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Digital Deposit Return Systems: *What You Need to Know*

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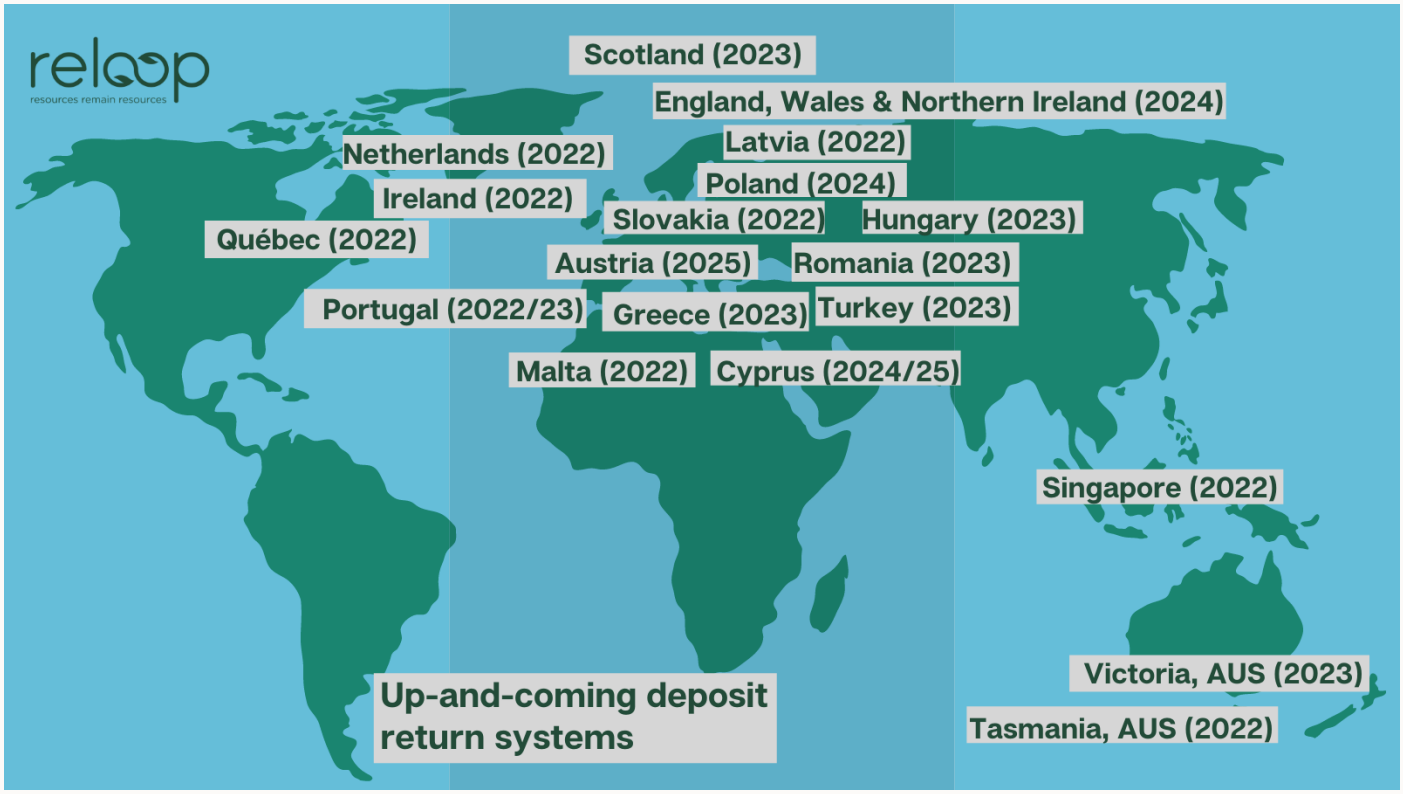
Introduction

By the end of 2020, over 290 million people worldwide had access to deposit return systems (DRS) for recycling their single-use beverage containers, and that number continues to grow. In fact, in the last two to three years, several countries, states and provinces have announced they too will implement or expand DRS.



