VRMA
VINYL RECORD MANUFACTURERS ASSOCIATION

VINYL ALLIANCE

VINYL RECORD INDUSTRY
First carbon footprinting report

VRMA/Vinyl Alliance Working Group on
Carbon Footprinting the Vinyl Record Supply Chain

June 2024

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Summary

The Vinyl Record Manufacturer's Association (VRMA) and the Vinyl Alliance (VA) have formed a working group to examine the carbon footprint of vinyl records.

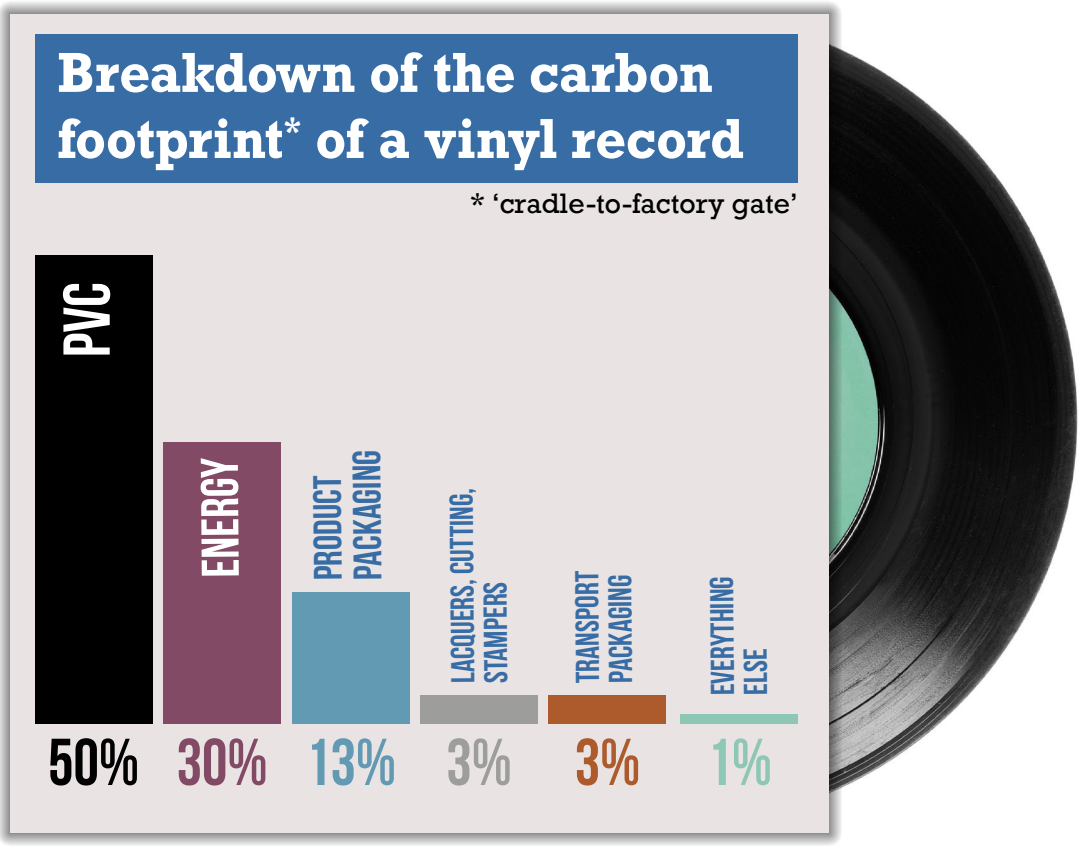
Our long-term ambition is to understand the carbon impact of our industry – from cradle to grave, across different supply chains – so that we can identify the most effective steps we need to take in response to the climate crisis.

In this report we present the first-ever Corporate Carbon Footprints covering Scopes 1 & 2 and Upstream Scope 3, from within the vinyl record industry, that have been independently verified against the GHG Protocol. These are of a pressing plant, a stamper manufacturer, and a lacquer cutting studio.

Our findings include:

- The 'cradle-to-factory gate' footprint of a vinyl record is in the region of **1.15 kg CO_2e**
- **50% of those emissions** come from the **PVC compound** used to press the records
- A further **30% of emissions** are from **energy** consumption at the factory
- **Print packaging** (jackets, inserts, sleeves) make up the next biggest element of emissions at **13%**
- lacquers, cutting and stamper manufacture, packaging for transport, are all comparatively small elements of the footprint of a vinyl record.

Because the PVC compound is the largest part of the footprint at the manufacturing stage, using heavier weights of vinyl should be avoided. Specifying the record weight at **180g** increases the carbon footprint by **14%** compared to 140g. It's a 19% increase if you specify 200g, and 26% if you ask for splatter.



