers are assumed to last five years. These costs are therefore repeated on a seven and five-year bases in the yellow rows in the table, presenting the accrual costs. In line with the Government's IA it is assumed that, once purchased, these assets will still have some value beyond the accounting period if they have not reached the end of their lifespan. An accounting provision has been used in the table at the end of the appraisal period to account for any remaining asset value in the equipment. In the case of the capital investment costs described above, this is presented as a negative cost in 2032. In the case of serialisation code printers this value is subtracted from the replacement cost in 2032.

The annualised cost of capital is presented in the blue table row, and represents both the capital investment costs and the serialisation code printer costs.

Additional counting centres and bulking points are not required for the DDRS. However, when these costs were subtracted from the Government IA figures there remained no organisational set-up costs. Whilst many of the set-up costs for DDRS are covered in other cost headings, e.g. IT installation and relabelling,

[27] Defra (2021), Introducing a Deposit Return Scheme on beverage containers – Impact assessment, https://consult.defra.gov.uk/environment/consultation-on-introducing-a-drs/supporting_documents/Impact%20Assessment.pdf

there will be some organisational set-up costs for any system, e.g. to set up the DMO. An additional £5 million has therefore been allocated in 2022.

Table 4: Economic Costs of All-In Digital DRS (DDRS)

Costs £m	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Capital investment costs	50.10	9.39	6.26	0.00	0.00	0.00	0.00	50.10	9.39	6.26	-31.31
QR code printers	36.76	0.00	0.00	0.00	0.00	36.76	0.00	0.00	0.00	0.00	7.35
Cost of capital - annualised	17.53	17.53	17.53	17.53	17.53	17.53	17.53	17.53	17.53	17.53	17.53
Organisational set up costs	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IT Installation	65.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Training & familiarisation (initial)		2.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Central admin costs		22.35	22.35	22.35	22.35	22.35	22.35	22.35	22.35	22.35	22.35
Enforcement		1.55	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31
Counting centre costs		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Relabelling		38.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RVM maintenance costs		6.30	7.56	8.40	8.40	8.40	8.40	8.40	8.40	8.40	8.40
RVM handling (labour) costs		7.09	8.51	9.45	9.45	9.45	9.45	9.45	9.45	9.45	9.45
Retailers opportunity costs		2.57	3.08	3.43	3.43	3.43	3.43	3.43	3.43	3.43	3.43
Retail rental costs		2.01	2.41	2.68	2.68	2.68	2.68	2.68	2.68	2.68	2.68
Manual take-back labour costs		7.92	9.50	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56
Logistics (post-return)		149.69	179.62	199.58	199.58	199.58	199.58	199.58	199.58	199.58	199.58
IT operational costs		71.89	86.26	95.85	95.85	95.85	95.85	95.85	95.85	95.85	95.85

Total Cost	157.26	321.46	326.86	353.61	353.61	390.37	353.61	403.70	363.00	359.87	329.65
	87.93	329.60	338.13	371.14	371.14	371.14	371.14	371.14	371.14	371.14	371.14

Present Value **(Costs)** (2022-32)	**3,002**
	2,999

EAC Gross (2022-32)	**£322.22**

The transition period from 2022-24 represents the staged adoption of a DRS, consistent with the Government IA. The total cost over this three-year transition period is shown in Table 5. This is calculated by simply summing the 'Total Cost' (yellow row for accrual costs) in the table above. The average annual cost after the transition period (2025-32) is also presented. The same values are presented for the All-In RVM-DRS for comparison. Note that these values differ from the transition and average annual costs presented in the Government IA, which uses a different method. A simpler calculation method was used in the table below to allow a fair comparison of DDRS and RVM-DRS.

Table 5: Transition costs and average annual cost, constant price, £m

	'All-In' DDRS	'All-In' RVM-DRS
Transition costs (3-year total, 2022-24)	806	2,430
Average annual cost (excl. transition)	363	651

4.4 DDRS economic modelling – benefits

4.4.1 Litter disamenity value

The benefits of reducing the total disamenity value of litter under a DDRS are conservatively assumed to be the same as those delivered by an RVM-DRS as the same return rate is modelled (85%). This is a conservative approach because it is plausible that the convenience of engaging with a DDRS at the kerbside could attract greater container return rate from consumers.