In Europe, a key driver of interest has been the requirement in the EU's Single-Use Plastics Directive (SUPD) for countries to meet a target of 90% separate collection for plastic beverage bottles by 2030. Most European DRSs achieve return rates above 90%, diverting significant quantities of beverage containers from disposal and keeping that material circulating in the economy.

DRS is the only proven way to ensure the separated, high-quality collection of more than 90% of the materials included. A well-designed DRS can also bring cost savings for local authorities, reduce carbon emissions, and create green jobs in the circular economy. As more jurisdictions consider DRS, stakeholders are wondering whether more digital elements should be part of the legislation from the beginning.

This fact sheet offers an overview of the new digital elements that are included within the concept of digital deposit return systems (DDRS). We also look at the key questions that need to be addressed before real consideration can be given to incorporating these technologies into a DRS.

Finding information on digital DRS

Globally, there is currently only one publicly available research paper on the concept of digital deposit return systems (DDRS). This high-level economic impact assessment [i] was commissioned by a UK-based industry working group (IWG), which was established in response to the UK government's reference to the concept of DDRS in their 2021 DRS consultation. The group is comprised of drink container manufacturers, beverage producers, retailers, local authorities, and other waste handlers and re-processors. The report, written by Resource Futures, is based on several hypothetical assumptions and confirms that the feasibility of DDRS at scale is currently unproven.

"There are areas of a DDRS that require further research, particularly which technology to use for managing deposits and data systems. [...] Further work is recommended to determine if a DDRS can be implemented at scale and within the desired timescales [ii]."

Additional information on the concept of DDRS can be found: on the websites of companies promoting the concept; in communications about the three small-scale trials that have taken place, including a consumer survey conducted by Queen's University of Belfast [iii], and; written evidence submitted to UK Environmental Audit Committee [iv].

What are the components of the digital deposit return system concept?

The concept of DDRS is defined by the UK's IWG as "an alternative DDRS system largely based on kerbside collection of drinks containers on which a unique serialisation code (to individual containers) is printed. Under DDRS the deposit on a drinks container would be redeemed by the consumer scanning the serialisation code via a smartphone application, which would also notify the supporting IT system that the deposit could not be redeemed again – a key security measure to prevent fraud" [v].

The same group previously defined DDRS as "an emerging technology solution that has the potential to make Deposit Return Systems even more attractive and convenient for consumers of drinks both at home and 'on the go'. The technology is centred on the use of blockchain and coding on packaging, linked to scanning of containers via a smartphone app to redeem deposits paid" [vi].

While there is currently no holistic deployment at scale of the DDRS concept, the main components that various propositions have in common, include:

Unique marking of eligible containers: Unique beverage container (UBC) recognition is made possible by a unique traceable identifier, often in the form of a serialised QR-code attached to, or printed directly onto, the container.

Consumer smartphone app: All end users would be required to have a smartphone application to scan the QR code before returning their container. This app would recognise the QR code through camera technology, geolocation and near-field communication (NFC) for location verification (allowing the consumer to declare they are at the collection point).

Smart collection points: There would be four ways for consumers to return their used beverage containers. These include the use of existing kerbside recycling bins, and new "smart bins" located in public spaces such as parks and transport hubs. For both options, consumers would be required to scan the QR code on their container before they return it. There would also be the option of returning empty containers to retailers using an RVM, or at manual take back points.

