THE CO_2 BENEFITS OF USING COLLECTION-DELIVERY POINTS FOR FAILED HOME DELIVERIES

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Abstract

Unlike much of the previous research on this topic which assesses the economic consequences of failed deliveries to the home, this paper examines the issue of failed delivery from a carbon auditing perspective. It considers the potential environmental savings from the use of alternative forms of collection-delivery over traditional delivery methods for failed home deliveries. Using a spreadsheet carbon audit model, carbon dioxide (CO_2) emissions for a failed delivery are calculated, based on a typical van home delivery round of 120 drops and 50-mile (80-km) distance. Three first-time delivery failure rates (10%, 30% and 50%) are assessed.

The additional CO_2 from a second delivery attempt increases the emissions per drop by between 9 and 75% (depending on the delivery failure rate). The vast majority (85-95%) of emissions emanating from a traditional failed delivery arise, not from the repeat van delivery, but from the personal travel associated with the customer collecting a missed re-delivery from the carrier's local depot.

A range of Collection-Delivery Points (CDPs), (super markets, post offices, railway stations) were all found to reduce the environmental impact of this personal travel. Post offices (currently operating a CDP system through the Royal Mail's 'Local Collect' service), yielded the greatest savings, creating just 13% of the CO_2 produced by a traditional collection by car from a local depot.

Overall, the research suggests that the use of CDPs offers a convenient and more environmentally-friendly alternative to redelivery and customer collection from a local parcel depot.

INTRODUCTION

There has been phenomenal expansion of online shopping in the UK, with recent growth rates exceeding 35% year-on-year (*1*), and in spite of the current economic downturn, the online retail sector remains buoyant. Forecasts predict continued double digit online sales growth in many countries over the next few years (*2,3*). Retail sales for this channel now account for £18.5bn ($28.8bn)[1] in the UK (*4*) and it has been estimated that 820 million parcels were delivered to UK online shoppers in 2008 (*1*). This delivery experience is critical to the success of online shopping.

General consensus among consumers is that online shopping is good for the environment (*1,5*), yet consideration needs to be given to the frequency and treatment of failed deliveries, as a significant number of online orders are not delivered at the first attempt. Not only are unsuccessful deliveries costly and time-consuming for both retailers and carriers and inconvenient for the consumer, they also have a detrimental effect on the environment (*6*). It has been estimated that up to half of UK households are unoccupied between the hours of 9.00 and 16.00 (*7*) when most home delivery companies operate (*8*) and the majority of failed deliveries occur because no one is available at the delivery address to receive the item (*1*). In the main, parcel carriers must cope with this failed delivery problem. IMRG (*9*) estimated that 65 million first-time home deliveries failed in 2006, costing £682 million ($1,091.2 million). This comprised £300 million ($480 million) in direct costs to retailers, £123 million ($196.8 million) to carriers in making redelivery attempts and £259 million ($414.4 million) to customers in terms of wasted time, negotiating, arranging and waiting for redeliveries to be made or collecting parcels personally from a carrier's depot.

The aim of this paper is two-fold. First, to assess the additional carbon emissions generated by failed delivery (as opposed to a successful first-time delivery) on a per drop basis and second, to consider the potential environmental savings from the use of alternative forms of collection-delivery over traditional delivery methods. The likelihood of failed deliveries is discussed in light of previous research and industry experiences, before the methodology used to calculate the CO_2 emissions from failed deliveries is outlined. An overview of the various alternative collection-delivery points available then precedes a comparison of the potential CO_2 savings from the use of collection-delivery points (CDP).

HOME DELIVERY AND THE FREQUENCY OF FAILED DELIVERY

The vast majority of online orders result in the physical distribution of goods (*10*), and while several variations to the traditional home delivery method exist, generally goods are ordered by the customer and delivered to their home, often within relatively narrow time windows defined by the retailer. Local dispatch is from parcel carrier depots, and the deliveries consist of mixed loads in vans[2]. Before commencing a delivery round, drivers load their vehicles sequentially in drop-order, based on their first-hand experience and detailed geographical knowledge of their delivery round. In the UK, routing and scheduling software packages are seldom used in this process.

