Sustainability in Invoicing 2023

Author	Moritz Leutenegger, carbon-connect AG
Review and certification	myclimate foundation
Client	SIX BBS Ltd
Date	February 2024

Contents

1 Introduction

1.1 Objective of the Study

Digitalization is leaving its mark on many industries. Whether it's the use of self-scanning devices for shopping or online tax returns, technological advances are being used in many areas to simplify processes for users and save time. Invoicing has also changed significantly in recent years. While companies used to send invoices by mail with a payment slip as standard, they are now increasingly sending invoices by e-mail or via online banking with eBill. This raises the question of the environmental benefits of these new ways of sending invoices, in addition to the time savings. On behalf of SIX, carbon-connect AG compared the three most common invoicing methods with regard to their carbon footprint.

The data used in this study are primarily based on information from SIX Interbank Clearing Ltd and the Swiss National Bank's payment methods surveys. The results of the unpublished representative survey[1] on payment behavior in Switzerland conducted by gfs.bern in the spring of 2023 were also included in this study. All relevant processes in the value chain were considered for the greenhouse gas balance of the various invoicing methods. These include the costs of issuing and receiving invoices, as well as payment processing via the SIX infrastructure. However, the energy consumption of the servers on which the invoice data are stored and the influence of the dunning process were not taken into account (see Chapters 1.2 and 1.3).

1.2 System Limits

The life-cycle analysis of all invoicing methods in this study (paper, e-mail, and eBill invoices) includes the following processes within the system limits:

- Digital creation of invoices
- Production and printing of invoices (invoicing, payment, and archiving)
- Production and printing of envelopes (paper invoicing)
- Sending invoices (invoicing)
- Effort required to pay invoices (time spent using the payment medium)
- Mobility for payment of invoices at the post office counter
- Effort required for data processing via the SIX infrastructure
- Transport of the paper to the recycling point
- Incineration of the paper

The following process data are not taken into account. On the one hand, the quantifiability of the data is subject to great uncertainty, and on the other hand, the share of these parameters is relatively small. Consequently, their omission is not decisive for the significance of the study.

- Storage of data on external servers (power consumption)
- Power consumption during data transmission
- Duration of archiving invoices (storage usage, room air conditioning)
- Dunning process

[1] Representative survey by gfs.bern: N = 1,007, sampling error ±3.1% at 50/50 and 95% probability.

1.3 Note on System Limits

Power consumption and server performance are a central part of data processing due to the growing digitalization of processes. The processing steps for creating and sending eBill and e-mail invoices are carried out digitally. Although paper invoices are physically printed out, they are still created and processed digitally. Invoice payments are processed and transmitted via a central, digital payment system, whether the payment takes place via online banking or at the post office counter.

There are various approaches to estimating the power consumption that occurs during data transmission. Aslan et. Al (2017)[2] compared different studies to determine a suitable average power consumption for Internet-based data transmission per GB of data. Using these power consumption figures and assuming a conservatively large file size for invoices, it can be shown that it is unnecessary to take into account the power consumption attributable to data transmission due to its small share of the CO_2 footprint.

The extent to which the storage of data on external servers and the duration of archiving could influence the results of the study was also examined. A detailed study on the environmental impact of various digital devices and services was published by Gröger et. Al (2020)[3]. Similarly, it can be concluded in connection with the storage of data on cloud-based systems that archiving an invoice with an average file size of < 1 MB has a negligible effect on the results of the study.

Firstly, the omitted categories are of low quantitative relevance, and secondly, there are no major systematic differences between the various types of invoicing: paper invoices, e-mail invoices, and eBill invoices are all created, transmitted, and stored digitally.

[2] Electricity Intensity of Internet Data Transmission: Untangling the Estimates, 2017

[3] Digitaler CO_2-Fussabdruck – Datensammlung zur Abschätzung von Herstellungsaufwand, Energieverbrauch und Nutzung digitaler Endgeräte und Dienste, 2020, im Auftrag des BUND

1.4 Functional Unit

To compare the invoicing, methods of paper invoicing, e-mail invoicing, and eBill invoicing, the following processes were analyzed: the creation, payment, and disposal of the invoice.

1.5 Methodology

This study compares the different invoicing methods with regard to the greenhouse gas emissions they emit. The emissions are reported in kilograms of CO_2 equivalent and are taken into account with reference to the Intergovernmental Panel onClimate Change Report ("Climate Change," IPCC 2021, 100a). The CO_2 equivalent (CO_2-eq) is a unit of measurement used to standardize the climate impact of different greenhouse gases. In addition to carbon dioxide emissions, other greenhouse gas emissions such as methane and nitrogen oxides are also taken into account. The individual greenhouse gases are aggregated according to their effect over the next 100 years, compared with the effect of carbon dioxide over the same period[4].

1.6 Database

The data records used for the balancing of the different types of invoicing – if available – are taken from the environmental database ecoinvent, v3.9 (Frischknecht et al, 2007). The system model used is "allocation, cut off by classification." The data records from the Swiss ecoinvent center are based on the following assumptions:

- Recycling processes are not taken into account ("cut off")
- Waste management is taken into account (end-of-life, including transport)
- The infrastructure is taken into account with a service life of 50 years (power plants, roads, rail infrastructure, etc.)
- The standard ecoinvent distances are used for the transport of raw materials to the point of use

For mobility (payment of the invoice at the post office counter), the emission factors of Mobitool (v3.0) were used, which in turn are based on the ecoinvent database.