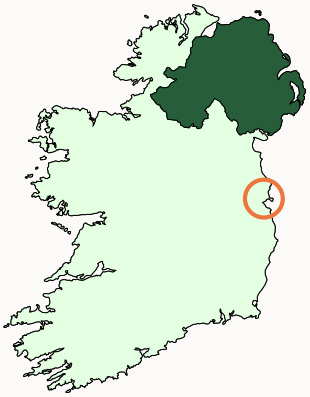
IT orchestration platform: An IT orchestration platform, such as blockchain, would be required to track all containers within the system in real time as they move through the supply chain. This platform would manage and transfer deposits, as well as provide an audit trail for the deposit through its activation, deactivation, verification, redemption, and reward.

DDRS Trials

As highlighted in the IWG report, only three small-scale trials of the concept have taken place so far: "To date, DDRS technology, including software and container marking, has been trialed 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 [vii]". Two digital incentive schemes [viii, ix] have run in Austria to encourage recycling, but are based on claiming rewards rather than a deposit. It's important to distinguish between these two ideas.

None of these trials have incorporated all the elements of DDRS into a holistic system. Each trial has experimented with only some elements of DDRS, such as QR-code stickers applied by retailers or the use of a mobile application for scanning these codes. The rest of the concept has yet to be tested even at small scale. DDRS is therefore not an existing solution, but rather an evolving concept which - in terms of Technology Readiness Levels - is far from being qualified and ready for deployment [x].

Dublin, Ireland - July 2021 [xi]

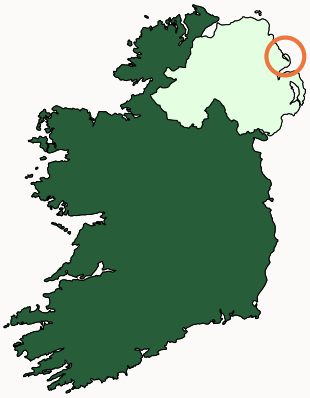


Reward4Waste, created by UK tech company CryptoCycle, ran their second trial for 4 weeks. The trial involved 200 households in Dublin and was run in collaboration with the Irish Waste Management Association. Participants paid 20 cent deposits on purchase and were refunded when they returned their empties. Information regarding the results of this trial will be available at the end of 2021.

Conwy, Wales - June 2021

Conwy county borough trialled digital DRS in partnership with resources charity WRAP, the Welsh Government and Polytag [xii]. As part of the four-week trial, launched on 16 June 2021, 264 households were given a set of plastic water bottles with "Polytag unique codes" on them. Once used, they were scanned using a free app, and put out for recycling as usual. Results published in October 2021 [xiii] show that 97% of these households scanned at least one bottle before returning it to their usual kerbside bin. However, this sample size is very small, and there is no information about how the bottles were processed after collection.

Whitehead, Northern Ireland - September 2020-January 2021 [xiv]



This pilot, again run by Reward4Waste, was paid for by Pepsio, EnCirc and Britvik Ireland. Two thousand households and one retail shop were invited to participate, with dedicated labels and mobile app for kerbside collection. Some 4,160 items were collected. Plastic milk bottles were the most recycled item (51%) with cans (8%) and glass bottles (9%). However, this trial did not charge residents a deposit so it is not the same concept as a deposit return system.

Key challenges and considerations

There are several fundamental questions that have yet to be answered:

- How can DDRS guarantee that used beverage containers are collected and not littered? By attaching value to a code instead of to the beverage container, DDRS risks undermining the proven anti-littering effect of DRS.
- How will a country regulate serialisation of beverage containers at scale? What is the cost of serialisation and who will bear those costs? By requiring all beverage containers to be serialised with a code, DDRS forces producers to adapt their production lines and distribution networks for one country only.
- How can kerbside and existing waste management infrastructure deliver the same collection rate and quality material as high-performing DRS? What are the related costs for the taxpayer? DDRS assumes that the waste management infrastructure will absorb and manage in-scope material in a dedicated stream, as part of the household waste. This would likely require infrastructure repurposing and upgrades that have not yet been explained or costed in detail.
- What impacts would DDRS have on the material value? The value of collected material would be driven down by contamination, and it's unclear who owns the material in the decentralised system that the DDRS concept is based upon. Moreover, it is unclear who owns the kerbside collected material, and who is responsible for selling it.

