Carbon Auditing the “Last Mile”: Modelling the Environmental Impacts of Conventional and Online Non-food Shopping

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Typical conventional or online shoppers?

We usually shop in the comfort of our own home but the computer crashed.
Stages of production and distribution
(after Green Press Initiative, 2008)

- Loss of Biomass & Wood Harvest
- Paper Production
- Printing
- Publishing
- Distribution & Retailing
- Last Mile
- Consumer
- Return / Disposal of unsold books

% figures indicate relative portion of greenhouse gas emissions

- Landfill (Methane) Release: 8%
- Distribution & Retailing (excluding the last mile): 14%

Borealis Centre for Environment and Trade Research, 2007
8.85lbs (4.02kg) CO₂ per book

Distribution & Retailing
(excluding the last mile)
= < 600gCO₂
Environmental claims by some online retailers

Evening Standard, 20 June 2007

The Guardian, 12 September 2007
Personal travel choices & the impact of Home Delivery

- Shopping trips eliminated
  - Continue to shop for some products
- Remove shopping from multi-purpose trips
  - Browse before buying online
- Shop for other additional / related products
  - Substitute with other car-based travel
- Usually walk / use public transport to shops

Effects on car traffic
Environmental Impact of Online Shopping

• Frequent purchases of small quantities, often from several different web-based companies;

• Additional sortation requirements to combine multiple customers’ orders prior to delivery;

• Internet-browsing encouraging people to go shopping for additional &/or supplementary purchases;

• Little travel savings when conventionally goods were purchased as part of multi-activity trip;

• Treatment of failed deliveries and returns.
## Products & Delivery Methods

<table>
<thead>
<tr>
<th>Product type</th>
<th>Typical order size</th>
<th>Main delivery vehicle type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Books</td>
<td>2-3 items</td>
<td>• Parcel delivery van&lt;br&gt;• Postman (walk / bike)</td>
</tr>
<tr>
<td>Small electrical</td>
<td>c 2 items</td>
<td>• Parcel delivery van&lt;br&gt;• Postman (walk / bike)</td>
</tr>
<tr>
<td>Large electrical</td>
<td>1 item or set</td>
<td>• Two-man delivery</td>
</tr>
<tr>
<td>Clothing</td>
<td>2 items</td>
<td>• Parcel delivery van&lt;br&gt;• Postman (walk / bike)&lt;br&gt;• Home delivery courier (private car)</td>
</tr>
<tr>
<td>Groceries</td>
<td>c 15-20 orders</td>
<td>• Temperature-controlled vans</td>
</tr>
</tbody>
</table>

Source: Iain Beveridge Associates
Devised an Excel spreadsheet to model:

1. CO₂ emissions for home delivery for the last mile (from parcel depot to the consumer’s home); &
2. dedicated shopping trips (single trips) versus multi-purpose trips by consumers (trip chaining).

- Representative delivery scenarios;
- Issue of returns (unwanted goods).
Freight transport to the home

• What type of vehicle is used for the delivery? (diesel / electric van; courier’s private car)

• What type of round? (urban / rural )

• How many drops per round?

• What happens to failed deliveries?

• Does the parcel carrier collect product returns?
Typical conventional shopping behaviour?

- Where do people shop?
- How do they travel to the shops?
- How long is a typical shopping trip (distance)?
- How many items do they buy in that one trip?
- What type of goods are bought?
- Do shoppers combine shopping with other activities?
# The Last Mile: Trip assumptions

<table>
<thead>
<tr>
<th>HOME DELIVERY ROUND</th>
<th>DISTANCE</th>
<th>DROPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average van home delivery round</td>
<td>50-miles</td>
<td>120</td>
</tr>
<tr>
<td>City centre van delivery round</td>
<td>25-miles</td>
<td>110</td>
</tr>
<tr>
<td>Rural van delivery round</td>
<td>80-miles</td>
<td>70</td>
</tr>
<tr>
<td>Car-based courier delivery round</td>
<td>25-miles</td>
<td>40</td>
</tr>
</tbody>
</table>

Items per drop:
- 1 (for direct comparison)
- 1.4 (books/CDs/DVDs)
- 2.5 (clothing & household)

*Trip chaining: assumes only 25% of trip length is for shopping purposes*
Emissions for an average non-food home delivery

