SUSTAINIBILITY OF LAST MILE DELIVERY CONCEPTS

for B2C-Parcels

Developed by
SESAM GmbH

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1. EXECUTIVE SUMMARY

SESAM GMBH

According to a recent report by the World Economic Forum *(The Future of the Last Mile Ecosystem, January 2020), "There has never been a time of greater change for the 'last mile'. Consumers order more things online, expecting more control and faster deliveries".* The report goes on to study the complex, inter-related issues of traffic congestion, CO2 emissions and delivery costs.

It is clear from this evidence-based research that the new normal is coming and will change the way we live, purchase and communicate, with sustainability becoming the most important aspect in the new normal.

In response to the obvious last mile challenges, many major players in the industry are investing heavily in *"Out-of-Home" (OOH)* solutions such as parcel lockers and PUDO's *(Pick Up, Drop Off),* with frequent claims made at conferences and in social media that such solutions are significantly better for the environment and reduce congestion compared to at-home delivery. However, data-driven research to substantiate such claims is notable by its absence.

In order to provide a balanced view of the relative merits of the various solutions, Sesam recently published a data-based report *"Sustainability of delivery concepts for B2C shipments"*, in conjunction with Prof. Dr.-Ing Ralf Bogdanski of the TH Nürnberg and Birgitt Helms from the Efficiency Agency North Rhine-Westphalia.

Using *"ecocockpit"*, a leading CO2 modelling tool, the report calculated emissions for both at-home parcel-boxes and Out-of-Home locker/PUDO deliveries, based on anticipated parcel volumes in Germany in 2018, 2025 and 2032. A number of scenarios were modelled considering variables such as route productivity, delivery mix incl. same day / grocery mix, distance to pick-up point and return volumes.

The report concludes that the delivery to a private parcel box or a workplace box, will have close to zero CO2 emissions and cause no traffic congestion. In fact, even at 4 times the delivery volume compared to 2018, there would be less congestion than today using private and workplace boxes.
The report also showed a significant increase in secondary traffic, I.e. consumers picking up and returning parcels, even after having taken more than 70% trip chaining into the calculations in the OOH scenario. The worst-case scenario showed an increase of 1,000% in secondary traffic adding significantly to traffic congestion.

It is recognized that a variety of last mile solutions will be required to cope with the rising demand for ecommerce deliveries, whilst also providing customers with a choice of solutions that meet their personal requirements. However, it is clear from this data-led research that the much-lauded environmental benefits of OOH solutions are dwarfed by those of successful first-time delivery to an at-home or workplace parcel box.

As consumers increasingly question the environmental impact of their shopping habits, it is imperative that those customers should have clear, unbiased data on which to base their purchase and delivery choices.

Jörg Schauerhammer
CFO and Managing Partner

Jesper Okkels
Founder

2. INTRODUCTION

"Public parcel lockers and PUDO's (Pick Up Drop Of), which are Out of Home (OOH) delivery solutions, benefits the environment and improves customer experience (CX)!"

This statement is being repeated in social media and from speakers at conferences over and over again. ***But is it true?*** The carriers might pollute less but will overall pollution also go down? ***This is a question not yet really addressed so we decided to do a study to get some answers***. But first, let us have a look at the OOH arguments.

2.1 The arguments for OOH solutions, Pro's and Con's

Figure: Exemplary Public Parcel Lockers and PUDO's

"People should pick up their parcels on foot or bicycle"

The carriers pollute less, and the rest is up to the consumer. If the consumer would behave *"correctly"* they would always pick up their parcels on foot, on bicycle or when they are at the locker / PUDO location anyway *(Trip chaining).*

According to some sources, around 50% purchase goods at the OOH locations at the same time they pick up their parcels. And the other 50%? Did they go to the location extra and if yes, did they remember to do so on foot / bicycle? How does one get to a PUDO or locker location when the weather is bad?

"The PUDO's and Lockers must be carrier agnostic"

Apart from the Chinese lockers, which in reality are residential lockers, basically all lockers and PUDO's are exclusive to one carrier. Amazon Locker, DHL, InPost, Posti, are all operating closed systems and usage comes with having to use the carrier as well.

Carrier agnostic sounds good but will immediately lower the drop rate per locker and carrier, thereby a big chunk of the expected CO2 footprint reduction disappears as five to six or more carriers now share the Parcel locker. Real carrier agnostic Public Parcel Lockers are basically non-existing, so the argument is kind of hard to take seriously.

"The OOH's must be placed near where people live"

The definition of *"near"*. It is a known fact that PUDO's and Public Parcel Lockers which are more than 200m away from people's apartments / houses, increase Parcel Time in Locker severely cutting the number of available doors in the lockers. Putting up carrier agnostic lockers every 400m in the big cities will be a financial challenge, if possible, at all. Most cities will not allow so many big lockers to be installed.

Why must it be big lockers? Because we all accept as a fact that the parcel volume will triple or quadruple within the next 15 to 20 years. In the not so mature markets, i.e. where parcel volume is still under 20 parcels per year per cap, the increase will be far higher. This basically means a parcel per household per day, i.e. a locker door per household in the neighborhood is required. But why not put up the locker at the home of the recipient if all of us will receive a parcel a day? Putting up non-agnostic lockers is definitely not an option if the 200m is to be adhered to.