Detailed considerations of the DDRS concept

Consumer Experience:

Accessibility

Supporters of the DDRS concept claim that the technology they provide makes using DRS more convenient for consumers. This is based on the idea that having the option of returning containers to kerbside or "smart" bins could make redemption more accessible for a wider range of consumers, particularly those living in rural areas.

Consumers who use mobile apps could also potentially be sent marketing about DRS, and encouraged to use the system using loyalty rewards, competitions, and giveaways [xv].

This relies on all consumers having access to handheld devices, payment plans, and a reliable internet connection. The options for people who don't have smartphones would be to find a shop with a reverse vending machine (RVM), or a manual take-back point at a retailer, where they would use a shop-owned, handheld serialisation code scanner.

The consumer would have to scan each individual item they return, which is impractical and time consuming for those with multiple containers. Doing so would increase the amount of time required to redeem a deposit, which we know from international experience is a key factor influencing consumers' decisions on whether to participate in DRS.

This claim also ignores the fact that existing "best-in-class" DRSs allow consumers to return their used beverage containers via their same online delivery service, making it accessible for people who are housebound.

Data Ownership

Valuable data is collected to facilitate the tracking and tracing of individual containers. This could include, for example: insight into the distribution of products and materials after sale; insight into problem container types or formats (e.g. low collection and recycling rates), and; insight into individual consumption patterns, behaviours, and locations.

Consumers may have concerns about sharing such information, especially if they see the benefits as minimal. There are also likely to be issues around general data protection regulations. Current concepts do not provide details on how personal data will be managed and how consumers will be protected.

This claim also ignores the fact that existing "best-in-class" DRSs already establish fully transparent system operations, data-driven clearinghouse and reporting.

Transparency and system integrity:

System fraud

Proponents of DDRS claim that by using a unique code on individual containers, the risk of fraudulent activity is reduced as it makes it harder to fake the marking of a container and redeem an ineligible item. Unique coding also eliminates the possibility of the same container being redeemed multiple times, since the deposit allocated to each individual container is cancelled after redemption.

The UK's IWG impact assessment highlights the caveats around these claims: "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 [xvi}."

"There is 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) [xvii]."

Although some fraud is likely to exist in all DRSs, the scale is unknown and likely to vary from country to country, depending on the set-up of the system. Across the EU for example, fraud is not flagged as a significant problem, and there is no evidence to demonstrate that the concept of DDRS would reduce fraud, or simply facilitate it in a different way. In order to determine the impact of DDRS on fraud, an independent comparison of the two systems would be required.

Consumer vulnerability

Serialisation makes it more difficult to fake codes and reduces the opportunity for over-redemption.

There are new opportunities for fraudulent behaviour which would impact consumers. For example, monetary value is attached to the QR code, rather than the beverage container itself. Therefore, photos of QR-codes can easily be taken from retailers' shelves and redeemed after some time (when beverages are likely to have been sold) by someone other than the purchaser of the beverage. To eliminate this type of fraud, all collection points, including "Point of Sale" (POS) systems and RVMs, need to be connected to a common, back-end system and database in real time so that the code is activated only when the product is sold.

There is also the possibility that empty beverage containers are stolen from smart bins and RFID containers after being placed inside. This problem is more likely to occur in lower income countries where the value of the material (i.e. PET or aluminium) is relatively high compared with average income levels. There is also the risk of radio-frequency identification (RFID) chips from waste bins being stolen, enabling "sofa-redemption" [xviii].

Individual marking is not sufficient to ensure the integrity of a system itself, and there remains a need to ensure that both the code and the container material are verified and secured into clean and closed-loop recycling, requiring reliable hardware technology such as RVMs.

Impact on material collection, littering, and the environment:

Lower material quality or value

It is claimed that the introduction of serialised UBCs could strengthen circular material flows.