4.4.2 Environmental impacts

GHG emissions modelling is often complex, combining many different factors including defining a model boundary, activity data, and choice of carbon factors (and understanding what they do a do not include to avoid double-counting). The Government IA does not sufficiently describe the calculation method used in order to create a like-for-like comparison.

Whilst sorting of kerbside-collected materials can produce high-quality materials for recycling, the sorting process would likely have a greater proportion of rejected materials than materials collected by RVMs and manual take-back points. To take this difference into account, the Government IA GHG emissions reduction value is assumed to be 5% lower for DDRS.

The Government IA values for 'Increase from additional transportation (GHGs)' are assumed to be the same for a DDRS.

Qualitatively, some sources of emissions will be higher, and some will be lower. In a DDRS, more material will be collected at the kerbside than at RVMs and manual take-back. This material is likely to require more processing to reach the same material quality for recycling, and these processes will emit GHGs. However, logistics are likely to be more efficient under a DDRS than those needed for an RVM-DRS. For the most part, consumers can return containers via their kerbside recycling collection and so do not need to transport the containers to a supermarket or convenience store. The degree to which these journeys under an RVM-DRS would be 'additional' is yet to be determined, but some will inevitably create GHG emissions that are reduced with DDRS kerbside container return. Furthermore, collecting materials at the kerbside using existing recycling services is likely to be significantly more efficient than creating a new waste collection and logistics service to collect materials from RVMs and manual takeback points. The waste collection and transportation emissions are therefore less under a DDRS compared to an RVM-DRS. A reduction in vehicle use would also result in reductions of emissions of NOx and particulates, including those from tyres and brake pads.

A DDRS would also avoid the embodied and operational carbon from dedicated DRS counting and bulking centres.

In addition, a DDRS would have much less reliance on RVMs – infrastructure which will, according to the Government IA estimates, last an average of seven years before requiring replacement. A DDRS would instead largely utilise smartphone technology, which is not dedicated to DRS (having numerous other daily uses) and is a pre-existing asset owned by members of the public.

It should be noted that the GHG emissions of the IT system must also be carefully considered. For example, blockchain provides security against tampering using a distributed ledger and decentralised records which are verified by multiple points. This technology can be computationally demanding, resulting in higher GHG emissions from electricity consumption. However, other technologies could be employed instead of blockchain using other methods to avoid tampering and fraud. The IT system used for DDRS is yet to be determined and so the associated GHG emissions are also as yet unknown. Given this uncertainty, the GHG emissions have not been separately calculated, but the costs presented above for DDRS information technology include the cost of offsetting GHG emissions. GHG emissions will be an important factor in future research to compare different IT systems that could be used to implement DDRS.

4.4.3 Net additional material revenue

Introducing a DRS is expected to increase recycling rates for the DRS containers as a whole. The Government IA estimates the revenue that would be received from this additional recycling, and this method is adopted for consistency when estimating the impacts of a DDRS.

RVMs and manual takeback typically produce a relatively homogenous waste stream by excluding non-target materials. Similarly, with multi-stream kerbside collections materials are actively selected by the waste vehicle crew and non-target materials are left behind. With comingled and twin-stream collections crews empty whole recycling containers into the waste vehicle compartments, which can introduce non-target materials and requires further processing at a MRF leading to losses from imperfect sorting.

However, RVMs do not necessarily produce the highest quality recyclate for all materials. Stakeholders from the glass industry have expressed that multi-stream kerbside collections may be preferential to RVMs for high quality glass recycling. If RVMs use compaction the glass collected will be broken and mixed colour, and therefore will require colour sorting leading to a high degree of losses compared to multi-stream collection where glass containers largely remain unbroken. The use of compaction for glass must therefore be carefully considered, weighing up RVM space requirements with material quality considerations. Indeed, some RVMs offer a 'soft drop' for glass to prevent breakages. A stakeholder from the aluminium industry also commented that the industry is able to handle the contamination associated with municipal waste streams, and do not necessarily need the homogenous waste stream associated with RVMs as they have already invested in recycling infrastructure to deal with contamination.

Nonetheless, for the purposes of the IA we assume that the additional recycling captured by a DRS will be, on the whole, of higher quality in RVM-DRS than in DDRS, given the current mixture of multi-stream, twin-stream and comingled kerbside collections. This will be reflected in the revenue gained from recycling this material. To estimate the net additional material revenue, the higher material values from the Government IA were applied to the additional recycling captured at RVMs and manual takeback, and much lower material values were applied to the additional material captured at the kerbside.