"With OOH the first-time conversion rate is 100%"

One could also say, we do not even try to deliver and leave the last mile to the recipient. That is very convenient for the carrier but less so for the customer. Is OOH delivery a choice between pest and cholera? Wait *(in vain?)* at home for the delivery, or drive to a PUDO / locker at your own convenience.

The OOH's advocates claim OOH's increase CX, we see it as just being less inconvenient than waiting in vain at home, but it is far from customer centricity to have people drive from one locker to another PUDO to pick up and return parcels.

Figure: Exemplary Parcel Lockers at work and residential

2.2 Are we bashing models which could impact our own business, i.e. residential parcel lockers?

As Sesam GmbH is a company selling residential parcel boxes and smart entry technology, it could be seen as if we are just bashing our competitors. That is not the case. We as a company took a very conscious decision not to pursue Public Parcel Lockers, as they do not really scale and once a certain point is reached in terms of parcel volume per household, one locker *(door)* will be required per household anyway. ***If one locker door is required per household, why would one then install these away from home?***

We reached that decision based on numbers, projections and taking consumer centricity into the equation. Logistics is a number-based business and if one wants to support the change our society is going through, i.e. B2C becoming the new normal, numbers should be the basis for all decisions.

We also took the decision on the basis of the change in delivery mix we expect. Same Day Delivery and food will be big and change the last mile completely. PUDO's and public lockers do not really make sense for those two types of delivery. Same Day Delivery and food will trigger a lot of cruising by the couriers when delivering with time slots. Covid-19 showed that time slots put severe limitations to food deliveries, keep cost high / prohibitive and scale badly.

Residential lockers with cooling can accommodate all types of deliveries. With 2FA and age verification feature only some oversized deliveries cannot be accommodated with residential lockers. Carrier agnostic PUDO's, which are also highly recommended in the McKinsey / WEF report, seem to be an idea nobody can let go of. The example mentioned in the report is a very subsidized PUDO in Bergendorf near Hamburg, where DHL is not taking part. This excludes over 45% of the German B2C parcels and funny enough, nobody is trying to copy this *"success".*

What the above-mentioned study argues, is that the congestion seems to be the big issue in the future, but the report nevertheless still recommends PUDO's and Public Parcel Llockers which both increase congestion.

2.3 And the future delivery mix?

The probability of PUDO's being a major solution in 15 years is not very high. Most studies do not take future parcel volumes as well as the number of retail outlets which could be PUDO's into consideration. Today PUDO's handle somewhere between 10 to 15% of all B2C parcels and many PUDO's are at their physical limits, especially around peak season.

Figure: Parcels in delivery vehicle today

Stationary retail outlets have diminished with around 1.5% per year for the last 20 years in Germany, with the exception of 2008/9 where around 10% of all outlets closed as a result of the financial crisis. According to the German Retail Trade Association, HDE, Corona is going to force between 10 and 20% of the retail outlets to close. Combined, the two projections will mean that 25 to 35% less retail outlets will have to cope with 3 to 4 times today's parcel volume in 15 to 20 years. The projection is for Germany, already one of the top three countries in the world in terms of parcels per person. And please do not forget the returns - a sixth of all parcels, if the number remains as high as today!

2.4 Strategic considerations

A strategic concern which came up during the work on the study is control / ownership of a public parcel locker infrastructure. Currently a group of companies, all UPU members, i.e. the old national postal companies, are gathering around Swipbox parcel lockers. Swipbox used to be an independent company but is today controlled by PostNord a national carrier and UPU member. Swipbox is currently being installed in DK, S, N and B and is praised as *"open".* This may be correct today, but what will happen once some 25 to 50% of all parcels are distributed over Swipbox'es? Other carriers will have to accept any price increase the Swipbox Coalition of UPU members may call up because they will have no choice. They will no longer have an infrastructure to deliver without the public lockers.

This will make the other carriers less competitive and part of their turnover will benefit a direct competitor. This could give the old UPU members their monopoly back! InPost in Poland, the Finnish Post and the Lithuanian Post are following similar strategies.
It should also be mentioned, that CO2 from carrier vehicles will not be an issue as of the 01.01.2026, where an EU Directive *"DIRECTIVE 2009/33/EC"* will ban delivery vehicles with emissions from EU cities. Using reduced carrier pollution is therefore a redundant argument.

Some interesting (German) data:
- 1 to 3% of all parcels in PUDO's and PPLs are never picked up. That is pretty bad news for the online shops.
- Returns trigger non-trip chaining trips to PUDO's and PPL's*****
  - Only 44% of people in the cities do trip chaining
  - Only 50% of people in the countryside do trip chaining
- The automatic re-direction to a PUDO or parcel locker is frown upon by*****:
  - 46% of consumers in the cities
  - 57% of consumers in the countryside

Will the carriers, and in the end the consumers, have to pay more for home delivery in a future with a 100% private, at home parcel box infrastructure?
We don't think so. With a 100% parcel box infrastructure, the first-time conversion rate will be almost 100% for almost all types of deliveries including food and parcels may be delivered in two or maybe three shift operation. This will mean smaller distribution centers and less vehicles, in fact, some 50% reduction in capex will be the result. This means a significant reduction in the CO2 footprint.
Being able to deliver 24/7 i.e. at times of low traffic density, will further increase route productivity and could lead to less requirements for the popular but expensive inner-city idea of micro hubs and limit the need for designated parking space for carrier vehicles.