The reality of this claim is unproven and the problem of co-mingled materials in a kerbside bin is not addressed in the same way as it is with existing DRS.

One of the key issues is that RFID-enabled bins and other "smart" containers offer no control on contamination. Although a smart bin might be less contaminated than a regular waste or recycling bin, there is no guarantee of improved material quality, as consumers could discard any type of non-deposit-bearing container or other litter into the bin. This would remove one of the fundamental benefits provided by the unique closed-loop recycling process of existing DRSs. It is also unlikely that PET collected through co-mingled containers would be of food-grade quality (as required by the EU's Single Use Plastics Directive [xix]).

Increased littering

The focus of a DDRS is on redeeming the deposit value of a serialised code, and so there is less incentive to pick up a littered bottle or can, but rather rip off the code (physically or by taking a photo of it to redeem the deposit value). Why bother recycling the container when you can simply scan the code(s) to claim the deposit back? Further, if an RFID-enabled bin is filled to capacity (which is likely because they do not have compaction abilities), it is likely that the empty container is redeemed and then left beside the bin as litter. The effect of this phenomenon is that the proven anti-littering credentials of conventional DRS are undermined.

High energy requirements

To make the DDRS concept happen there will be the need for a large database, and some propose the use of blockchain. Blockchain technology is decentralised, and so it requires numerous servers in the networks to operate simultaneously to be the first to validate the next transaction, which requires substantial amounts of energy. For example, a 2019 article estimated that the energy expenditure for Bitcoin alone, which is supported by blockchain technology, rivals the total energy consumption of some countries (e.g. Switzerland, Czech Republic) [xx]. Not only does the high amount of energy required to power blockchain result in higher direct energy costs, but it could also result in higher carbon footprints since much of this energy is generated from fossil fuels. There are concerns that the carbon emissions generated because of blockchain may outweigh the carbon savings from recycling.

In a context where regulation and consumers are pushing for greener IT, using blockchain is unlikely to be a viable solution. For example, in November 2021, France introduced a new law to limit the environmental footprint of ICT - with chapter IV dedicated to "promoting less energy-intensive datacenters and networks"

Technical requirements

Serialisation

Proponents of the DDRS concept say that unique serialisation allows secure end-to-end traceability of items, giving full accountability.

Individual serialisation of container packaging is challenging and will cause significant business disruption. Digital DRS proposals have not explored the challenges in this regard. These vary by: size and location of producer; type of product and the material in which it is sold; design of the label and how it is applied to the container, and; the type of production line required for the packaging. There exist real complexities (that have not yet been considered) in applying and scanning a unique mark in a high-speed wet environment to large volumes of cans, glass and plastic containers.

For example, graphics are currently printed to sheet material prior to the cutting and forming of each aluminium can [xxi]. A possible solution includes either printing the unique code onto the tab (ring-pull) or onto the base of the can. However, adding individual markings under the tab may present problems when consumers return cans to RVMs or smart bins, as the physical configuration of the scanners and the angle at which containers are scanned might mean that scanners are unable to locate the unique code [xxii]. Likewise, adding a code onto the concave base of a can would require further development of scanning technology and be more prone to generate reading errors.

Individually coding every bottle and can is different to including a simple barcode on a container. The printing of unique codes requires a new production set-up for beverage producers, which would require significant investment and process change. Resource Futures estimate the cost of GBP 36.76 million for serialisation code printers and a replacement rate of five years (noting that "opinions differ on how serialisation will affect beverage container production line speed." [xxiii])

High dependency on technological advancements

The concept of a serialised system where all beverage containers can be tracked and traced through either a database or blockchain relies on 100% high-quality, on-line connection. This is not currently realistic. To prevent fraud related to scanning of unsold products from store shelves, all Point of Sale systems would need to be connected to the common back-end system (database/blockchain solution) to activate the deposit. RVMs must also be connected if individual codes are to be read and devaluated.