The material values used are shown in Table 6. High material values are taken from the Government IA of RVM-DRS. Kerbside material was not part of the impact calculations in the Government IA and so material values were not published. The collected material typically has a positive market value once it is separated and cleaned and ready to be used in manufacturing new goods. This 'ready for manufacturing' material typically competes on price with virgin material, although due to growing environmental awareness and public corporate commitments, brands and manufacturers are increasingly seeking recycled material for its environmental benefits too.

Multi-stream collections separate materials at the kerbside as waste operatives sort materials into different compartments on the collection vehicle and leave behind items not suitable for recycling that were mistakenly put out by the householder. This additional time to sort materials is reflected in the higher collection costs of multi-stream authorities and was factored into the logistics costs calculations. Comingled and twin-stream do not have such a high degree of separation at the kerbside, require less labour in putting materials in the collection vehicle, and so logistics are often cheaper. However, the kerbside material from comingled and twin-stream collections requires additional sorting, typically at a Materials Recycling Facility (MRF). Whilst the MRF will eventually receive a revenue from selling most materials, it will incur costs in sorting, removal of contamination and cleaning the materials ready for sale. Costs include labour, electricity, rent, and capital expenditure in buildings and equipment. Contracts vary around the UK, and the allocation of costs and revenues can be quite complex. However, we assume that on average MRFs charge collection authorities for the kerbside waste material received (known as a gate fee).

MRF gate fees for comingled and twin-stream collection authorities are shown in Table 7. Multi-stream authorities collect material through manually sorting items onto separate compartments on the collection vehicle, as described above, producing relatively homogeneous waste streams similar to RVM outputs. The RVM material value projections are adjusted to account for any difference. Aluminium and steel hold their value well and are relatively easy to remove small levels of contamination, and so it would be reasonable to assume there would not be a major difference between RVM and multi-stream material values. The value for multi-stream aluminium is therefore set at £50/t lower than the average value for RVM aluminium, and the multi-stream steel value is set at £10/t lower than the average RVM value. Even though plastics and aluminium are often collected in the same compartment of a multi-stream (kerbsort) vehicle the aluminium is easily separated using an eddy current separator. The material value for multi-stream mixed polymers is taken from the Materials Recycling World (MRW) materials pricing report (average of mid-point prices in

2020). This reflects that RVMs will collect only drinks containers (predominantly PET), whereas multi-stream collections may integrate DDRS collections into existing kerbside collection services and so mix the containers with non-DRS items such as pots, tubs and trays. The value of multi-stream collected glass was set at the average value for RVM glass, reflecting comments above that multi-stream glass is expected to be at least as good as RVM output. Kerbside material values were kept constant throughout the policy appraisal time period. Actual current prices are dependent on when local authorities have entered into contracts with the MRF. There are also a variety of contract types with some including a profit share mechanism on the value of material once sorted by the MRF.

Table 6: RVM and kerbside multi-stream material values

£/tonne	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Aluminium: High Quality	862.9	872.8	879.8	889.3	898.6	906.1	908.4	911.4	915.9	921.7	928.9	937.5
Steel: High Quality	123.0	133.2	136.4	143.2	151.5	158.2	162.6	164.7	164.8	163.2	159.9	155.1
Mixed Polymers: High Quality	182.5	199.6	212.5	221.5	224.2	221.4	216.4	212.4	206.5	198.7	189.1	178
Glass: High Quality	16.9	17.8	18.3	18.6	18.9	19.1	17.3	15.9	15.4	15.2	14.6	14.1

£/tonne	Multi-stream
Aluminium	852.8
Steel	141.3
Mixed polymers	88.1
Glass	19.1

Table 7: MRF gate fees

£/tonne	Comingled	Twin-stream
Mixed materials	-40.0	-10.0

4.4.4 Overall Benefits

The following table sets out the estimated benefits of the DDRS at the UK level over the appraisal period. As per the cost estimates, the presentation of benefits recognises that there will likely be a phased introductory period, with staged adoption leading up to 2025. The table below can be compared to Table 8 in the Government IA, which outlines the economic benefits of an All-In RVM-DRS in the same manner.[28]

Table 8: Total Economic Benefits of an All-In Digital DRS (DDRS)