[4] "IPCC Second Assessment, Climate Change 1995", Intergovernmental Panel on Climate Change, 1995

2 Basics

2.1 Survey

SIX provided most of the data for this study. The gfs.bern research institute was responsible for collecting consumer-specific data. The questions relevant to the survey were compiled by SIX and carbon-connect AG. The resulting data are representative for Switzerland, and the methodological details of the survey are summarized in Table I.

Population	Swiss persons aged 18 and over
Data collection	Panel and telephone survey
Type of sampling	Random sampling
Survey period	February 14 to 24,
Sample size	Total: 1,007
Sampling error	±3.1% with 50/50 and 95% probability

Table I: Methodological details of the survey study

Data that could not be collected via the gfs survey were provided by SIX and checked for plausibility by carbon-connect AG. Invoice processing is divided into four main processes: invoicing, payment of the invoice, archiving, and disposal of the paper generated.

2.2 Invoicing

The invoicing methods examined differ fundamentally in the way they create an invoice. Both the capture of the invoice information and the creation of the invoice are done digitally by the invoice issuer. In the case of an eBill or e-mail invoice, the invoice recipient receives a digital notification by e-mail or in the eBill mailbox. A paper invoice is printed out, placed in a printed envelope and then sent by mail.

The time required to create the invoice has been estimated by SIX in accordance with Table II. The time required for the creation of the paper invoice is estimated to be higher because, in addition to the creation, the invoice must also be transmitted to the printing center. The resulting emissions were calculated on the basis of the corresponding power consumption of the computer used.

Type of invoice	Parameter	Value	Unit	Source
Paper invoice	Effort for invoice issuer	1.5	min	SIX
E-mail invoice	Effort for invoice issuer	1.0	min	SIX
eBill invoice	Effort for invoice issuer	1.0	min	SIX

Table II: Effort for the invoice issuer for the creation of an invoice

Table III summarizes the assumptions used to calculate the emissions from invoice printing, envelope printing, and dispatching, including both paper production and printing. For the dispatch of the invoice, Swiss Post provided the emission factor for domestic mail delivery.

Parameter	Value	Unit
Invoice format	A4	–
Envelope format	C5	–
Paper grammage	80	g/m^2
Number of papers per invoice	1.5	–
Proportion of invoices dispatched by A Mail	50	%
Proportion of invoices dispatched by B Mail	50	%

Table III: Assumptions about the printing of the invoice and the dispatch method

2.3 Paying Invoices

The various invoicing methods also differ in the payment process. For both paper and e-mail invoices, the invoice information is transmitted via a QR code. As of October 1, 2022, the QR-bill has completely replaced the pay-in slip and is now widely used. In both cases, the invoice information must be entered in online banking via an external medium (smartphone or computer) in order to subsequently approve the payment. The payment information for an eBill invoice, on the other hand, passes directly into online banking for payment approval. There is therefore no media disruption when paying with eBill, so there is less effort involved than with paper or e-mail invoices. After the invoice recipient has triggered the payment process, the SIX infrastructure processes the transaction and the invoice issuer receives the credit. Regardless of the invoicing method used, the estimated time required by SIX is six seconds per invoice. Table IV shows the time required by the invoice recipient (time required to pay the invoice) and by the data processor (on the part of SIX).

Type of invoice	Parameter	Value	Unit	Source
Paper invoice	Time required to pay the invoice	2.0	min	SIX
E-mail invoice	Time required to pay the invoice	2.0	min	SIX
eBill invoice	Time required to pay the invoice	1.5	min	SIX
All	Effort required by SIX	0.1	min	SIX

Table IV: Time required to pay an invoice

The emissions balance considers the time spent on payment and processing as active time on the computer. Although a considerable proportion of invoices can now be paid via mobile methods, the power consumption of a computer is used to calculate emissions.

This study assumes two options for paying an invoice: via online banking or at the post office counter. The gfs survey determined the proportion of respondents who pay their invoices at the post office counter, depending on the invoicing method. This proportion is relevant because the study takes into account the mobility of the invoice recipient when paying at the post office counter. Table V shows the proportion of invoices paid at the post office counter by invoicing method.

12.8% of paper invoices are paid at the post office counter, while this proportion is less than 5% for e-mail and eBill invoices. Paying eBill and e-mail invoices at the post office counter requires the invoice recipient to print out the invoice. This study has taken into account the printed invoices in the emissions balance with the assumptions given in Table III.

Type of invoice	Parameter	Value	Unit	Source
Paper invoice	Proportion of invoices paid at the post office counter	12.8	%	gfs survey
E-mail invoice	Proportion of invoices paid at the post office counter	4.1	%	gfs survey
eBill invoice	Proportion of invoices paid at the post office counter	3.4	%	gfs survey

Table V: Proportion of invoices paid at the post office counter

The relevant basis for calculating mobility is the trip to the post office. These data come from the gfs survey and are summarized in Table VI. The analysis of the gfs survey showed that respondents live on average about 3.8 km from the post office where they mainly pay their invoices. On average, 5.7 invoices are paid per trip to the post office. A substantial proportion of respondents carry out their postal business and two additional activities at the same time, such as shopping or going to the hairdresser.