Weltevreden & Rotem-Mindali (*11*) established that in the Netherlands, 80% of online purchases (excluding 'daily' groceries, health and personal care items) were delivered to the home address, with half of all deliveries (49%) involving attended delivery. Just under a third of these deliveries (31%) were made through the letterbox, and as such rarely failed to be delivered. In the study, only 10% of non-daily online purchases were delivered to

[1] The current exchange rate at 30/07/09 is £1 = $1.60

[2] A van denotes a light goods vehicle up to 3.5-tonnes maximum permissible gross vehicle weight of van-type construction on a car chassis that operates on diesel fuel.

alternative locations such as a post office or shop (i.e. goods picked-up in-store). The dominance of 'the home' for delivery of online goods was also noted by Synovate (*12*).

When the delivery fails because no-one is at the address to receive the item, the carrier may make several re-delivery attempts as part of the round. If these also fail, the recipient is left a notification card detailing a number of options, typically that:

- The item has been left with a neighbour;
- The item has been left somewhere outside the premises (unsecured delivery);
- The item has been returned to the carrier's depot and further instructions are required from the intended recipient. (Under these circumstances, the recipient can request a further redelivery attempt which could be chargeable, or could visit the carriers' depot personally to collect the item).

Actual first-time delivery failure rates[3] among carriers vary considerably depending on the carrier's policy for dealing with 'no-one-at-home' events. Some parcel delivery companies achieve very high first-time delivery rates (*13*), as they are prepared to leave deliveries in alternative locations, e.g. with neighbours or in 'unsecure' areas around the premises (a practice known as 'doorstepping'). According to IMRG, 84% of online shoppers report that they would be happy for a neighbour to receive a delivery on their behalf (*1*), though interestingly, only 6% of customers registered for a nominated neighbour in a recent Royal Mail home delivery trial (*14*). Other carriers require proof-of-delivery. Cybersource reported that 13% of online merchants lose more than 5% of their revenue through fraud (*15*), and while obtaining proof of delivery from a recipient may help to limit fraudulent claims, much higher delivery failure rates result when no-one is available to sign for receipt. As a result of these different delivery practices, estimates of first-time delivery failure rates vary widely from a high 6 out of every 10 small-package deliveries (*8*) to a more conservative one in nine deliveries (*1*). Even at the lower delivery failure rate, IMRG estimated that the direct costs of delivery inefficiencies and failures to be £420million ($672 million) in 2008 (*1*).

QUANTIFYING CO_2 EMISSIONS FOR SUCCESSFUL FIRST-TIME HOME DELIVERY AND FOR FAILED DELIVERY

Methodology

An Excel spreadsheet has been constructed to calculate the carbon intensity of home delivery. Rather than relying on only one information source for freight-related emissions factors, emissions data from four statistical sources were used: Defra (*16*), NAEI, (*17*), RHA (*18*) and FTA (*19*) for diesel- and petrol-fuelled vans, and averaged. The analysis presented here is based on a typical van home delivery round consisting of a mixed load of 120 drops and 50-miles distance, figures that were derived from discussions with one of the leading parcel delivery carriers in the UK. It was also assumed that each delivery was of non-food products and weighed less than 55lb (25kg is the maximum permissible weight for a one-man delivery in the UK). No distinction was made between different product types as it was assumed that all items would be treated equally. Groceries have not been considered as they are generally delivered in dedicated supermarket vans in larger quantities at a time nominated by the recipient, thereby reducing both the number of drops per round and the likelihood of a failed delivery.

[3] IMRG (2008, p.25) define a first-time delivery failure "as a delivery for which a signature cannot be obtained, either from the customer or a designated customer representative, and this results in the customer's address being carded and the item returned to the delivery depot for either redelivery or customer collection".