Benefits (m)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Reduction of disamenity from litter	1089	1307	1452	1452	1452	1452	1452	1452	1452	1452
Net additional material revenue	1.19	1.56	1.86	1.93	1.95	1.83	1.74	1.68	1.63	1.54
Direct costs of litter clean-up savings	64.33	77.2	85.78	85.78	85.78	85.78	85.78	85.78	85.78	85.78
GHG emissions										
Savings from recycling (GHGs)	1.70	4.42	8.15	9.48	10.90	12.41	14.00	15.70	17.89	20.21
Increase from additional transportation (GHGs)	-3.31	-3.61	-4.32	-5.74	-8.57	-10.02	-11.78	-12.11	-13.52	-15.26
Total Benefit	**1153**	**1387**	**1543**	**1543**	**1542**	**1542**	**1542**	**1543**	**1544**	**1544**

Present Value (Benefits)	
(2022-32),	**£11,893m**

4.5 DDRS economic modelling – net present value and benefit-cost ratio

Taking the benefits and costs together, the table below presents the overall situation in terms of:

- **B – C** – Net benefit in each year, calculated as benefits (B) minus costs (C). A positive value means that the estimated benefits outweigh the estimated costs in that particular year. Yellow rows use accrual capital expenditure costs, blue rows use annualised capital costs.
- **NPV (B-C)** – Net present value (NPV) of net benefit over the 11-year period of the economic appraisal. A positive value indicated the value to which the estimated benefits outweigh the estimated costs.
- **BCR** - Benefit to cost ratio (BCR), calculated as the present value of benefits divided by the present value of costs. A BCR greater than 1 means that overall the estimated benefits outweigh the

[28] Defra (2021), Introducing a Deposit Return Scheme on beverage containers – Impact assessment, https://consult.defra.gov.uk/environment/consultation-on-introducing-a-drs/supporting_documents/Impact%20Assessment.pdf

estimated costs. A BCR of 2 for example indicates the value of the estimated benefits is twice the value of the costs.

Table 9: BCR and NPV of an All-In Digital DRS (DDRS)

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
B - C	-157.26	831.44	751.09	975.79	975.77	974.38	974.32	2.45	793.19	854.64	1583.84
	-87.93	823.31	680.48	783.72	783.70	782.31	782.25	781.99	783.30	784.03	784.52

NPV (B-C)	**£8,891.03**
BCR	**3.96**

4.6 Funding the DRS

It is noted that the producer fee and use of unredeemed deposits (URD) is subject to the current Government public consultation. For the purpose of comparison, the same assumptions are followed as used in the Government IA for RVM-DRS, i.e.:

- Additional net material revenue is used to offset the costs of the DRS
- Producer fees will make up 50% of the remaining DRS net costs
- Any additional unredeemed deposits needed to fund the day-to-day costs of the scheme will be reinvested into the scheme

Table 10: Funding the DRS, 2022-32 £m

All-In DDRS	
URD @ 85% RR	**738.55**
EAC to businesses (85%) (2022-32)	**322**
Material revenue - Equiv. Annual revenue of recycling materials	**1.5**
Net cost as EAC	**321**
Producers' fees obligation @ 50% liability for EACB	**160**
URD requirement (for outstanding/remaining costs)	**160**
Excess URD @ 85% RR	**578.17**

All-In RVM-DRS	
URD @ 85% RR	**738.55**
EAC to businesses (85%) (2022-32)	**681**
Material revenue - Equiv. Annual revenue of recycling materials	**37**
Net cost as EAC	**644**
Producers' fees obligation @ 50% liability for EACB	**322**
URD requirement (for outstanding/remaining costs)	**322**
Excess URD @ 85% RR	**416.55**

Comparing the results for the two DRS designs in the table above, the net cost as EAC (equivalent annual cost) of the All-In DDRS is £323m lower than that presented in the Government IA for an All-In RVM-DRS – i.e. an annual cost saving of £323m over the 11-year period, including set up costs and material revenue.

This results in an equivalent annual saving of £162m in producer fees (50% saving) and an additional £162m of excess unredeemed deposits (39% increase) when compared to the All-In RVM-DRS.

4.7 Key assumptions and limitations

The Government identified a number of areas for further research identified in the IA of RVM-DRS. This report presents an initial design for a DDRS to achieve the same objectives, and some indicative modelling of costs and benefits. However, the discussion and design of a DDRS in the UK is less developed than for RVM-DRS and would benefit from further research and discussion with industry. With this in mind, key assumptions and limitations of the DDRS impact assessment are discussed below.