***** *Source: ECC/Hermes "Stadt, Land Los" 2019*

3. HOW DID WE GET TO DO THIS STUDY?

We always found OOH's questionable, not only from an environmental point of view, but also because we question their scalability. In the last years social media was flooded with praise of OOH solutions and how they would change the last mile forever.

We did some internal calculations to confirm or dismiss these statements and came up with some very surprising numbers. We then spend 3 months confirming these number as well as we could and then in January 2020, we decided to go public with our findings.

The decision to go public triggered quite a lot of work. We did not want to make statements without some sort of scientific base, and we wanted to make it relevant, not only for the B2C / logistic community but also for politicians and city planners, i.e. the people deciding how smart cities will or should look like in the future, so we needed scientific support and outside organizations to check and validate our assumptions and calculations.

3.1 Methodology of the Study: *"Environmental impact of B2C delivery solutions"*

Firstly, the study is a model to compare environmental impact of the two major delivery options we believe have *"Game Changer"* potential.

1. ***Out of Home solutions (PUDO's and Public Parcel Lockers)***

2. ***Residential and workplace parcel lockers.***

Figure: Exemplary Parcel Boxes/Lockers

The major difference to other studies is that we built in the future parcel volumes and tried to forecast the change in delivery mix. *(Parcels, Same Day Deliveries, Food and so on)* This calls for quite a lot of assumptions, which led to a total of 10 cases to be calculated. The assumptions were kept conservative and are based on fact or what is seen as fact within the business.

As very little hard facts are available, we decided to keep the assumptions very conservative. To validate our assumptions and the calculations we asked for and got the help of efa+, an organization financed by the North Rhine-Westphalian government and Prof. Dr.-Ing Ralf Bogdanski of the TH Nürnberg, a professor in environmental impact of logistics.

We would like to thank Prof. Ralf Bogdanski for his advice, his critique and for checking each and every number in our calculations. Prof. Bogdanski holds a chair for environmental impact of logistics at TH Nürnberg and is the author of the *"Environmental report"* issued in 2017 by the carrier association *(BIEK)* in Germany. He is also advising the German Ministry of Environment on pollution and traffic flows.

Birgitt Helms
Efficiency Agency NRW
Resource Efficiency
Consultant

Prof. Dr.-Ing Ralf Bogdanski
Professor of Logistics &
Environmental
Management

We would also like to thank Ms. Birgitt Helms from the Efficiency Agency North Rhine-Westphalia for her time and patience when teaching us how to use the tool ecocockpit, a tool for calculating CO2 footprint, and for playing devil's advocate on basically everything around the study.

3.2 How did we set up the study to analyze the eco-friendliness of last mile solutions in the future?

First of all, we had to decide delivery volume. We calculated that a doubling of parcel volume could happen every seventh year. This may be wrong by a couple of years, but all forecasting and changing market conditions, suggested this to be a reasonable assumption. We identified the major factors which will influence the growth of online shopping.

3.3 Current market maturity and growth rate

Some countries have experienced ecommerce growth rates of 15 to 17% over the last couple of years, but those countries came from rather low online penetration. We used the historical growth rate in Germany and pepped it up a bit as the other factors speak for a steeper growth over the next 15 years than the pure forecasting based on historical numbers. Those factors are:

1. Digital Natives and Gen Z are starting to make up a higher part of the online buying adults. They will make around 50% of their purchases online, against currently 12 to 13% on average in in Germany.

2. The future senior citizen is online and will buy online.

3. Traditional retailing is shrinking, and each closed store makes the inner cities less attractive. It is a downward spiraling where it is hard to see a way out.

4. Direct to Consumer is finally coming. The brands reduce outlets and increase online sales.

5. Local retail will go online to survive. Today an almost non-existing part of B2C, local retailers will get a two-digit percentage of the future B2C. This also indicates changes in first mile and sorting and speaks for micro hubs.

6. Curbside pickup and Click & Collect will impact the number of parcels entering the B2C parcel structure. How much could not be determined but should these two types of delivery not be established, the growth in B2C deliveries will be even faster.

4. THE STUDY AND METHODOLOGY

4.1 The assumptions for the various models

Below we have listed all assumptions we believe to be relevant. As mentioned before, and confirmed by Prof. Bogdanski, very little data is available. We might have made the wrong assumptions or the absolute value of the assumptions could be wrong, but as we explain later in this paper, we have excluded a lot of factors which could have increased the validity of the calculations.