Operational challenges and increased transactional costs

The concept of DDRS relies on IT systems that would be more complex than those required for existing DRS - likely to result in additional costs. For example, there would have to exist the capability of processing billions of unique container codes and millions of app users, acting in real time for the system to avoid duplicate returns on the same container, and providing the consumer with a convenient redemption experience. Additional costs would include: the development of a smartphone app and back end software technology; supporting IT infrastructure (e.g. network server hosting or blockchain nodes), and transaction processing costs.

Use of existing infrastructure

The concept of DDRS promotes the use of existing household waste collection infrastructure, and so the number of containers being returned to retailers would be reduced. This would reduce the need for investment in modern reverse vending machines and the requirement for retailers to offer manual take-back.

The concept relies on “smart bins” being installed in public spaces, which would incur additional costs. The three aforementioned DDRS trials utilised existing household collection infrastructure, claiming that this lowers the cost and carbon footprint of a DRS. However, the addition of smart bin and RFID redemption points will add cost and complexity to this infrastructure. While smart bins are referenced in the IWG report, there remains no clear definition of what they are, how much they might cost, and who would be responsible for paying for them. Indeed, the report states that “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 [xxiv]."

Increased logistical costs

Increased number of redemption points may make it easier for consumers to redeem containers.

This adds significant logistics cost to the system, even when existing waste collection infrastructure is utilised. It is unclear who will be responsible for paying for these costs. A key feature of many existing DRSs is their use of reverse logistics to transport and aggregate much of the material collected at RVMs. Because plastic bottles and cans are usually compacted in the RVMs prior to transport to recyclers, the marginal cost of transport to the point of aggregation at regional distribution centres is kept low. In contrast, the redemption points envisaged in the concept of DDRS (e.g. low-technology RVMs and smart bins) would not have compaction abilities, which means less material being transported in one truck.

Increased requirement for collection journeys

The DDRS concept is based on increased pick-up infrastructure, including on-demand collection and transportation of materials from numerous redemption points, many of which are low-volume.

In existing DRS, the transport of containers from consumers’ homes to redemption points (e.g. retailers) is essentially “outsourced” since it is done by consumers at the same time as they are going shopping or undertaking other routine activities. In contrast, a DDRS would require frequent pick-ups from several sites.

Lost revenues for materials recovery facilities

Under existing DRSs, a materials recovery facility (MRF) typically collects the material value for any in-scope materials that are processed through their facility. A small number of MRFs (i.e. in Calgary, Canada) extract the deposit containers by hand from their sorting lines, meaning they can claim back the deposit amount in addition. Any MRF that currently collects the deposit in addition to the material value, or any upcoming systems that base economic predictions on this assumption – would lose this revenue stream within the concept of DDRS.

Advice to policy makers

Reloop welcomes initiatives that aim to further improve the efficiency and effectiveness of a DRS and recognises that digital elements will likely have a larger role to play in the future.

The proposed Digital DRS concept has yet to be proven and thus it is simply not ready to be implemented as a readymade solution for an entire country or region. Many fundamental questions are yet to be resolved, and the concept is still immature.

Despite the potential opportunities presented by emerging digital technologies like serialisation, there are still significant technological advancements and changes within the whole industry that are required to be able to track and trace individual beverage containers throughout the supply chain in a manner that is both practical and cost-efficient.

While trials of DDRS concept are underway to demonstrate its feasibility, these pilots are being done at a small scale, and as such, there remains much uncertainty about how (or whether) they can be scaled up to a national level.

In short, it is still too early to understand the benefits of the concept and what problems it is trying to resolve when proven DRS systems are available to tackle the urgent issue here and now. For these reasons, Reloop strongly believes that the prospect of a DDRS should not stall or delay the implementation of DRS laws where they are being considered and drafted.