The economic modelling is designed to present high-level indicative results, suitable for exploring the economic case for implementing DRS in the UK via DDRS. More detailed estimates of costs and benefits could be derived through further research, and by exploring different system designs.

The return rate of a system is likely to have the most significant impact on the costs and benefits. A key question is whether the additional convenience of collecting containers at the kerbside outside consumers homes would improve the return rate, and therefore increase the material captured and further reduce litter. Integrating with or enhancing existing recycling-on-the-go infrastructure could further improve return rates, particularly for on-the-go materials which have the highest risk of littering. On the other hand, fewer RVM and manual take-back points could reduce the convenience for consumers wishing to return containers outside of the home. On balance, this could result in a higher or lower return rate. Further research is required to understand return rates likely under each system.

The serialisation mark used is another key question. This impact assessment presents costs for if a QR code is used but other options are available. Industry views differ on whether the DDRS code serialisation will slow down production lines. Some stakeholders think there will be no impact, whereas others have serious concerns. The exact impacts are likely to be technology dependent. No estimates for potential slow down and economic impacts were provided by stakeholders or discovered during this research and so could not be included in the economic modelling.

The IT systems also needs careful thought. Several technology providers exist, and some pilots have been conducted in the UK. However, exactly how the system will operate at scale is yet to be resolved. This could impact greatly on the direct costs of operating the system, the nature and availability of the data that is collected, and the associated GHG emissions. This impact assessment presents costs based on blockchain technology, which is considered to provide security benefits that can help to reduce data tampering and fraud, although this may have higher associated GHG emissions than some other technologies as described above.

The estimated cost of fraud is not explicitly given in the Government IA, although it forms part of the £30m 'central administration costs'. As discussed previously, a DDRS can help prevent fraud through unique serialisation codes individually linked to deposit values and other digital measures. Fraud prevention measures can also be built into an RVM-DRS. The relative cost-effectiveness of fraud prevention in the two systems should be researched further to determine if there is a significant difference in overall cost.

4.8 DDRS non-monetised impacts

Several advantages of a DDRS are outlined in section 3.2.2. In addition, a DDRS system has the potential to have positive outcomes that are beyond the scope of the modelling in this research – specifically around convenience, value of consumers' time and participation rates.

The Government IA states:

> "*Unclaimed deposits are a loss to consumers. Experience from similar schemes abroad indicates that there will probably always be some proportion of consumers who will not return their containers for a refund regardless of the size of the deposit. Consumers that prefer to continue using existing household recycling infrastructure would lose the value of their deposit.*"[29]

A DDRS would allow consumers to participate in the DRS using existing household recycling infrastructure and a mobile app. This may be deemed more convenient in terms of their personal time (travelling and potentially queuing at busy RVMs) and travel expenses than taking the containers to a deposit return location away from the home. The group of consumers described above is, therefore, plausibly more likely to participate under a DDRS, in which case they will not lose the value of their deposit. Under an RVM-DRS it is likely that dedicated journeys to collection points will be lower than incidental journeys, e.g. using RVMs as part of regular shopping habits.

5 Impacts on household waste kerbside collections

Under a DDRS, it is assumed that the DMO will contract local authorities to collect in-scope materials from the kerbside. The allocation of costs and benefits to different actors in the system is a key question in the current public consultation. As this is an open question, preliminary modelling was undertaken to determine the change in costs for household waste collections at the kerbside.

It is expected that a DDRS would influence consumers' recycling behaviours, resulting in less drinks containers being placed in the kerbside residual waste streams and instead placed in kerbside recycling bins. We estimated that there will be approximately 400,575 tonnes[30] additional material presented for recycling annually at the kerbside under a DDRS, which is assumed to be a diversion from the current residual waste arisings.

Several factors influence these costs, notably the type of collection system implemented by the local authority. Certain types, such as comingled collections, often have flexibility in their collection rounds and are able to absorb collection costs associated with a small increase in material. Others, however, such as multi-stream collections, may already be operating close to the threshold of weight/volume capacity for each vehicle, so even a small increase would mean additional costs to accommodate collection of this additional material.

We have taken these considerations into account and have undertaken high-level cost modelling based on dry recycling tonnages in the UK (data from Waste Data Flow), and apportioned this tonnage to either comingled, twin-stream or multi-stream collections (based on WRAP local authority data).