The assumptions

#		Unit of measure	2018	2025	2032
1	B2C parcels per year	in Million	2120	4240	8480
2	Returns quota	in % of total	12,5	10	8
3	CO2 production car	g CO2/km	128	95	59
4	Tours to OOH to pick up/return parcels (City)	in % of parcels in OOH	32	29	26
4.1	Tours to OOH to pick up/return parcels (Countryside)	in % of parcels in OOH	80	76	72
5	Distance to OOH to pick up/return parcels (City)	km	1,6	1,2	0,8
5.1	Distance to OOH to pick up/return parcels (Countryside)	km	5,3	3,96	2,65
6	CO2 production carrier vehicle	g CO2/km	200	175	150
7	Tour length incl. distance to depot (City)	km	40	40	40
8	- with +15% tour productivity	km	45	45	45
9	Tour length incl. distance to depot (Countryside)	km	75	75	75
10	- with +15% tour productivity	km	80	80	80
11	Number B2C parcels per tour (City)	parcels	120	120	120
11.1	- with +15% tour productivity	parcels	138	138	138
11.2	Number B2C parcels per tour (Countryside)	parcels	75	75	75
11.3	- with +15% tour productivity	parcels	86	86	86
12	Number B2C parcels per tour with "only OOH" (City)	parcels	500	500	500
12.1	Number B2C parcels per tour with "only OOH" (Countryside)	parcels	250	250	250
13	Parcels per tour - "Time window delivery" (City)	parcels (assumption)	48	48	48
13.1	Parcels per tour - "Time window delivery" (Countryside)	parcels (assumption)	30	30	30
14	Share Same Day Delivery and chilled food in %	%	1	5	10

Table 1: Assumptions for CO2 calculations

The following assumptions and data formed the base for the calculations or were deliberately excluded:

In general, we tried to keep all variables unchanged in all cases. Only when the variables had different impact on the two game changing concepts, did we assess the development of these variables in the future.

1. Total B2C parcel volume was taken from the BIEK yearly report using 2018 as the base. We doubled the volume for 2025 and once again doubled it for 2032. Those years are to be seen as *"probably"* but the volumes will come. Corona could change when we arrive at these volumes. *Source: BIEK 2019*

2. % Returns will decrease with the change in delivery mix. Food and same day deliveries have less or no returns.

3. As the calculation were done for the future, we used the future EU limits for CO2 emissions for private cars. This is too low, but we had no other number, and this also supports our claim of very conservative numbers.

4. The calculation *„Tour to the OOH's"* is based on the IFH/ECC study *"Stadt, Land, Los" (City, Countryside, Go)* from 2019.

   As we had no other sources nor data, we have taken the consumer behavior when picking up parcels from the OOH's and made the assumption this equals the behavior when returning parcels. We lowered the number of non-trip chaining tours as increased OOH density will get more people to do trip chaining or pick up and return parcels by foot or bicycle in the future. Non-trip chaining was taken from the same study where the definition of non-trip chaining is not 100%. Due to lack of better data we used the number, but it could be too high, and we do recommend research in this area.

   One thing is for sure. Should it not be possible to set up carrier agnostic OOH's, the number will be far higher.

5. In order to calculate the distance to the OOH's, we used a statement from DHL, that all Germans on average live within 1.6 kilometers from a DHL OOH. Again, this is a very conservative number, as no DHL competitor has more than maximum 50% of the OOH locations which DHL has. In the two future scenarios, we further reduced the distance to the OOH's.

6. CO2 emissions from the CEP vehicles could not really be determinated. We therefore took a new Mercedes Sprinter and reduced the CO2 emission with 25g/Km for each of the future periods.

   We calculated cases with zero emissions as well *(5.1, 5.2, and 5.3)*. This because as of 01.01.2026 *EU directive 2009/33/EG* prohibits CEP vehicles with emission in EU cities.

7. Tour length in kilometer *(City)* is an assumption incl. driving to and from depot.

8. Tour length in kilometer at +15% more parcels per tour is an assumption incl. Driving to and from depot. An extra 5 kilometer was added.

9. Tour length in kilometer *(Countryside)* is an assumption incl. driving to and from depot.

10. Tour length in kilometer at +15% more parcels per tour is an assumption incl. driving to and from depot. An extra 5 kilometer was added.

11. Number of parcels per tour: When doing B2C parcels only *(City)* the chosen number is ok, even if DHL is probably doing more parcels per tour in the cities. New technologies and the increased number of parcels will lead to higher density especially in the cities. We kept this number *(11.1 to 11.3)* unchanged in all scenarios, except in +15% tour productivity cases. This to keep a variable down which could benefit one of the game changers concepts more than the other and thereby make comparison harder..

    We did do productivity calculations, but the data was insufficient and partly based on individual statement from couriers, so we chose not to include these numbers. We did show up to 100% tour productivity improvement if a certain delivery mix is calculated.

12. Number of parcels per tour at *„only OOH's' "*: It is an assumption based on carrier agnostic lockers and with the assumption that a parcel locker has 140 doors. In Germany only DHL, with around 50% market share in B2C, would then be dropping approx. 70 parcels per stop, everybody else would lie around 10 to 15 parcels per stop.

    The productivity of servicing the parcel lockers is kept the same for all 3 years.

    We believe the number of parcels per day and tour is too high but there is no data for carrier agnostic parcel lockers as they do not really exist yet.

13. Parcels per tour at time window deliveries: This is the food and same day deliveries, where OOH's do not really make sense. PUDO's cannot do chilled / frozen food and Same Day Delivery into a PUDO is not really a case either. Parcel locker which can do chilled / frozen food are extremely expensive, requires maintenance and will have a high energy consumption. We have therefore concluded that in the OOH only case, these time window deliveries will remain as today. With parcel boxes the time window deliveries will disappear completely.

14. Percentage of same day and food deliveries: Pure assumption. In Germany today very little, in 15 years at 10%. Corona will probably prove our assumption too low. Food has seen incredible growth during Corona and seem to grow further. This speaks for parcel boxes.

We have used averages everywhere. This probably means that no CEP finds themselves in these numbers as each CEP has their own delivery mix and as each city is different.