Calculations were initially performed for a successful first-time home delivery and this value used as a base when comparing three first-time failed delivery ratios for non-food orders. The failure rates have been selected to be representative of the wide variations in non-food failed deliveries. They are as follows:

- 10%, similar to the 12% assumed by Weltevreden & Rotem-Mindali (*20*), and recorded by IMRG (*1*);
- 30%, in line with findings by McLeod *et al.* (*21*), Song *et al*. (*22*) and Belet *et al*. (*23*);
- 50% failure rate (worst case scenario) of a magnitude noted by Retail Logistics Task Force (*8*).

Low first-time failure rates of approximately 2%, achieved by parcel companies practising unsecured deliveries, and couriers who have made prior arrangements with regular customers in the event of failures are not considered here. In these cases, there will be only a very marginal increase in carbon emissions.

For each of the three different first-time failure rates, emissions have also been calculated for a second attempted drop (the customer is notified of the intended re-delivery). Normally, the two delivery attempts are on consecutive days, which results in a high percentage of second, re-delivery attempts also failing, assumed to be 50% in this research (*24*). Often, the customer will then travel to the carrier's local depot to collect the package rather than arrange for another delivery attempt which could be at additional cost. The CO_2 implications of the above scenarios have been analysed.

Only 5% of people would wish to nominate a local depot as an alternative delivery address (*8*) implying that the location of a typical depot is inconvenient for the majority of online customers. Therefore, we can assume that most customers collect undelivered packages either by car or by public transport with previous surveys suggesting that the vast majority of these trips (87%) are by the former (*21*). Even in the Netherlands, a country known for its high bicycle use, Brummelman *et al.* (*25*) (cited in *26*) reported that 89% of their respondents picked-up missed deliveries by car, with the remainder collecting them by bicycle. Defra's emission factors (CO_2 per km travelled) for average car and bus journeys have been used to calculate the emissions generated by these individual trips by motorised transport (*27*).

Three different collection depot scenarios have also been modelled (10-miles, 15-miles and 25-miles away from the average home), in accordance with references *28, 24 & 22* respectively. Further, as customers wherever possible will wish to minimise both the time and expense involved in retrieving a missed delivery from a depot, we assume that they will try to combine collection with other activities (i.e. a non-dedicated trip). Few previous studies have examined consumer travel behaviour in relation to missed deliveries. Turner (*29*) found that out of a sample of 167 visitors collecting failed home deliveries at a Royal Mail delivery office, 62% drove and 60% claimed to be making dedicated trips (no trip chaining on either leg), and 84% said that personal collection was their usual response to a failed home delivery. Parcel carrier depots are often more distant and not as accessible as Royal Mail delivery offices. As a result, we assume that only 50% of the overall return trip from customer's home to the depot is allocated to the collection of the missed package, and that most people will travel by car. Conversely, the recent Royal Mail pilot study, using post offices as delivery points, found that 44% of interviewees had changed from using motorised transport when accessing more distant delivery offices to travelling on foot or by bicycle to their local post office, and so saving on average 14 minutes per trip (*27*).

Results

Carbon emissions for a standard home delivery round have been calculated (see *30* for further details). A typical 50-mile delivery round produces 21,665gCO_2 in total, and with an average delivery rate of 120 drops per trip, each successful first-time drop would be allocated 181gCO_2 (or its ‘share’ of the 21,665g total). Using this emissions value per drop as a base, Table 1 shows the re-calculated emissions generated for the different first-time failed delivery rates. The additional gCO_2 attributable to delivery failures arise from the extra vehicle mileage generated by *subsequent* delivery attempts. We assume that a re-delivery attempt as part of the same round (when a driver returns to an address within the original working shift) does not create additional emissions as the driver, based on their best knowledge, would re-schedule deliveries to incorporate another attempt en-route.