The majority of people travel on foot, by car, by bicycle, or by public transport. Only a few use electric bicycles or motorcycles to get to the post office.

Parameter	Value	Unit	Source
Average distance to the post office	3.77	km	gfs survey
Number of invoices paid per trip to the post office	5.68	–	gfs survey
Proportion of people who perform another activity in addition to paying an invoice	81.44	%	gfs survey
Number of activities in addition to going to the post office	2.32	–	gfs survey
Main means of transport: on foot	37.67	%	gfs survey
Main means of transport: car	34.25	%	gfs survey
Main means of transport: public transport	11.64	%	gfs survey
Main means of transport: bicycle	10.96	%	gfs survey
Main means of transport: electric bicycle	3.42	%	gfs survey
Main means of transport: motorcycle	2.05	%	gfs survey

Table VI: Data on mobility: the trip to the post office

Based on this information, the number of passenger kilometers (pkm) of each main means of transportation can be determined for each invoicing method.

2.4 Archiving

gfs.bern asked whether and to what extent invoice recipients in Switzerland archive their invoices. In particular, a distinction was made between digital archiving (data storage) and analog archiving (printed out in a folder). It was found that there are major differences in the behavior of invoice recipients when it comes to archiving invoices, depending on the invoicing method.

While approximately two-thirds of paper invoices are archived in analog form, this proportion is significantly lower for e-mail invoices (20%) and eBill invoices (10%). More than half of the respondents indicate that they digitally archive e-mail invoices as PDFs (53%), while 54% use automatic archiving in the eBill portal for their eBill invoices. Archiving data resulting from the survey are compiled in Table VII.

Type of invoice	Parameter	Value	Unit	Source
Paper invoice	Proportion of physical archiving	62	%	gfs survey
	Proportion without archiving	23	%	gfs survey
	Proportion of electronic archiving	15	%	gfs survey
E-mail invoice	Digital archiving as PDF, locally	53	%	gfs survey
	Analog archiving (printed out)	20	%	gfs survey
	No archiving	27	%	gfs survey
eBill invoice	Digital archiving as a PDF, locally	25	%	gfs survey
	Analog archiving (printed out)	10	%	gfs survey
	No archiving	11	%	gfs survey
	Archiving in eBill Portal	54	%	gfs survey

Table VII: Invoice archiving data

The archiving of the invoice is considered on the one hand by the printing of the invoice (for archiving) and the time needed for digital archiving, and on the other hand by the related power consumption of the computer.

How long an invoice remains archived is not part of the balance. For the printing of the invoice, the assumptions listed in Table III have been made, while the costs for archiving can be found in Table VIII.

Parameter	Value	Unit	Source
Scanning and saving as a PDF	1.0	min	SIX
Automatic archiving of an e-mail invoice	0.0	min	SIX
Printing out an e-mail invoice	1.0	min	SIX
Saving an e-mail invoice as a PDF	0.5	min	SIX
Automatic archiving of an eBill invoice	0.0	min	SIX
Printing out an eBill invoice	1.0	min	SIX
Saving an eBill invoice as a PDF	0.5	min	SIX

Table VIII: Effort required for archiving invoices

2.5 Disposal

Disposal of mailed paper invoices and invoices printed at home are included in the balance. In Switzerland, paper is either recycled or incinerated in a waste incineration plant. In 2021, the collection rate was 81.3%[5]. For the proportion of recycled paper, only the transport from the invoice recipient to the recycling point is taken into account, assuming an average transport distance of 27.8 km. For the proportion of paper incinerated in a waste incineration plant, the emission factor (specific to Switzerland) for municipal waste incineration is used.

[5] Annual Report on Waste Paper in Switzerland, 2021: https://www.altpapier.ch/files/statistischer_Jahresbericht_RPK_2021.pdf

3 Emissions Balance

Emissions were calculated based on the data described in Chapter 2. The resulting emissions of the different invoicing methods are explained in the following sub-chapters.

3.1 Paper Invoicing

To obtain the emissions balance as shown in Table IX, the entire invoicing process (invoicing, payment, archiving, and disposal) of a paper invoice is weighted and listed in a comparable manner. Taking all parameters into account, a paper invoice thus generates 38.42 grams of CO_2 equivalent per invoice. Invoicing accounts for just under 85% of emissions. Slightly less than a fifth of emissions are caused by paying the invoice (15%). Paper disposal and archiving play a minor role in paper invoicing.

When looking at a specific invoicing process, the range of variation in the emissions balance becomes clear. The following two situations show a specific process flow with an unweighted emissions calculation. For example, if a paper invoice is paid at the post office counter, 73.14 grams of CO_2 equivalent per invoice are generated by the entire invoicing process, taking mobility emissions fully into account. However, if the paper invoice is paid via online banking, no transportation is required, and only 33.30 grams of CO_2 equivalent are emitted per invoice.