[29] Defra (2021), Introducing a Deposit Return Scheme on beverage containers, Date 24/02/21.

[30] We used individual material POM values from the Government's IA and pre-2025 recycling rates, and calculated how much additional material would be needed under each waste stream to reach 85% return rate.

In our preliminary model, we modelled impacts to kerbside operations under one potential DDRS scenario at a high level. This scenario assumes:

- Treatment and disposal: Reduced disposal costs for residual waste across all authorities due to higher capture rates under DDRS diverting material to recycling streams at the kerbside. For treatment of recyclate, some authorities make an income, but most must pay material recycling facilities (MRFs) a gate fee for this material (profit sharing mechanisms between MRFs and local authorities are not covered in the modelling).
- Collection logistics: Residual waste collection costs are assumed to be the same as the baseline, despite the decrease in residual waste arisings. Regarding recycling waste collections, all multi-stream authorities will be impacted by the increase in recyclable material at the kerbside, and only 1/3 of twin-stream and comingled authorities (which together make up 84% of collection types). 2/3 of twin-stream and comingled authorities are assumed to be able to cope with the additional material at no additional cost compared to the baseline.

The headline results of the modelling are provided in Table 11, which show that under a DDRS, kerbside waste service costs could **decrease by £16 million per annum** when considering collection costs, increased revenue from sale of recyclate, and decreased disposal costs of residual waste. As mentioned above, the allocation of costs and revenues under a DRS is currently part of a public consultation.

Table 11: Impacts on household waste kerbside collections per annum

Scenario	Residual waste costs	Net recycling costs*	Total costs	Difference to baseline
Baseline	£2,104m	£705m	£2,809m	n/a
DDRS	£2,070m	£723m	£2,792m	- £16m

** Includes revenue from sale of some recyclate (i.e. from multi-stream collections)*

Further breakdown of the impacts is provided in Table 12 and Table 13.

Table 12: Changes in household kerbside waste treatment and disposal costs

Scenario	Residual waste treatment costs	Recycling treatment costs	Total collection costs	Difference to baseline
Baseline	£1,505m	-£67m	£1,438m	n/a
DDRS	£1,471m	-£68m	£1,402m	- £36m

Table 13: Changes in household waste kerbside collection logistics costs

Scenario	Residual waste collection costs	Recycling collection costs	Total collection costs	Difference to baseline
Baseline	£599m	£772m	£1,371m	n/a
DDRS	£599m	£791m	£1,390m	£19m

6 Potential further developments

One of the key features signalled by proponents of a DDRS is that it provides greater flexibility for future developments and to expand the scope of a DDRS, whereas RVM-DRS is seen to 'lock-in' large capital investment in RVMs and not provide as much space for innovation. While many of these innovations are not currently fully developed to be modelled under this IA, it is worth discussing them qualitatively to understand how they may be symbiotic with other upcoming targets and policy.

6.1 'Smart' recycling on-the-go bins

'Smart' recycling on-the-go bins could be an additional source of separated recyclate from the street scene and parks, which would otherwise be placed in the residual waste stream. Such bins could be used in either a DDRS or an RVM-DRS. Smart on-the-go bins, such as the one in Figure 8 below, could also be an incentive to encourage consumers away from the habit of littering, thereby reducing disamenity value and litter picking operations. However, smart bins are more expensive than regular on-the-go bins and their contents would need to be kept separate from the contents of residual waste bins on collection in order to maintain material quality. Furthermore, the same connectivity requirements as the simple RVM apply to this type of smart bin. However, as we assume bins will be located outside in an on-the-go context, the method of connecting the bin to a power source must be discussed with the technology provider. If solar power is not an option, connecting it to the city's power grid will involve slightly higher installation costs.

Costs for this smart E-bin are **£4,500**[31] per unit, with operational costs of about £675 per year (15% of capex). Installation costs have been estimated at £1,350[32], and have a lifetime of between 5 and 10 years.

Figure 8: Example E-bin. Source: RLG

Another type of smart bin is one produced by Recircula Solutions called RecySmart, pictured in Figure 9. The RecySmart tech is a piece of kit that can be retrofitted onto any waste container, including kerbside recycling bins. It is equipped with a scanner that can read any barcode/QR code. It is powered by a battery,

[31] Average of range provided by RLG: £3,000 (for non-crushing e-bin), £5,000 (for e-bin with crushing capability), up to £6,000 for multi-chamber e-bin with crushing capability.