TABLE 1 First-time van-based delivery and failed deliveries: Emissions (gCO_2) per drop

	100% successful first-time delivery	10% failure rate	30% failure rate	50% failure rate
gCO_2 per drop	181g	199g	235g	271g

Emissions of CO_2 per average drop increase from 181g for 100% first-time delivery to the worst-case scenario of 271g when one in two deliveries are assumed to fail. Moreover, as mentioned earlier, when a parcel carrier finds no one at home at the first attempt most delivery companies repeat the delivery 24-hours later. Customers normally out during the working day, therefore, have very little advance notice to arrange receipt of the package; consequently, the second attempt often fails, compounding the effects of the initial failed delivery (Table 2). It has been assumed that regardless of initial delivery failure rates, half of all second attempts fail.

TABLE 2 Re-delivery factoring in a 50% failure rate for the second delivery attempt: Emissions (gCO_2) per drop

	1st delivery attempt failure rate (plus 50% 2nd delivery failure)		
	10% failure rate	30% failure rate	50% failure rate
gCO_2 per drop	208g	262g	316g
% increase over base case	15%	45%	75%

When a carrier experiences a 50% delivery failure rate for both first and second delivery attempts, each drop in a typical round would be allocated 316gCO_2 or approximately three-quarters more CO_2 per drop than a successful first-time delivery.

Normally, after two failed delivery attempts the parcel carrier returns the package to a local depot for the customer to collect. While 15% of online shoppers claim not to visit a parcel depot to collect a missed delivery (*1*), the Department for Transport (*31*) estimate that around 3% of all home delivery recipients make a trip to retrieve an item left at a post-office, depot or outlet. In comparison, in a survey of 379 households across West Sussex, Song found that 21% of respondents claimed to have travelled to a carrier’s depot for the purpose of collecting failed home deliveries between 3 and 11 times per year (*32*). When these individual trips are undertaken by private cars or public transport (buses), the carbon intensity of online retailing rises steeply.

TABLE 3 Emissions (gCO_2) per consumer trip to a local depot to collect a missed delivery[4]

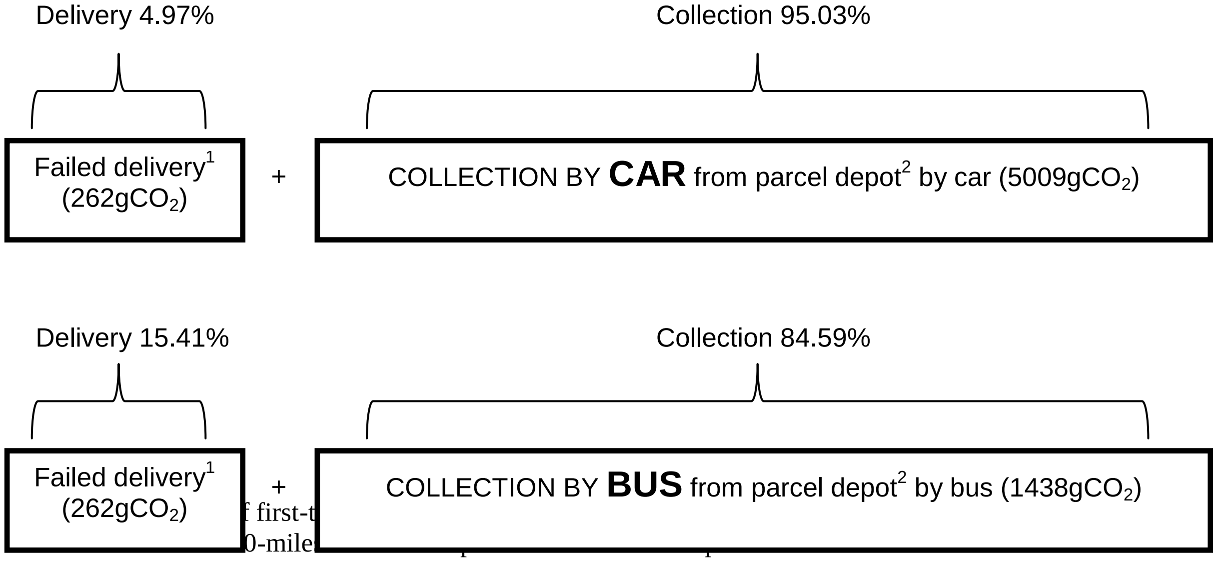
	Distance to local depot (one-way)		
gCO_2 per trip	**10-miles**	**15-miles**	**25-miles**
Car	3,339g	5,009g	8,348g
Bus	1,438g	2,157g	3,595g