Category	Process	Emissions [g CO_2-eq][6]
Invoicing	Creating an invoice	0.49
	Production of paper and printing an invoice	14.37
	Production of paper and printing an envelope	11.40
	Dispatch	6.23
	Total for invoicing	32.49
Paying the invoice	Payment process	0.65
	Mobility	5.10
	Total for the payment process	5.75
Archiving	Digital archiving	0.05
	Analog archiving	0.00
	Total for archiving	0.05
Disposal	Incineration at a waste incineration plant	0.08
	Transport for recycling	0.05
	Total for disposal	0.13
Total		**38.42**

Table IX: Emissions balance: paper invoicing

[6] The emissions have been weighted according to the effective share of the respective processes in the table.

The emissions attributable to mobility when going to the post office (regardless of the type of invoicing) amount to 39.84 grams of CO_2 equivalent on average. The value shown in Table IX is weighted, as only 12% of respondents in the gfs survey pay paper invoices at the post office counter. A detailed list of the individual means of transport and their proportion of emissions can be found in Table X.

Means of transport	pkm	Emissions [g CO_2-eq][7]
On foot	0.215	0.00
Car	0.196	36.52
Public transport	0.067	0.83
Bicycle	0.063	0.35
Electric bicycle	0.020	0.22
Motorcycle	0.012	1.92
Total		**39.84**

Table X: Payment at the post office counter: emissions resulting from mobility

[7] The emissions have been weighted according to the effective share of the respective processes in the table.

3.2 E-Mail Invoicing

The emissions balance for the invoicing process for an e-mail invoice can be found in Table XI. Over the entire invoicing process, an e-mail invoice emits 6.27 grams of CO_2 equivalent on average, taking into account the weighted parameters. This is only about 16% of the emissions generated by a paper invoice. This is mainly due to the fact that no invoice or envelope needs to be produced or printed during the invoicing process. The share of invoicing in total emissions is only 5% for e-mail invoices (paper invoices: 80%). In the case of e-mail invoicing, payment (46%) and archiving (49%) are responsible for just under 95% of emissions.

Here, too, it can be seen that the individual parameters have a greater impact when a specific invoicing process is considered. Paying an e-mail invoice via online banking generates 4.04 grams of CO_2 equivalent. If the e-mail invoice is printed out and paid at the post office counter, 58.32 grams of CO_2 equivalent are generated.

Category	Process	Emissions [g CO_2-eq][8]
Invoicing	Creating an invoice	0.32
	Production of paper and printing an invoice	0.00
	Production of paper and printing an envelope	0.00
	Dispatch	0.00
	Total for invoicing	0.32
Paying the invoice	Payment process	0.65
	Printing the invoice	0.59
	Mobility	1.64
	Total for the payment process	2.88
Archiving	Digital archiving	0.08
	Analog archiving	2.97
	Total for archiving	3.05
Disposal	Incineration at a waste incineration plant	0.01
	Transport for recycling	0.01
	Total for disposal	0.02
Total		**6.27**

Table XI: Emissions balance: e-mail invoicing

[8] The emissions have been weighted according to the effective share of the respective processes in the table.

3.3 eBill Invoicing

When an invoice is issued with eBill, 4.18 grams of CO_2 equivalent are emitted per invoice on average. The details of the emissions balance can be found in Table XII. Thus, the processing of an eBill invoice emits on average 89% (paper invoice) and 33% (e-mail invoice) less CO_2 equivalent than the other invoicing methods examined. In a similar way to e-mail invoicing, payment (56%) and archiving of the invoice (36%) are the processes that account for the largest proportion of total emissions. Invoicing (8%) and invoice disposal together account for less than 10%.

The comparison between the respective payment options shows that paying an eBill invoice in the eBill portal generates 2.34 grams of CO_2 equivalent, while paying at the post office counter generates 56.62 grams of CO_2 equivalent.

Category	Process	Emissions [g CO_2-eq][9]
Invoicing	Creating an invoice	0.32
	Production of paper and printing an invoice	0.00
	Production of paper and printing an envelope	0.00
	Dispatch	0.00
	Total for invoicing	0.32
Paying the invoice	Payment process	0.49
	Printing the invoice	0.49
	Mobility	1.35
	Total for the payment process	2.33
Archiving	Digital archiving	0.04
	Analog archiving	1.48
	Total for archiving	1.52
Disposal	Incineration at a waste incineration plant	0.01
	Transport for recycling	0.00
	Total for disposal	0.01
Total		**4.18**

Table XII: Emissions balance: eBill invoicing

[9] The emissions have been weighted according to the effective share of the respective processes in the table.

3.4 Comparison of Invoicing Types

Figure 1 shows a bar chart of the average emissions generated when paying an invoice for the various invoicing methods. It can be seen that a significantly higher amount of CO_2 equivalent is emitted when processing a paper invoice than when processing an e-mail or eBill invoice. This is due to the emission-intensive invoicing process and the associated production of the paper, the printing of the invoice and the envelope.

On the other hand, if e-mail and eBill invoices are only printed out for payment at the post office counter or for archiving, each paper invoice sent must be printed.

In total, the paper invoice emits an average of 32.15 grams of CO_2 equivalent (e-mail invoice) and 34.24 grams of CO_2 equivalent (eBill invoice) more than the other two digital invoicing methods.