Based on the organisational footprint of Vinyl Factory Manufacturing Ltd, 2022-2023. This is a ***'cradle-to-gate' footprint*** *and does not include emissions from distribution, use or disposal, or the emissions from non-manufacturing companies such as labels or brokers.*

New PVC compounds are coming to market that use 'bio-attributed' hydrocarbons as their feedstock. At the moment, only one supplier has a verified product footprint for their new compound, but switching to this would reduce the footprint of a vinyl record by around 44%.

These figures cover emissions up to the point that the records are ready to leave the pressing plant.

Although we have not yet footprinted any of the lifecycle stages beyond the factory gate, we do have authoritative data on the carbon impact of different ways of shipping records out from the pressing plant.

If the records are airfreighted from Europe to America (or vice versa) that would add another **1.36 kg CO_2e** to the footprint. Air freight from Europe to Australia would add **3.46 kg CO_2e** per record.

The carbon footprint figures in this first report reflect the activities of one pressing plant, one stamper manufacturer and one cutting studio, in one particular year. Records produced at other pressing plants and with different supply chain configurations will have different carbon footprints.

We will do further work to build on and refine our understanding, particularly for the stages beyond the factory gate. We are actively seeking other companies across the supply chain to join us in this project, to help build up a wider data-set.

But from the data we have so far, we can identify 5 important steps to take that will reduce the carbon footprint of a vinyl record – shown below.

Some of these steps will increase the manufacturing cost of a record. 'Bio-attributed' compounds are currently more expensive than conventional PVC compounds.

And for pressing plants to switch away from gas-powered boilers will require huge investment and in most cases, higher energy bills – both of which will also increase the cost of manufacturing a record.

These initial findings also allow record buyers and media commentators to compare the environmental impact of buying a record compared to other everyday activities.

We can't say – yet – whether buying a physical record is more damaging to the environment than streaming music. But we have provided the first verified data from the vinyl industry to help tackle this question.

Five significant steps to reduce the carbon footprint of a vinyl record

1. Eliminate air freight.

If a label or artist presses at a single location, then ships records to global markets by air freight, these shipping emissions will dwarf anything else you might do to reduce the carbon footprint of your release.

2. Switch to a new 'bio-attributed' PVC compound.

Depending on the verified product footprint, this could cut the footprint of your record by around 44%.

3. Press on 140g.

Heavier weights and splatter can increase the footprint of the record by between 14% and 26%

4. Keep packaging simple.

Making a jacket a gatefold (on a single record) adds around 10 to 15% to the typical footprint of a record compared to a simple 3mm spine jacket.

5. Switch to zero-carbon energy.

All companies in the supply chain should switch to electricity from renewable sources. Pressing plants often have gas boilers, and replacing these with electric or hydrogen boilers represents a huge challenge, but one that has to be grasped.

Introduction

Almost every human activity contributes greenhouse gases to the atmosphere, causing global warming. The scientific assessment of the likely impact of these greenhouse gases is unequivocal and irrefutable – our collective carbon footprint threatens the future existence of human society.

So every individual, organisation and government needs to urgently understand their contribution to the climate emergency, and take steps to reduce this risk.

The vinyl record industry must play its part, like every other business sector. For us, the first step is to get hard data on the emissions generated from manufacturing and distributing vinyl records. Without this data, we can't confidently identify the areas we should focus on to reduce our emissions.

To do this, the Vinyl Record Manufacturers' Association and the Vinyl Alliance set up a working group in October 2023 with the objective of carbon footprinting the vinyl record supply chain.

This report gives you our preliminary findings. It includes the first published, rigorous analysis of the footprint of a vinyl record from ***'cradle to factory gate'***. We can also start to identify the relative contributions of lacquer manufacture, lacquer cutting, galvanics and pressing, as well as that from sleeves and jackets.

At this stage, our data is based on a very limited number of businesses in the supply chain. But we have a range of other companies who are in the process of contributing their carbon footprints, and we hope this report will encourage many more businesses in the supply chain to participate as well.

But already we can identify the most important steps to take to reduce the carbon footprint of a vinyl record. And at the same time, we can identify those things that are not so significant.

If you are a pressing plant, this report will give you confidence about the areas to focus on in order to reduce your emissions as effectively as possible.

If you are a record industry buyer, the report will give you food for thought about how you choose your supply chain.

For our industry as a whole, we can start to talk more confidently about the steps we are taking to work more sustainably. The faster we build a deep bank of auditable and transparent data about the environmental footprint of vinyl records, the quicker we can improve.