Oversized parcels have not been included as these will probably be done as today, i.e. with time windows.

We expect the following to happen which will benefit both concepts:

- Better / smarter routing tools will lower kilometers driven impacting congestion and emissions.
- Over time we will see more bicycle and low emission vehicles.
- The much-discussed bundling or White Label delivery will come, and it will probably start in the countryside.
- Cities will start to regulate windows of operation and this could, triggered by Corona, come a lot faster than expected.

The assumptions for the various models, here the KVI's explained in detail:

- Out Of Home location density will improve. We took DHL as an example. DHL probably has the highest density of parcel lockers and PUDO's in the world. Distance to DHL PUDO's and parcel lockers was set at 1.6 km *(2018)* and reduced in the two future periods.

- Consumer behavior when picking up and returning parcels in OOH's was taken from the ECC / Hermes study *"Stadt, Land Los" (City, Countryside, Go)* published in 2019. Prof. Bogdanski correctly mentions, that consumer behavior should be scientifically researched and see our assumption on consumer behavior as being just that, an assumption based on very little data.

- More people will commute to PUDO's and parcel lockers on foot or bicycle as density increases.

- % Returns will decrease with the change in delivery mix. Food and same day deliveries have less or no returns.

Some assumptions are logical and were included and we also had to distinguish between city and countryside, as the numbers differ quite a bit.

The assumptions combined with the timeline, forced us to do very simple cases. We changed only one or two parameters per case and ended up with ten theoretical cases. All cases are *"either / or"* cases, thus they will never happen. However, we had to do the cases in this way in order to compare the environmental impact case by case.

Figure: Possible bundled delivery

5. THE CALCULATED CASES

All cases, except the base case 0, are either / or cases calculated for 2018, 2025 and 2032. An *"either / or"* case will never happen, but in order to be able to compare the concepts and to get clear and understandable numbers, this method was chosen and confirmed as being sound be Prof. Bogdanski.

The reality will be a mix of all kind of solutions for many years to come.

- ***Case 0***
  The base case. We chose 2018 as base case and calculated this case for 2025 and 2032 as well. This can and will not be the reality, as sheer volume makes it inadequate for the future.

- ***Case 1***
  100% delivery in parcel boxes at home or at the workplace. No more trips to return or pick up parcels at OOH's.

- ***Case 2***
  Equal to case 1, but with a 15% Route productivity caused by the usage of private parcel boxes.

- ***Case 3***
  100% in OOH's *(Public Parcel Lockers and PUDO's).*

- ***Case 4.1***
  Case 0 with Same Day Delivery and Food.

- ***Case 4.2***
  Case 1 with Same Day Delivery and Food.

- ***Case 4.3***
  Case 3 with Same Day Delivery and Food.

- ***Case 5.1***
  Case 4.1 - with zero Emission delivery vehicles.

- ***Case 5.2***
  Case 4.2 – with zero Emission delivery vehicles.

- ***Case 5.3***
  Case 4.3 – with zero Emission delivery vehicles.