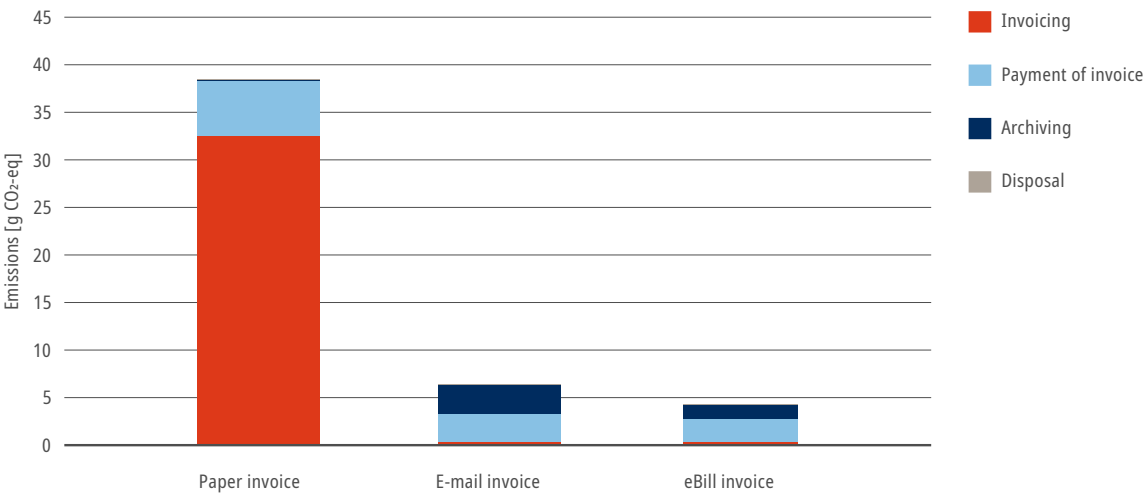

Figure 1: Comparison of emissions by invoicing method

The fundamental differences between the invoicing methods studied can also be seen in Figure 2.

The invoicing process for an e-mail invoice emits more CO_2 equivalent than eBill invoices. This is mainly due to the fact that a higher proportion of people pay at the post office counter when using e-mail invoicing, and that e-mail invoices are printed out for archiving about twice as often as eBill invoices. The media disruption that occurs during the payment process for an e-mail invoice and the associated increase in the time required to pay the invoice have only a minor effect on carbon emissions compared to the eBill invoice.

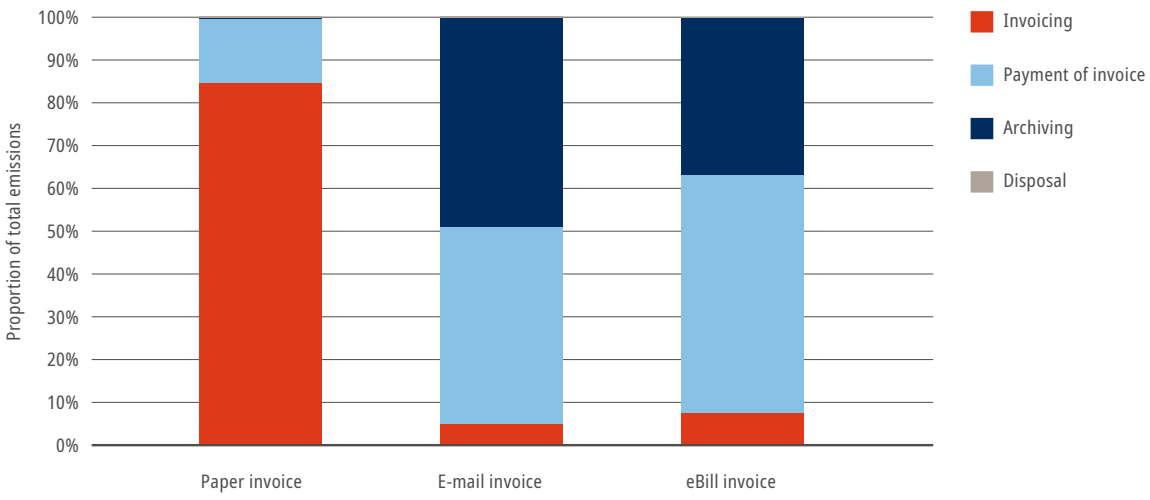

Figure 2: Proportion of total emissions of the different invoicing methods

3.5 Overarching View

3.5.1 Invoicing in Switzerland

According to SIX, a total of 1,102 million invoices (excluding direct debits) were paid in Switzerland in 2022, of which 58 million were paid using eBill. The way in which the remaining bills were sent is based on the information provided by the respondents to the gfs survey. Based on the results provided, it can be assumed that in 2022, the share of paper invoices was 59% and that of e-mail invoices 36%.

SIX and the Swiss financial center are striving to increase the level of digitalization in accounting and to shift volumes to eBill. The medium-term goal is to expand the share of eBill invoices in Switzerland to 50%.