Table 3 shows the CO_2 emissions produced by a customer travelling to a local depot of varying distance from their point of origin to collect packages. Generally, local depots, often on the outskirts of urban centres for ease of access to the trunk road network, serve much wider areas than their immediate conurbation (urban region). Consequently, the greater the distance a customer has to travel to the local depot, the more CO_2 will be generated by that trip. Clearly, using a car to make a 25-mile journey to bring back a missed delivery will produce 8,348CO_2 (or the equivalent of 26 re-delivery attempts by delivery van, when half of first and second-time deliveries fail) (Table 3). When the bus is the chosen mode of travel to a depot, the consumer, assuming the bus has average patronage of 9.2 passengers (*16*) will be responsible for 3,595g (11 times less CO_2 than that generated by the two missed parcel deliveries) for the 25-mile journey. Even the shorter distance of 10-miles, representing for example an customer's city centre-to-suburb trip to collect a package, will generate 3,339gCO_2 by car and 1,438gCO_2 when the journey is made by bus.

The customer's trip to the local depot accounts for the vast majority of the CO_2 emissions associated with the failed delivery (Figure 1). In the case of a failed delivery and a 10-mile trip by car to the local depot, 95% of the emissions are generated by the personal collection trip. Even when the bus is the mode used, 85% of emissions come from the depot pick-up. Therefore, minimising the emissions associated with personal consumer travel to the depot is vital to mitigating the overall environmental impact of failed deliveries.

[4] It was assumed that a customer used a standard car of unknown fuel

FIGURE 1 Proportion (%) of CO2 attributed to van delivery and personal travel for car and bus users



ALTERNATIVE COLLECTION-DELIVERY POINTS (CDPS)

Failed deliveries are clearly undesirable from a number of viewpoints:

- The carrier incurs additional costs in trying to make further attempts to deliver (related to the associated logistics and call centre charges which have been estimated to be up to £38.50 ($61.60) for each delivery failure (*9*)),
- The customer is inconvenienced and may have to travel to the carrier's depot personally to collect the item,
- There are wider environmental impacts owing to the additional vehicle trips made by carriers and consumers.

With such a large proportion of failed deliveries, different delivery options have emerged, allowing carriers to drop consignments without the need to obtain the final customer's signature. One solution is to deliver packages to secure storage boxes, sometimes fitted as an integral part of the house, or secured to an outer wall, or for communal use in the form of locker banks (*33,34,35*). Another solution is for the carrier to take failed deliveries to a local attended 'collection/delivery point' (CDP), which could be a shop, a petrol station or a post office. The customer is left a card, or could in principle be sent an email or a text message, to inform them where to collect their package. Customers then collect their online orders from the CDP. McLeod *et al*. found that 83% of respondents in their survey of 790 households in Winchester (UK) favoured collecting a failed delivery at a service point rather than a parcel carrier's depot (*21*).

Cairns *et al* (36) commented that the use of 'intermediate' CDPs should reduce the transport impacts of home deliveries, as little additional travel will be generated by the consumer collecting a missed parcel when CDPs are carefully positioned near residential areas (e.g. post offices) or in locations already frequented by consumers (e.g. supermarkets and railway stations) (*26*).