Assumptions

Round trip (miles)  50
Drops per round   120
Items per drop    1 / 1.4 / 2.5

$\text{CO}_2$ per drop  181g
$\text{CO}_2$ per item (1.4) 137 g
$\text{CO}_2$ per item (2.5)  72g

* Average values, calculated from 4 sources: Defra; NAEI; FTA; RHA
Emissions for an average conventional shopping trip

<table>
<thead>
<tr>
<th>Mode</th>
<th>Journey trip</th>
<th>Round trip – miles</th>
<th>CO₂ per trip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car</td>
<td>Local</td>
<td>2- miles</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>12.8-miles</td>
<td>4,274g CO₂</td>
</tr>
<tr>
<td></td>
<td>Distant</td>
<td>40-miles</td>
<td></td>
</tr>
<tr>
<td>Bus</td>
<td>Local (urban)</td>
<td>2-miles</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>8.8-miles</td>
<td>1,265g CO₂</td>
</tr>
<tr>
<td></td>
<td>Inter-urban</td>
<td>40-miles</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>20-miles</td>
<td></td>
</tr>
</tbody>
</table>
Carbon intensity of non-food home deliveries ‘v’ shopping on the High Street

\[ \text{CO}_2 = 181 \text{g per drop} \]

**Dedicated shopping trip by CAR**

\[ \text{24 items or more} \]

**Dedicated shopping trip by BUS**

\[ \text{7 items or more} \]

- Low emissions car (< 100gCO₂ per km) = 12 items or more
- High emissions car (> 350gCO₂ per km) = 40 items or more

Source: based on National Travel Survey 2007 data, Defra average bus patronage, Vehicle Certification Agency
CO$_2$ per drop for different home delivery rounds

<table>
<thead>
<tr>
<th></th>
<th>gCO$_2$ per parcel delivered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average:</td>
<td>181</td>
</tr>
<tr>
<td>delivery van</td>
<td></td>
</tr>
<tr>
<td>City centre:</td>
<td>98</td>
</tr>
<tr>
<td>delivery van</td>
<td></td>
</tr>
<tr>
<td>City centre:</td>
<td>28</td>
</tr>
<tr>
<td>electric</td>
<td></td>
</tr>
<tr>
<td>vehicle</td>
<td></td>
</tr>
<tr>
<td>Rural:</td>
<td>492</td>
</tr>
<tr>
<td>delivery van</td>
<td></td>
</tr>
<tr>
<td>City centre:</td>
<td>417</td>
</tr>
<tr>
<td>courier:</td>
<td></td>
</tr>
<tr>
<td>(car)</td>
<td></td>
</tr>
<tr>
<td>City centre:</td>
<td>340</td>
</tr>
<tr>
<td>Courier (car</td>
<td>plus</td>
</tr>
<tr>
<td>delivery van)</td>
<td></td>
</tr>
</tbody>
</table>

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Failed delivery: Emissions (gCO₂) per item

<table>
<thead>
<tr>
<th></th>
<th>100% successful first-time delivery</th>
<th>12.5% failure rate</th>
<th>25% failure rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average delivery</td>
<td>181g</td>
<td>204g</td>
<td>226g</td>
</tr>
<tr>
<td>Urban delivery</td>
<td>98g</td>
<td>110g</td>
<td>123g</td>
</tr>
<tr>
<td>Rural delivery</td>
<td>495g</td>
<td>557g</td>
<td>619g</td>
</tr>
</tbody>
</table>
Implications of shopping trip type on CO₂ emissions (g)

Combined: (bus-based shopping 25%)  Combined: (car-based shopping 25%)

Dedicated, average trip by bus  Dedicated, average trip by car

Browsing: 2 bus trips per purchase  Browsing: 2 car trips per purchase

316  1069  1265  1581  2530  4274  5343  8548
Summary: Home Delivery

• The Local Level dominates any environmental comparison of online & conventional shopping;

• Emissions from car-based shopping trips can far exceed those from distribution operations back along the supply chain;

• Numerous factors influence emissions from home deliveries: drop densities; distance & nature of delivery round; type of vehicle, failed deliveries & returns.
Summary: Conventional shopping

- It is always better to maximise the no. of items purchased at any one time;

- When using public transport at busy times & making several purchases, emissions per item are lower than home delivery;

- Consequently, use of public transport needs to be promoted wherever practical, especially for shorter trips.

Neither retail channel has absolute environmental advantage, though, in the case of non-food purchases, the home delivery operation is likely to generate less CO₂.
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