The forecast for the shares of the medium-term target of the respective invoicing methods is based on the following assumptions:

- Proportion of eBill invoicing: 50%
- Proportion of e-mail invoicing: 30%
- Proportion of paper invoicing: 20%
- The total number of invoices remains the same as in 2022
- The increase or decrease in the number of invoices from the baseline (2022) to the target value is linear

The number of invoices calculated under these assumptions, by invoicing method and year, is shown in Table XIII (values in millions).

Invoicing method	Baseline	eBill: 10%	eBill: 20%	eBill: 30%	eBill: 40%	eBill: 50%
Paper invoice	649	603	507	412	316	220
E-mail invoice	395	389	374	360	345	331
eBill invoice	58	110	220	331	441	551
Total invoices	**1,102**	**1,102**	**1,102**	**1,102**	**1,102**	**1,102**

Table XIII: Invoicing forecast until interim target is reached (eBill: 50%).

The proportions of each invoicing method are shown in Figure 3 as a bar chart.

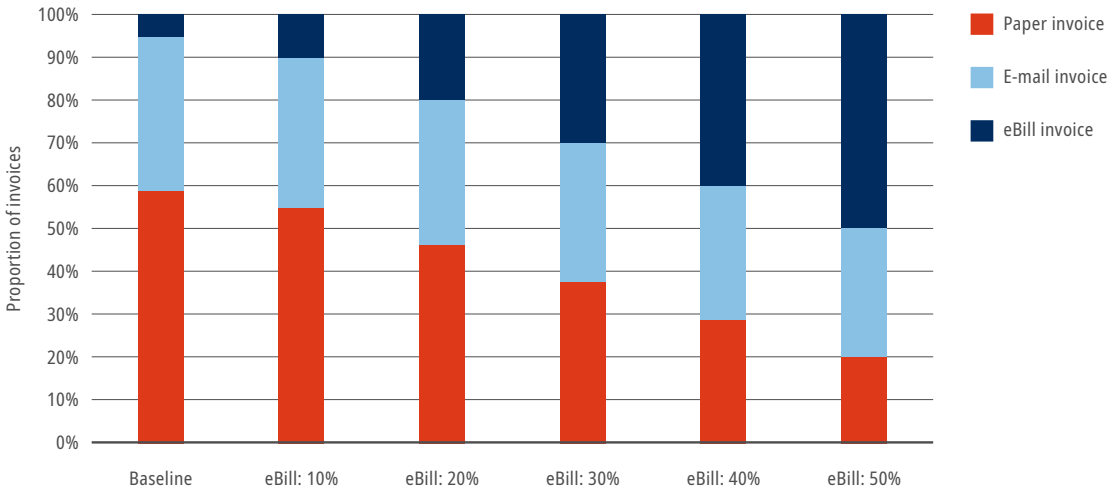

Figure 3: Proportion of individual invoicing methods until interim target is reached (eBill: 50%).

3.5.2 Swiss View of Emissions

Based on the total emissions attributable to payment transactions in Switzerland, this study can be used to draw up a possible forecast for future developments. Emissions are calculated depending on the various invoicing methods and taking into account the system limits described above. Future emissions are forecast on this basis, assuming that the eBill share is continuously increased.

The forecast calculation is based on the following assumptions:

- The number of invoices for each invoicing method corresponds to Table XIII
- The behavior of invoice recipients does not change (proportion of payment at the post office counter, mobility behavior,ratio of analog/digital architiving of invoices)
- Technical general conditions do not change (electricity mix, power consumption of computers, printing technology)

In 2022, around 28,000 metric tons of CO_2 equivalent (excluding direct debits) were emitted throughout Switzerland as a result of invoice processing. This corresponds to an average emission factor of around 25 grams of CO_2 equivalent per invoice.

Assuming that eBill invoices account for the target share of 50% of all invoicing methods in Switzerland, annual emissions can be reduced to around 13,000 metric tons of CO_2 equivalent by the time this interim target is reached. This represents a reduction of around 54% of total emissions compared to the 2022 figure.

The emission factor per invoice will be reduced to around 11.8 grams of CO_2 equivalent by the time the interim target is reached as a result of ongoing digitalization and according to the forecast.

The emissions calculated on the basis of these assumptions are summarized in Table XIV.

Invoicing method	Baseline	eBill: 10%	eBill: 20%	eBill: 30%	eBill: 40%	eBill: 50%
Paper invoice	24,904	23,158	19,484	15,810	12,136	8,462
E-mail invoice	2,479	2,436	2,345	2,254	2,163	2,072
eBill invoice	242	461	921	1,382	1,842	2,303
Total [t CO_2-eq]	**27,625**	**26,232**	**22,883**	**19,534**	**16,186**	**12,837**

Table XIV: Forecast of emissions until interim target is reached (eBill: 50%).

Figure 4 illustrates the development of invoice-related emissions in Switzerland – depending on growth in eBill invoices. In the year in which the targeted share of eBill invoices is achieved, around 15,000 tons CO_2-eq will be saved compared to the reference year (with the invoice volume remaining unchanged). This is roughly equivalent to the annual CO_2 emissions of 1,200 people in Switzerland (including imported goods)[10].