This delivery method is now operated by Royal Mail and Parcel Force in the UK using specific post offices as CDPs. By 2007, some 2 million packages and parcels had been delivered to post office branches through the scheme (*14*). Other examples use grocery stores, newsagents and petrol stations. Kiala, the major international drop-off point operator based in Belgium has 5000 CDPs across Europe with outlets in the UK, Germany, Austria, Spain, The Netherlands, Luxembourg and France, as well as Belgium. Van Oosterhout estimated that the use of Kiala CDPs in the Netherlands alone had the potential to save 875,000 vehicle kilometres a year (*37*). In Germany, Packstation has expanded rapidly over the last few years and now has an extensive network of CDPs across the country. The Kiala and Packstation systems differ in several respects. Packstation consists of a network of automated locker banks used exclusively by Deutsche Post, whereas Kiala points are managed by local businesses, and used by all retail companies that have a partnership with Kiala (*38*). A similar system using convenience stores operates successfully in Japan (*39*). In the UK, ByBox that mainly operates in the B2B market has recently diversified into B2C (*40*).

A delivery policy which automatically took failed first-time home deliveries to the customer's nearest CDP, if such a network of attended or unattended points were available, could benefit all parties. It would reduce the aggregate mileage associated with either redelivering or collecting failed consignments and save the parcel carrier (and potentially the consumer) time. Equally, delivering failed deliveries to CDPs would reduce the risk of theft that goods might have been exposed to when left unsecured or with neighbours (*25*). This arrangement would need the customer's agreement in advance and for a preferred CDP to be identified at the time of purchase, to be used by the carrier in the event of the failed first-time delivery.

Quantifying CO_2 implications from using alternative CDPs

The type of alternative CDP and typical distances from a consumer's home are listed in Table 4, after Song *et al.*, who looked at the impacts on householder collection mileage of varying the densities of CDPs across West Sussex (*21*). The increased CO_2 per average drop (compared with a successful standard delivery) reflects the additional distance travelled when a parcel carrier deviates from a round to drop failed deliveries at the CDP before returning to base. It was assumed that no deliveries were taken back to the depot, as they would either be delivered to the intended recipient first-time or taken to their nearest CDP, for the customer to collect. Extending an average delivery round by 4.03-miles (6.5km) to deposit failed deliveries at a Tesco Extra store would result in each drop being allocated an extra $23gCO_2$, while the relatively short additional mileage to a post office of 0.75-miles (1.2km) would add just $4gCO_2$ to each drop. The carrier benefits from having denser networks of CDPs as this minimises the length of the diversions that vehicles make in the event of delivery failures.

The results suggested that compared with a standard failed delivery[5], all the alternative CDPs offered significant CO_2 reductions owing to the consumer having to travel less distance (on average) to collect failed first-time deliveries, against travelling to the carrier's local depot. Even greater CO_2 savings could be achieved by incorporating a collection into a normal travel routine. According to Brummelman *et al.* (cited in *25*) 74% of locker point users combined their trip to collect their parcel with another activity (*24*). Only a quarter (26%) of users made a dedicated trip to collect their missed delivery. Similarly, a third of interviewed customers taking part in the Royal Mail trial in Nottingham combined their last trip to a participating post office branch to collect an item with another trip, most often to the supermarket (*13*). Both these examples are encouraging as Belet *et al*. reported that end consumers could reduce CO_2 emissions per parcel by as much as 83% when items were retrieved from CDPs as part of a trip chain (*22*).