[32] According to RLG, if in a shop-based context, installation costs will follow a similar structure to the simple RVM. However, it will likely less expensive as the machine is smaller. If the machine is used in an on-the-go context (i.e. outside), it will likely cost a bit more than the simple RVM installation, as it must be connected to a power source. We have thus used the same figure for simple RVM installation as an average between the two.

so no connectivity is required. It functions best when paired to a smartphone via Bluetooth, so no internet connectivity is required in basic applications but would be required if integrated into a DDRS. It can also work without an app/smartphone, given internet connectivity in order to release the deposit in real-time onto a user card (similar to gift-card used in shops). RecySmart also can also come with an ultrasonic volume sensor to measure the filling level of the container and can notify the system when the bin requires emptying.

Average costs per unit for the RecySmart device, including a solar cell and connectivity kits are **£460**, with operational costs of about £75 per year (more maintenance and to replace the batteries, if used). The devices have a lifetime of between 4 and 6 years. It was estimated that installation would take approximately 15 minutes per device, installation costs would depend on the hourly cost of the technician.

Figure 9: RecySmart Technology. Source: Recircula Solutions.

6.2 Additional scanning at MRFs

The possibility of additional scanning of containers at MRFs was discussed in the IWG's Technology Providers meeting. Scanning at MRFs is not a fundamental requirement of a DDRS if the container carries a unique serialisation code and this is scanned by the consumer when they return the item. However, scanning at MRFs could provide the DMO and its stakeholders with recyclate tracking information which may be of value. Practical considerations include:

- The ability to consistently read unique serialisation codes on all containers (e.g. if in less than pristine condition, or not visible if containers are crushed); and,
- The potential effect on a MRF's line speed.

Options to mitigate the potential disadvantages of a secondary scan at a MRF include the use of multiple printed identification marks on containers using dyes which can be scanned from any angle and would identify various aspects of a container (though not unique identifiers).

6.3 Home scanners

One perceived drawback of a DDRS system is that the smartphone integration does not suit the segment of the population that do not have smartphones or do not wish to use smartphones. While this has been considered through the integration of RVMs and manual take back points that do not require a smartphone, further developments could include at-home handheld scanners. The target price for these home scanners is around £30 per unit and could be incorporated into the DDRS system.

6.4 Potential for wider scope of products

As mentioned previously, as the DDRS is built on digital platforms, there is greater potential for increasing the scope of a DRS compared to traditional RVMs, as it would just require the printing of a unique code on a container to include it. Some candidates for a wider scope could be:

- Plastic shampoo and cleaning bottles, which currently have very low recycling rates.
- Tetra Pak which are often difficult for local authorities to collect at the kerbside, particularly if consumers are not clear on whether they can be recycled by their Council and where to place them in waste receptacles.
- Commonly littered items, such as crisp, snack, and sweet wrappers, and takeaway food and drink containers.

7 On-the-go DDRS

There is the option of limiting DRS legislation to products considered to be consumed 'on-the-go', i.e. drinks containers less than 750 ml in size, sold in single format rather than multipack. The Government IA presents costs and benefits for such a system in which some costs are reduced compared to the All-In RVM-DRS, largely because fewer RVMs are needed and the average RVM unit required is smaller and cheaper.

If a DDRS were designed to cater solely for on-the-go materials there may be no need for kerbside collections as the total material captured would be dramatically reduced and a lot of it would, presumably, be consumed out of the home. Instead, the network of RVM and manual takeback points outlined for the All-in DDRS could be further supplemented with smart recycling on-the-go bins, as described above.

The primary focus of this research has been to compare an All-in DDRS and a full economic impact assessment has not been conducted for on-the-go DDRS. However, a very high-level comparison of costs is presented below to support further discussion, with appropriate caveats highlighting estimates and assumptions.

These costs are largely adjusted from those presented above for an All-in DDRS. The following cost lines were scaled by the quantity of containers, i.e. reflecting that on-the-go material by unit makes up just 31% of the 'All-In' material:

- Serialisation code printers – fewer will be needed as fewer cans will bear a serialisation mark[33]
- IT installation and IT operational costs – costs relate to transaction costs and the servers or block chain nodes needed to support the IT system. Fewer containers will result in fewer transactions and smaller IT infrastructure requirements.