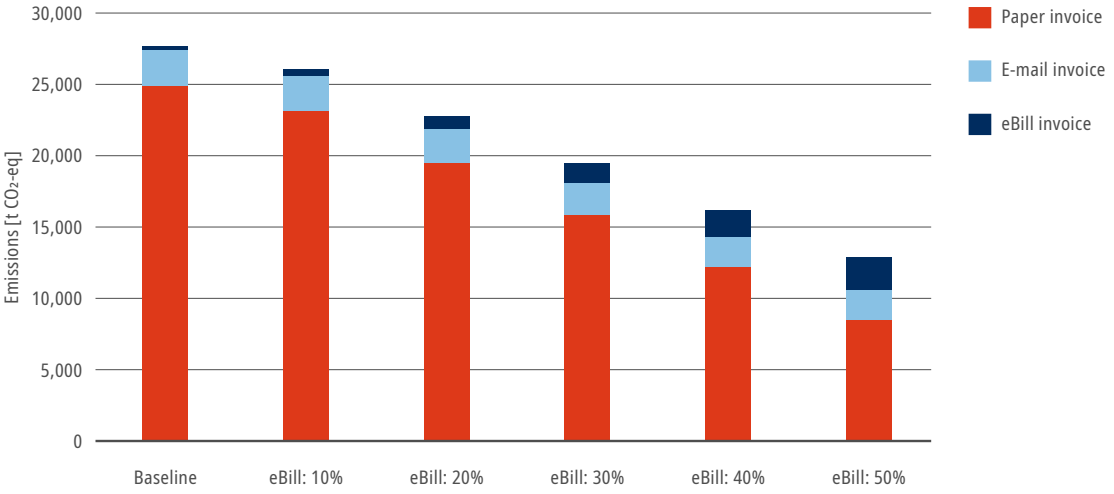

Figure 4: Development of emissions and proportion of invoicing methods until interim target is reached (eBill: 50%).

[10] Parameters for the Development of Greenhouse Gas Emissions in Switzerland 1990–2021, FOEN, April 2023

3.6 Sensitivity Analysis

The emissions balance produced is subject to uncertainties resulting from both the data used and the emission factors. To evaluate the robustness of the emissions balance of the different calculation methods, the most sensitive and uncertain parameters were identified and their influence on the resulting emissions was calculated.

3.6.1 Sensitivity

Based on the sensitivity analysis, the parameters "average distance to the post office" and "number of papers per invoice" were varied, as well as the emission factors "power consumption for active time on the computer" and "production and printing of paper". Table XV shows the varied parameters and the case studies (––, –, +, ++) in tabular form. All parameters were varied by ±20%.

Varied parameter/emission factor	– –	–	+	++
Average distance to the post office	–20%	–10%	+10%	+20%
Number of papers per invoice	–20%	–10%	+10%	+20%
Emission factor: power consumption for active time on the computer	–20%	–10%	+10%	+20%
Emission factor: production and printing of paper	–20%	–10%	+10%	+20%

Table XV: Variation of parameters/emission factors

Figure 5 illustrates the sensitivity analysis of the paper invoice. In the emissions calculation, the emission factor for paper production and printing proved to be the most sensitive parameter, with a 20% change in this parameter leading to a 13% change in emissions. The number of papers per invoice was also identified as a sensitive parameter. The distance to the post office and the power consumption for active time on the computer play a minor role in the sensitivity of the paper invoice.

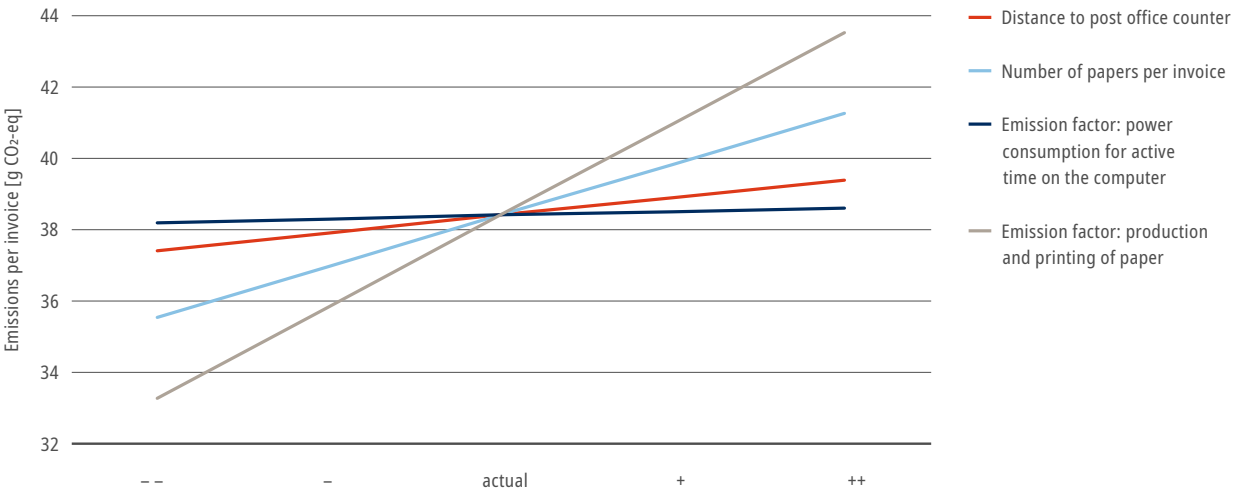

Figure 5: Sensitivity of the emissions balance: paper invoice

The sensitivity analysis showed that for e-mail invoices, the number of papers per invoice and the emission factor for paper production and printing have a significant impact on the resulting emissions. A noticeable effect on the final result (Figure 6) was also found when the distance to the post office was varied (±5% when changing the distance by ±20%).