Overall, the results suggested that the local post office was the most environmentally-favourable location for a CDP, as a package left there would be responsible for just 13% of the CO_2 generated by a collection from a carrier's local depot. This reflects the relatively high density of post offices and short average distance to customers' homes. In 2007 the Post Office Ltd. in the UK had around 16,500 branches and at the time 96% of people lived within

[5] The calculation for a standard failed delivery assumes 30% of first-time deliveries fail, 50% of the re-attempts fail and a customer, having been notified of the unsuccessful second delivery attempt, makes a 9.3-mile (15km) trip by car to collect the package from the holding local depot.

a mile of a post office (*13*). As a result a high proportion of customers can walk to post-offices to collect packages. 40% of householders in the West Sussex sample stated that walking would be their preferred mode to collect packages from their local CDP (*21*). Additional CO_2 emissions associated with the walking trip are very difficult to calculate and are normally excluded from carbon auditing calculations. Post offices have another advantage in that they are familiar sites to customers, as some 28 million people visit a post office branch every week in the UK (*13*).

Rail commuters could also collect packages from railway stations as part of their daily commute, in effect eliminating the additional customer trip to the CDP. ByBox unveiled its first consumer box bank at Victoria railway station, in central London in March 2009, allowing a commuter access to a 24-hour, unattended pick-up facility with only a very marginal deviation to their commuting journey (*40*). Large supermarkets are potential CDPs, although located the greatest distance from the average householder (6.5km). They are regular destinations for shoppers and the collection of a failed delivery could easily be incorporated into a more general grocery trip (with minimal additional travel on the part of the consumer). Moreover, unlike post offices that have restricted working day opening hours, many of the larger supermarkets have extended (and sometimes 24-hour) opening hours.

TABLE 4 Emissions (gCO_2) per consumer trip to alternative CDPs

Type of collection/delivery point	**Average distance miles (km) from customer's home**	**CO_2 per average drop (including additional mileage to CDP)**	**CO_2 for consumer trip to CDPs**		**% CO_2 per CDP drop compared with traditional delivery**
			Car	**Bus**	
Tesco Extra	4.03 (6.5)	204g	1,349 g	581g	47%
Other supermarkets[1]	1 (1.6)	186g	332g	143g	16%
Average supermarket	2.48 (4.0)	195g	830g	357g	31%
Post office	0.75 (1.2)	185g	249g	107g	13%
Railway station	2 (3.2)	192g	664g	664g	26%

[1]From ASDA, Morrison, Sainsbury, Waitrose

CONCLUSIONS

Various traditional failed delivery scenarios have been examined, based on realistic failure rates for home delivery. When only the freight component of failed delivery is assessed, the additional CO_2 from the second delivery attempt increased the emissions per drop by between 9 and 75%. However, the vast majority of emissions associated with traditional failed delivery arise from the personal trip to the local depot by a customer collecting a missed package. In the worst case scenario, an additional 8,348gCO_2 is produced by a car journey of 25-miles to a parcel carrier's depot, which is equivalent to 26 re-delivery attempts by a delivery van. In addition to the environmental effects, these collection trips are inconvenient and costly for the customer.

As a result, viable alternative delivery methods have the support of consumers: 78% of respondents said that they would use a carbon-friendly delivery alternative over a traditional method when available (*1*). This research has highlighted the potential CO_2 savings from the use of alternative CDPs for failed deliveries. Supermarkets, railway stations and post offices each offer distinctive benefits for consumers, and all lessen the CO_2 emissions from failed home deliveries. Post offices, owing to their extensive network, present the greatest savings.

It should be remembered that smaller CDPs (e.g. post offices and corner shops) have limited capacity for receiving packages and if such a system was to be adopted more widely, particularly as a first-time delivery address, storage, handling and security issues might arise.

While the research presented here considers only the potential CO_2 savings for failed deliveries, CDPs can also be well-positioned to receive products that consumers are returning or used as delivery locations in the first place. To date the take-up of alternative CDPs has been slow. For example, in the Netherlands only 1.4% of all online orders were delivered and collected at a service point in 2006 (*25*). Therefore, the CO_2 benefits of CDPs have yet to be realised, though with potentially a million UK online shoppers a year having to collect orders from parcel depots that carriers were not able to delivery to the home (*29*), CDPs could make a major contribution to reducing the environmental impact of online shopping.

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