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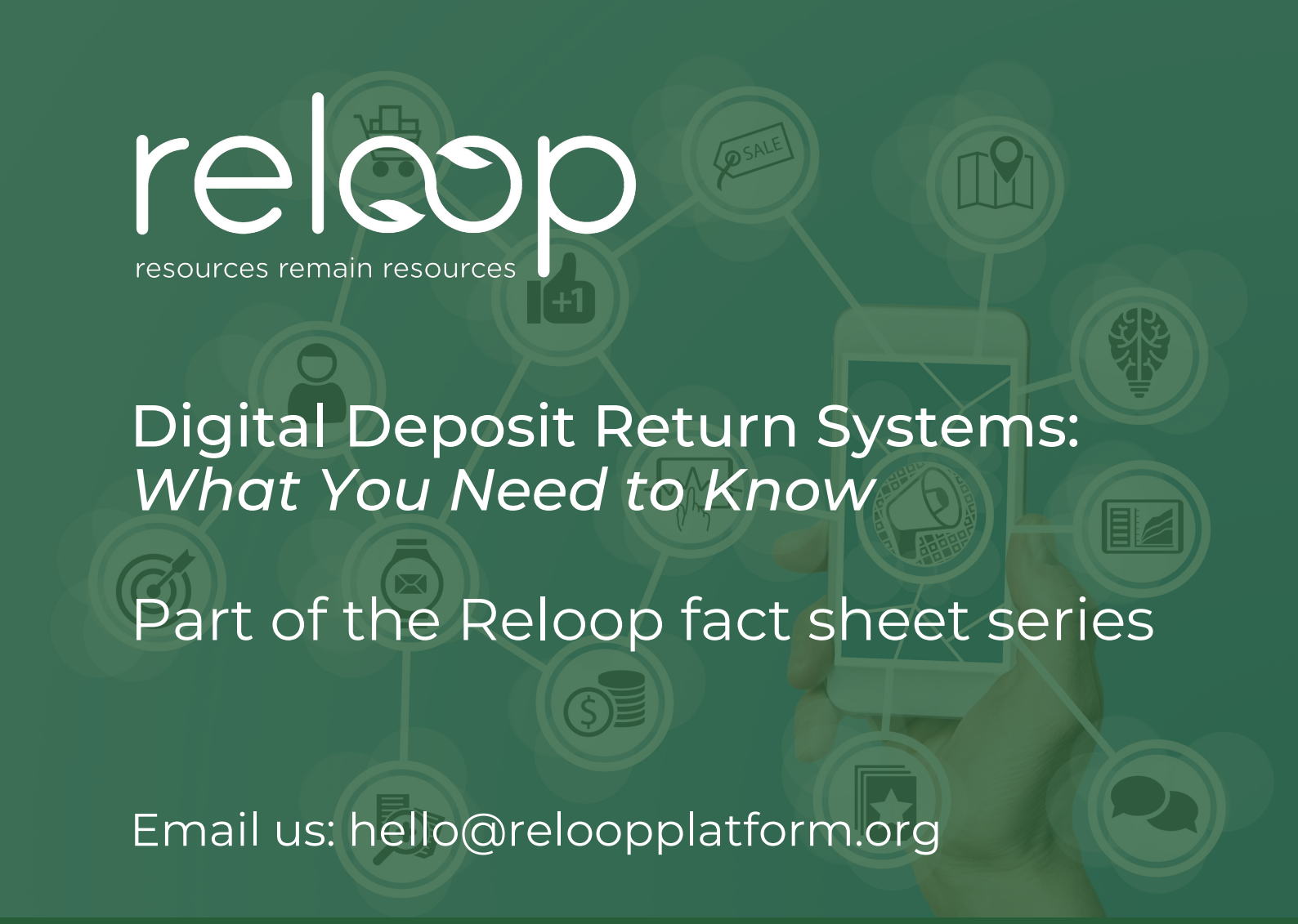

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