Compared to e-mail and paper invoices, the emissions balance for eBill is more robust. None of the parameters studied has an impact greater than ±10% when varying by ±20%. The result for eBill is most sensitive to the "number of papers per invoice" and "emission factor: production and printing of paper" parameters (Figure 7).

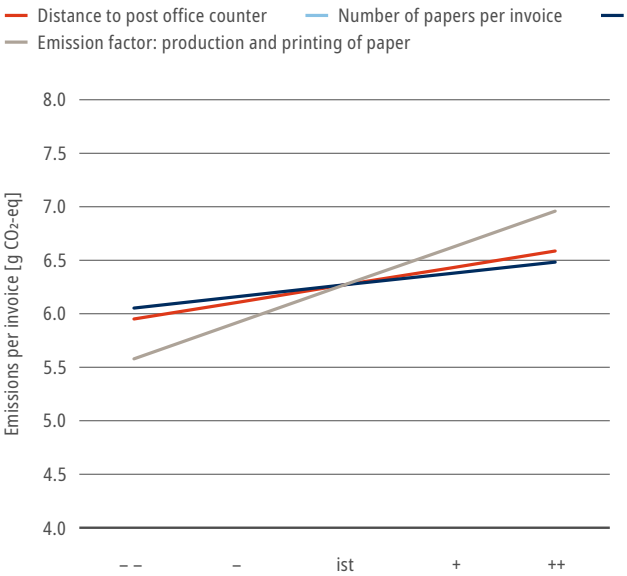

Figure 6: Sensitivity of the emissions balance: e-mail invoice

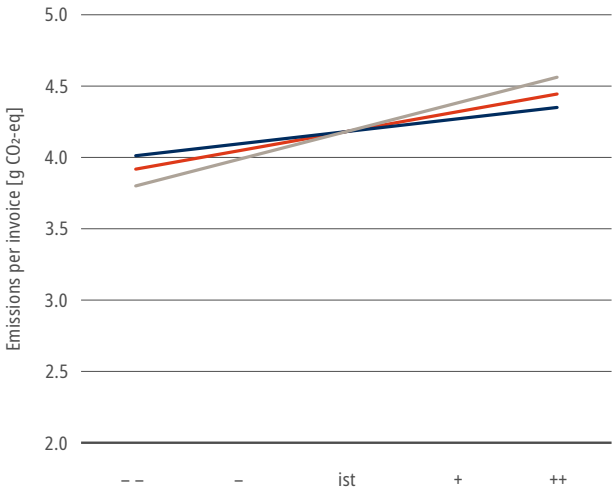

Figure 7: Sensitivity of the emissions balance: eBill invoice

3.6.2 Uncertainty

Overall, this study estimates that taking into account all uncertainties (from survey data, emission factors, and destimates), the calculated emissions for all invoicing methods have an uncertainty level of around 25%.

4 Summary

In Switzerland, invoicing is an essential element of payment transactions. More than one billion invoices circulate annually, most of which are still sent by mail.

According to the most recent data, 27,625 metric tons of CO_2 equivalent were emitted in 2022, which is equivalent to the annual carbon footprint of over 2,300 people living in Switzerland. Digitalizing payment transactions can make processing more efficient while promoting sustainability overall.

On behalf of SIX, carbon-connect AG conducted a study that analyzed the carbon footprint of the three best-known invoicing processes in Switzerland – paper, e-mail, and eBill. The calculations compare the CO_2 emissions of the three invoicing methods, taking into account the most relevant steps of invoicing, invoice processing, and invoice transmission, as well as the most relevant data parameters. As is customary in scientific studies, parameters that proved not to be decisive for the significance of the study were excluded from the scope. The definition of the system limits was shown transparently.

The analysis came to the conclusion that eBill invoicing is the most sustainable alternative among the invoicing methods analyzed, with an average reduction in CO_2 equivalent emissions of 89% (compared to paper invoicing) and 33% (compared to e-mail invoicing).

The goal is to increase the proportion of eBill invoices in Switzerland to 50% in the near future. Assuming that the target set by SIX is achieved, the annual CO_2 emissions will be reduced by 54% from around 28,000 metric tons of CO_2 equivalent to around 13,000 metric tons of CO_2 equivalent compared to 2022, with the invoice volume remaining unchanged.

The CO_2 equivalent values resulting from the calculations of carbon-connect AG were verified and confirmed by myclimate, as were the underlying data and sources. This shows that eBill can make a significant contribution to reducing the carbon footprint in the invoicing sector if it continues to grow. In this way, SIX is contributing to the transition of the economy to a more sustainable and climate-friendly economy within its sphere of influence.

Prepared by

CARBON connect

Certified by

myclimate shape our future

Client

SIX