6. THE RESULTS OF THE STUDY

6.1. The results are surprising!

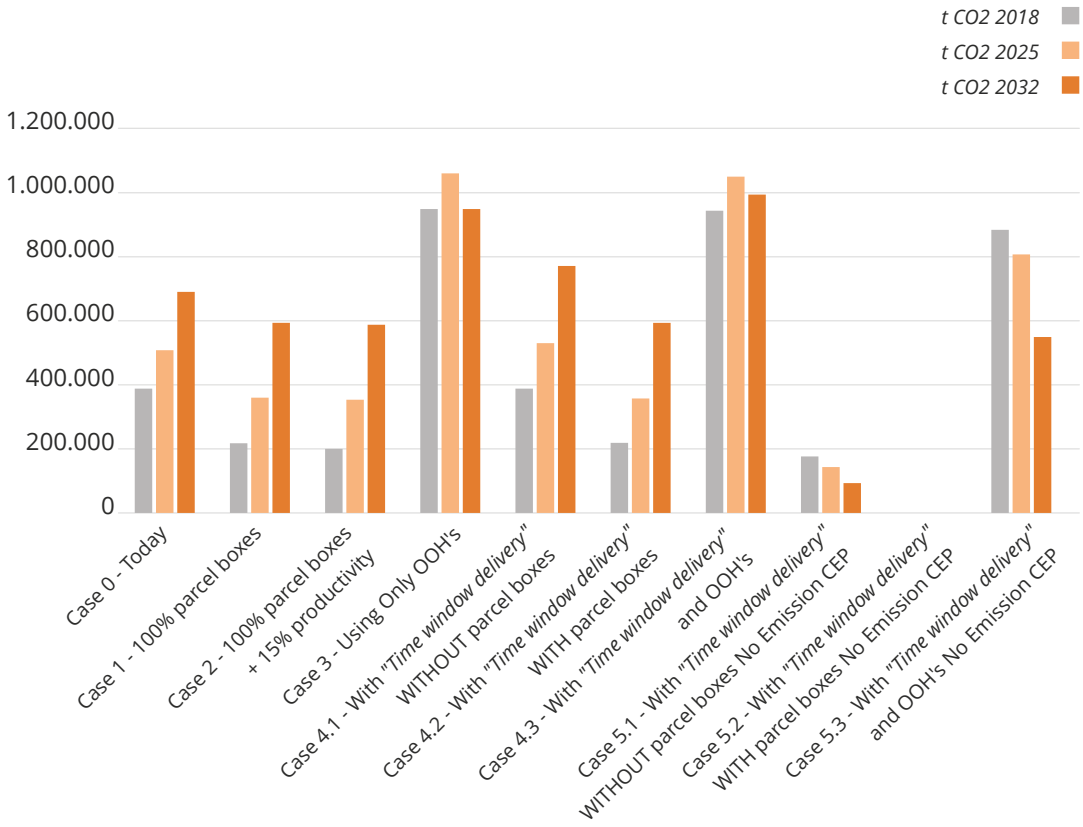

Table 2: CO2

	mT Co2		
	2018	**2025**	**2032**
Case 0 - Today	387.553	505.368	691.460
Case 1 - 100% parcel boxes	215.107	356.160	593.600
Case 2 - 100% parcel boxes + 15% productivity	205.548	351.966	586.226
Case 3 - Using Only OOH's	950.199	1.059.377	942.308
Case 4.1 - With *"Time window delivery"* WITHOUT parcel boxes	389.055	524.620	770.714
Case 4.2 - With *"Time window delivery"* WITH parcel boxes	215.107	356.160	593.600
Case 4.3 - With *"Time window delivery"* and OOH's	946.075	1.050.928	996.477
Case 5.1 - With "*Time window delivery"* WITHOUT parcel boxes No Emission CEP	170.722	141.748	88.074
Case 5.2 - With *"Time window delivery"* WITH parcel boxes No Emission CEP	0	0	0
Case 5.3 - With *"Time window delivery"* and OOH's No Emission CEP	883.549	807.344	545.850

Table 3: Numbers CO2

CO2 will phase out as being important in the future last mile discussion. With reference to the above-mentioned EU directive, CO2 emissions from carrier vehicles will be zero from the 1st of January 2026. This does not get rid of all emissions and led to the most / only important parameter identified: ***Secondary consumer traffic to pick up or return parcels from OOH's.***

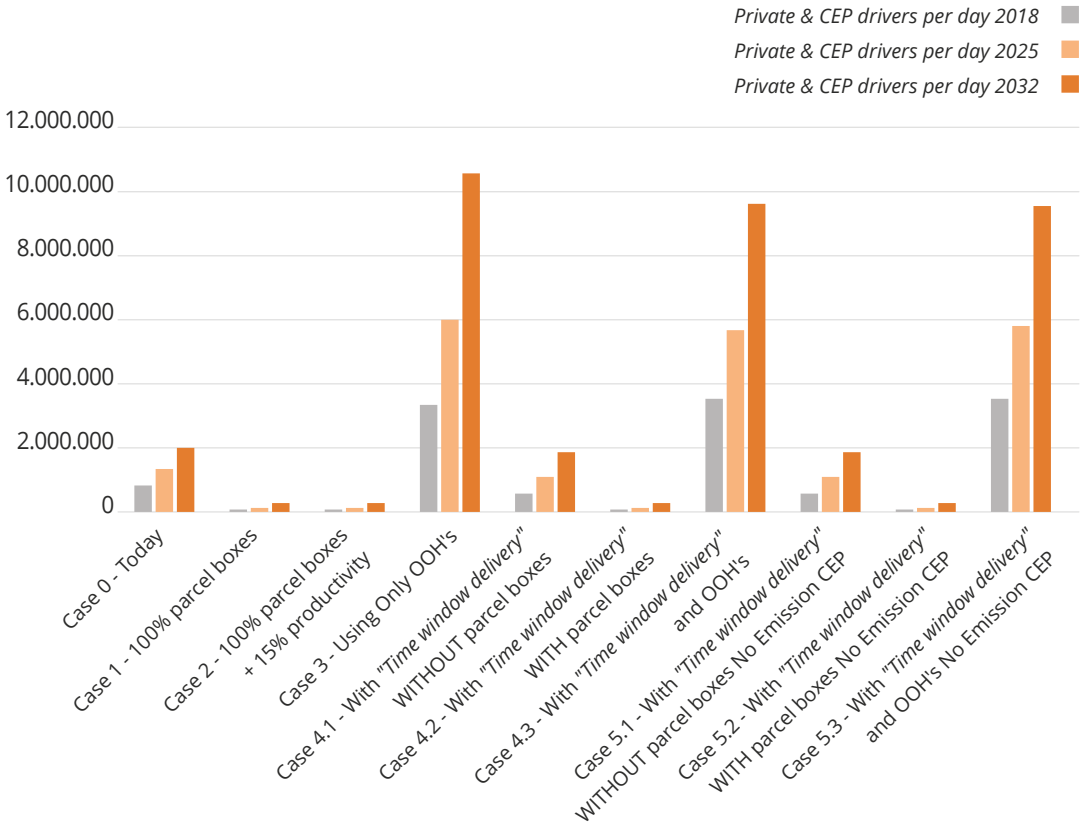

Table 4: Table Drives

	Private & CEP drives per day		
	2018	**2025**	**2032**
Case 0 - Today	772.355	1.231.790	2.052.415
Case 1 - 100% parcel boxes	67.607	129.024	255.312
Case 2 - 100% parcel boxes + 15% productivity	58.844	114.920	226.966
Case 3 - Using Only OOH's	3.469.415	5.980.224	10.515.929
Case 4.1 - With "Time window delivery" WITHOUT parcel boxes	766.321	1.186.329	1.911.002
Case 4.2 - With *"Time window delivery"* WITH parcel boxes	67.607	129.024	255.312
Case 4.3 - With *"Time window delivery"* and OOH's	3.436.411	5.703.058	9.543.921
Case 5.1 - With *"Time window delivery"* WITHOUT parcel boxes No Emission CEP	766.321	1.186.329	1.911.002
Case 5.2 - With *"Time window delivery"* WITH parcel boxes No Emission CEP	67.607	129.024	255.312
Case 5.3 - With *"Time window delivery"* and OOH's No Emission CEP	3.436.411	5.703.058	9.543.921