Further changes were made:

- Relabelling – the additional cost of 'new label design and relabelling' was taken from the costs presented in the Government IA for an on-the-go RVM-DRS.
- Smart e-bins – costs were added for 40,000 smart on-the-go recycling bins to facilitate convenient container return, and improve material quality. Costs are based on the RLG E-bin, which has a typical annualised cost of £1,511 per unit.[34]

[33] Fewer can will require a serialisation mark because cans sold in multipacks would not be included in the scope of an on-the-go DDRS.

[34] £4,500 CAPEX, £1,350 installation, £675 per annum OPEX, and a lifetime of between 5 and 10 years – assumed 7 years.

- Logistics – Cost of collecting materials from smart e-bins in outdoor locations such as streets, parks, and bus shelters is likely to be higher than collecting from supermarkets and convenience stores. The logistics costs presented in the Government IA for an on-the-go RVM-DRS are therefore conservatively multiplied by 150% to provide a cost estimate in lieu of detailed logistics modelling.

Other costs were kept the same as those estimated for an All-in DDRS as these are not thought to reduce significantly for the on-the-go system. Whilst the Government IA reduces the physical size and footprint of RVMs we conservatively keep them the same size as those used in the All-in DDRS, as with fewer containers but also fewer return points the quantity of material passing through each machine may be broadly unchanged.

It is assumed that there will be 20,000 supermarket RVMs and manual take-back points, the same as presented for an All-in DDRS. The additional 40,000 smart e-bins creates a network of 60,000 return points. It is difficult to compare this figure to the On-the-Go RVM-DRS as the Government IA does not state the number of return points. However, based on the information available they are likely to be comparable in magnitude.

Table 14: Economic Costs of On-the-Go Digital DRS (DDRS)

Costs £m	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Capital investment costs	50.10	9.39	6.26	0.00	0.00	0.00	0.00	50.10	9.39	6.26	-31.31
QR code printers	11.40	0.00	0.00	0.00	0.00	11.40	0.00	0.00	0.00	0.00	2.28
Organisational set up costs	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IT Installation	20.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Training & familiarisation (initial)		2.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Central admin costs		22.35	22.35	22.35	22.35	22.35	22.35	22.35	22.35	22.35	22.35
Enforcement		1.55	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31
Counting centre costs		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Relabelling		18.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RVM maintenance costs		6.30	7.56	8.40	8.40	8.40	8.40	8.40	8.40	8.40	8.40
RVM handling (labour) costs		7.09	8.51	9.45	9.45	9.45	9.45	9.45	9.45	9.45	9.45
Retailers opportunity costs		2.57	3.08	3.43	3.43	3.43	3.43	3.43	3.43	3.43	3.43
Retail rental costs		2.01	2.41	2.68	2.68	2.68	2.68	2.68	2.68	2.68	2.68
Manual take-back labour costs		7.92	9.50	10.56	10.56	10.56	10.56	10.56	10.56	10.56	10.56
Logistics (post-return)		135.96	163.16	181.29	181.29	181.29	181.29	181.29	181.29	181.29	181.29
IT operational costs		22.29	26.74	29.71	29.71	29.71	29.71	29.71	29.71	29.71	29.71
Smart e-bins		60.43	60.43	60.43	60.43	60.43	60.43	60.43	60.43	60.43	60.43
Total Cost	86.77	298.51	311.31	329.61	329.61	341.00	329.61	379.70	339.00	335.87	300.58

PV $_{(Costs)}$ (2022-32)	**2726**

The On-the-Go RVM-DRS presented in the Government IA has an PV (2022-32) of £3,503. The economic impact assessment presented above suggests that a DDRS could lower costs whilst introducing a sizeable network of smart e-bins. The economic benefits are assumed to be broadly the same[35] but further research is recommended. For example, the litter and material revenue benefits would be higher in the DDRS system if the large network of e-bins increases convenience for the on-the-go consumer and so increases the return rate. The DDRS may increase GHG emissions from transport for collections from smart e-bins, but may reduce journeys where the consumer returns home with empty containers and then transports them in bulk to a supermarket or convenience store. GHG emissions savings from additional recycling would be the same as smart e-bins could produce the same quality of material as RVMs and manual takeback.

[35] I.e. the same as those presented for the on-the-go DRS presented in the Government IA