Table 5: Numbers Drives

Secondary traffic, i.e. consumers picking up and returning parcels, may be the decisive factor for future city planners. The calculations showed an increase of up to 1,000% in secondary traffic *(In the event of all delivery being done using OOH's).*

This would seriously slow down inner-city traffic, i.e. increase congestion. With an infrastructure of residential and workplace boxes, this type of traffic would be almost non-existent, i.e. even bring down todays secondary traffic levels.

There is a type of delivery which doesn't really fit OOH's. Food deliveries!

Corona made e-Food a major area and all suppliers failed due to the lack of capacity on the last mile, i.e. the time slots make it very hard to scale and time slots trigger a lot of carrier cruising. Again, the carrier CO2 footprint will be irrelevant after 2026, but the cruising will increase traffic congestion. A residential and workplace parcel box infrastructure would increase route productivity significantly *(+100 to 250%, when making time slots redundant)* and get rid of cruising.

The results of all the cases pointed in one direction only. ***An infrastructure of residential and workplace parcel boxes must be established.*** Not only to get pollution and traffic congestion under control but also because it is the only solution, which can handle future delivery volumes and delivery mix. Some PUDO's will still be required and public parcel lockers *"on route"* i.e. on train stations etc. make a lot of sense and do not trigger secondary traffic.

6.2. Not calculated

We did not calculate peak season, but only residential parcel lockers will be able to cope with the peak volume we normally see from Black Friday to Christmas. OOH's will not be able to accommodate peak season volumes. Christmas 2019 even DHL's own PUDO's more or less broke down in some cities. This will be even more so in 2020.

We did look into public parcel locker acceptance, locations and usage and identified some potential problems:

1. Parcel Time in locker will remain a problem, even if all consumers have a locker within 200 meters of their house. Bad weather will significantly increase time in locker and force the carriers to either hold back the parcels or re-direct these to PUDO's, but the PUDO's will not be able to handle these volumes.

2. There will be a big fight for locations, i.e. locker location could be even more expensive as they are today. The number of lockers and locations required in the future if lockers are to absorb the growth in parcel volume, is staggering. We estimated somewhere between 200,000 and 350,000 for Germany alone. There are currently less than 10,000 in total. Today the lockers are often placed at supermarkets and discounter, but we believe these will want this space back for their own Click & Collect Boxes.

3. If carrier agnostic lockers cannot be established, then even more cruising from recipients will be triggered.

4. Carrier agnostic lockers make carrier delivery less productive compared to carrier-controlled lockers. Any carrier will only have so many doors available per locker as is their market share. Drop rate will be far lower when using carrier-agnostic lockers.

5. Public locker advocates always point towards China and Eastern Europe as examples of public locker acceptance. We did research these lockers and realized, due to their location in apartment houses or near big apartment house blocks, these are in reality residential lockers to a high degree. Building structure in western Europe is quite different so a different type of locker must be installed.

6. Public lockers, as we know them in western Europe, only make out a small percentage of the lockers in China and Eastern Europe.

We asked if residential and workplace lockers are the best solution and came up with a *"not always"* answer.

Transport for London *(TfL)*, an organization with fantastic broad and deep supply chain knowledge, is not happy about workplace deliveries, at least not during the day. Apparently around 4 mill people commute into the City of London every day and receive around 1 mill parcels every day at work. TfL would like to see this volume, which results in a lot of both HGV as well as LGV traffic, either to be delivered at night or at the recipient's home addresses, i.e. not entering the City of London at all.

We did ***not include B2B*** parcels in the calculations. This had different reasons.

1. 80 to 90% of all parcels / deliveries will be B2C in the future.

2. A locker infrastructure makes just as much sense for B2B parcels, only we could not pinpoint the type and size of a B2B locker, in fact we came up with *"up to the size of a garage"*, which points toward smart access instead of lockers.

3. First mile and vehicle requirements further complicated a clear-cut case.

4. The analysis did indicate that dedicated flows, splitting B2C from B2B deliveries could make a lot of sense.

6.3 Some statements

A locker or smart access B2B infrastructure, which could be serviced in the night, would further decrease both HGV as well as LGV traffic during the day. First mile i.e. cut of times could be placed later in the day, again reducing daytime rush hour traffic.

Using ***smart access technologies***, even supermarkets, construction sites, etc. could be serviced outside of rush hours and most during the night. Vampire deliveries, i.e. deliveries and pick-ups during the night will and must become part of the new normal.

Drones and robots were not included in the cases. Both solutions are far from being operational or having a business case. In fact, based on our knowledge or lack of same, we concluded neither will play a bigger role in the future parcel delivery except for very special and limited types of deliveries. Weather dependency, limited payload and range and the question of where to land i.e. really lack of proof of the concept, made us decide to exclude these solutions.

We did look into ***micro hubs*** and came up with so many questions and assumptions that we decided to refrain from doing cases with micro hubs. Only so much. The concept of micro hubs will be rather expensive to operate, if a majority of future parcel volume is to go through micro hubs. One would either need a lot or very big micro hubs. Micro hubs which would be able handle Food and Same Day Deliveries would further increase size and cost.

We also looked into ***route bundling*** as a case, but like with micro hubs, there were just too many questions we could not answer. We did analyze that bundling seems to make sense until a city reaches a certain size. The bigger the less *(financial)* sense it seemed to make as other solutions came out better. First mile, main run, parcel exchange between carriers and sorting center questions came up, making it very hard to do a sensible case with route bundling.

As we could not find a clear answer to micro hubs and route bundling, we suggest more research and data sharing to establish a decision base for the usage of micro hubs and route bundling. City size seem to be decisive for both concepts.

Both concepts look logical, but the implications are far reaching, impacting the whole parcel chain.

We also asked ourselves whether the carriers are doing a good job today. The answer is a definite YES, they have done a fantastic job over the last couple of years trying to keep up with the constantly growing volumes.

Their reaction to Covid-19 was almost beyond imagination. And nobody doubts their importance in today's society anymore. Real heroes at all levels!

The cases showed one thing for sure. Parcel volume will make unattended delivery the only way forward. And we believe it will could a win-win-strategy for everybody.

7. SUMMARY

- In relation to total parcel volume, there will be far less PUDO's in the future.
- It will be hard to find enough Public Parcel Locker locations for the future parcel volumes.
- Carrier agnostic Out of Home solutions are still to come, if ever. Independent operators are handling almost no volume today. One way to establish such an infrastructure could be that the last mile will be taken over by the local authorities, like it is with waste.
- All Out of Home solutions trigger secondary traffic. How much exactly must be researched.
- Unless the share of unattended deliveries at home can be significantly increased, the number of delivery vehicles will continue to grow more or less at the same rate as the parcel volume.
- The expected change towards more food and Same Day Delivery will make PUDO's and Public Parcel Lockers less fitting for tomorrow's delivery mix.
- Carrier cruising and secondary traffic must be kept down to avoid even more congestion of the cities.
- Future delivery solutions must be carrier agnostic. This implies carrier bundling must be addressed. Countryside deliveries will probably be the first area to see carrier bundling.
- We could not do cases with route bundling and micro hubs. That doesn't mean it wouldn't work, but our data was not conclusive.
- OOH advocates seem to come from two camps. The manufacturers of parcel lockers and carriers looking to cut last mile cost.

8. CONCLUSION

Building a parcel box infrastructure will take time and in the meantime all solutions are needed.

We do not see OOH solutions as bad. We see not-so-good customer experience and not the best or correct solution for the future. OOH's could quickly turn bad for the consumers if the current market with non-agnostic OOH solutions do not change.

We also see a call to action to politicians at all levels. Building regulations, housing laws and laws regulating traffic must be changed to cope with the new reality, a reality which could be here a lot faster than we all thought before Covid-19.

Far more important is that all stakeholders in B2C should start re-thinking their positions before the politicians force laws and regulations on the industry, which could make the market conditions even more complex.

Coopetition, Sharing Economy, leaving the old standpoint of *"branded"* delivery, setting up common standards for parcel codes and area definitions to bundle tours, will change inter-operationality between carriers. Not just for environmental reasons, but for customer experience, variable cost reduction and capex reduction.

The fact is, whether the market goes the carrier agnostic OOH route, or a parcel box infrastructure is established, ***the consumer is not going to meet the driver nor see the delivery vehicle in the future.*** Therefore, carriers must ask themselves which role they will, should or could play in the future and what their clients, i.e. Etailers, will ask for.

We all have to change the way we think. It is a bit strange that we all have a letterbox, and hardly any of us a parcel box at home. In the future we will receive far more parcels than letters.

Our study may only be a theoretical calculation and we were not able to include and calculate many new solutions which look promising, but our study identified a potential problem which can be impacted.

Once a parcel box infrastructure is established, everybody will benefit.

- The consumer will get more convenience.
- Funding will be done according to the causer principle, i.e. it will be a recipient financed infrastructure.
- The carriers will double route productivity and cut capex significantly.
- Local retail will be included in the future local first and last mile structure.

9. HOW THE STUDY *"HAPPENED"*

It really started with some internal excel calculations in Oct. 2019, which came up a bit surprising and just kind of snow balled from there on. Around January 2020 we then decided to put the study together and a lot of work went into writing, checking data, re-building cases and so on.

We would like to thank all the people which helped putting this study together. Walter Trezek of Document Exchange Network for the tip on the EU directive, Prof. Bogdanski of TH Nürnberg for accepting to go over all these cases from non-scientific authors and Birgitt Helms from efa+ for her patience in teaching us to use the ecocockpit tool and playing devil's advocate on the study.

We have talked to people from carriers and locker producers and to people from startups with new ideas. We have been discussing the results with trade organization and politicians. Thank you to each and every one for your comments, questions and suggestions. You contributed more than you might be aware of!

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