And for the most important people of all – record buyers – we can for the first time tell them how the climate impact of buying a record compares to some other everyday activities. And in doing so we can start to address the question of whether buying a record is more damaging to the environment than streaming music.

In an age of planned obsolescence, vinyl has some things in its favour. Records are cherished for generations. They don't degrade, rarely go to landfill, but instead move from collection to collection, or continue their lives in charity shops. At the same time, they have traditionally been made from a plastic compound derived from fossil fuel, in an energy intensive process.

We hope this report – and a series of subsequent updates – encourages everyone in the vinyl record industry to be *radically transparent* about the environmental impact of making vinyl records, and what steps we can take to reduce that impact.

Our approach to carbon footprinting

GHG Protocol

Our carbon footprinting work adheres to the Greenhouse Gas (GHG) Protocol. This provides internationally-agreed standards, guidance and tools for businesses to measure, report and manage their greenhouse gas emissions.

Under the GHG Protocol, an organisation's emissions are grouped into three categories or 'Scopes'.

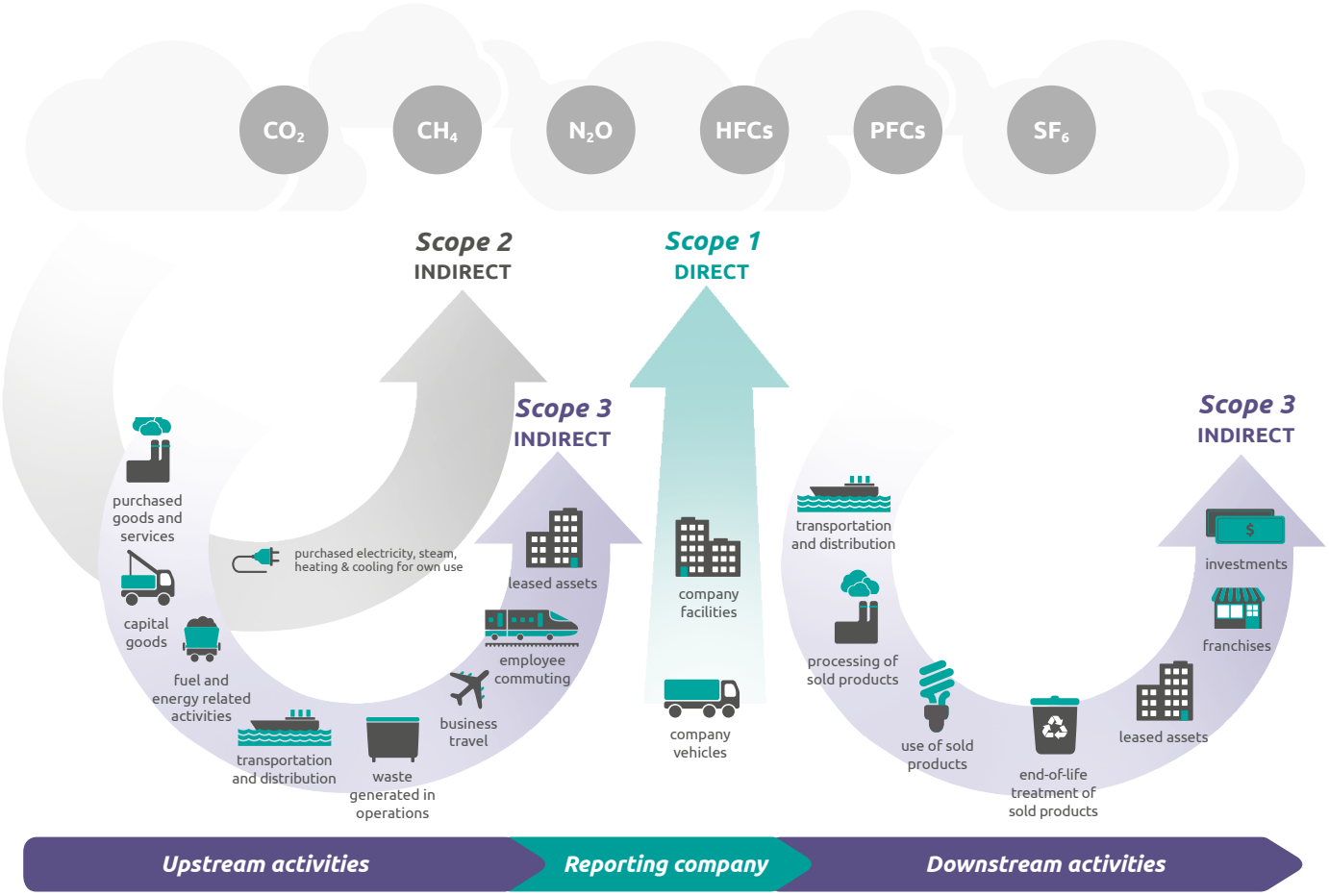
To measure its greenhouse gas emissions, a company collects data on:

- **Scope 1:** its own 'direct' emissions, such as gas used to heat buildings, or for industrial boilers, or fuel for company vehicles
- **Scope 2:** indirect emissions from electricity purchased
- **Scope 3:** all other indirect emissions in a company's value chain

There are other gases besides carbon dioxide (CO_2) that also contribute to climate warming, (e.g. methane – CH_4 – and nitrous oxide – N_2O). The global warming potential of these other gases is converted to the equivalent amount of carbon dioxide with the same global warming potential, and expressed as 'carbon dioxide equivalent', or CO_2e.

For example, the global warming potential of methane is 25 times that of carbon dioxide, so 1 tonne of methane is equivalent to 25 tonnes of carbon dioxide.

A company's total emissions across Scopes 1, 2, and 3, over a period of a year, expressed in tonnes CO_2e, represents the organisational carbon footprint of the company.



Scope 2 Electricity emissions

The GHG protocol requires companies to report emissions from purchased electricity in two ways. **Market-based emissions** are used in the reported footprint when a company has agreed a contract to buy energy wholly or partly from renewable sources. **Location-based emissions** are the emissions based on the average emission factor for electricity supplied in your area.

This dual reporting encourages companies to choose electricty from renewable sources, whilst at the same time still reporting on the impact of their total electricity consumption.

Product carbon footprints

If you have access to all the organisational footprints of the companies involved in producing and distributing a vinyl record, then – in theory – you have the raw data needed to work out the carbon footprint of an individual vinyl record – a 'product-level' footprint.

It is easy to do this for a small simple company, that only produces one product. The organisational footprint, divided by the number of products manufactured, gives you a product footprint.

It is still fairly easy for a company making a small number of variants of a product, for example, a pressing plant producing 12" records in 140g and 180g, and also 7" singles. The elements of the manufacturing processes that are physically linked to each product (or product variant) are separated out (e.g. the amount of PVC used in pressing the record), and other emissions related to activities that are not specifically linked to each product (for example, heating the factory, business travel) are distributed proportionally to each product.

It gets more involved when a company produces a range of different products or services. (For example a company that not only makes stampers and presses records, but also produces packaging, CDs and DVDs. Or a record label that manages artists, rights, streaming, tour promotion, as well as commissioning the manufacture of CDs, cassettes and vinyl…)

But the GHG Protocol provides guidance on how product-level carbon footprints can be derived from the data collected in organisational footprints.

Understanding the boundaries..

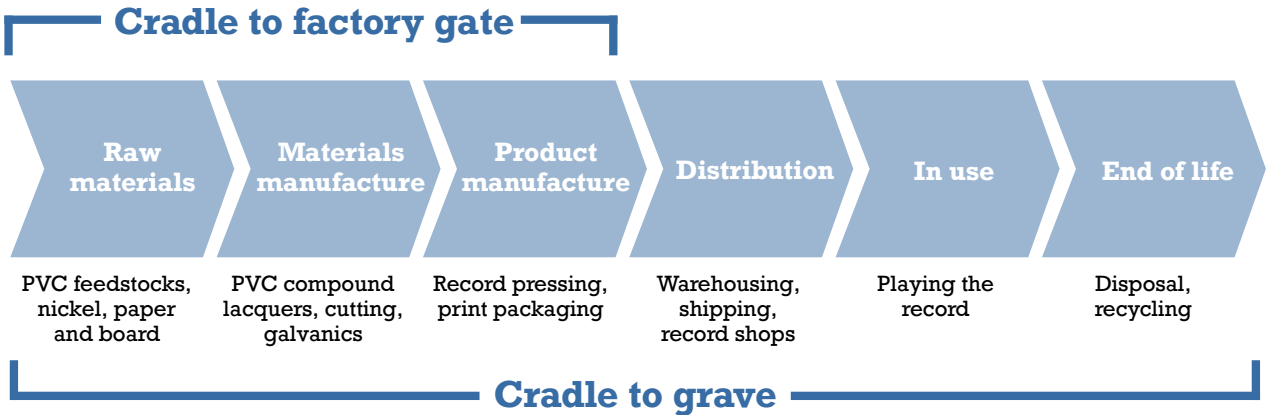
When talking about a carbon footprint – whether at the organisational or the product level – we need to be careful to define the boundaries of that footprint.

- Does an organisational footprint fully include emissions from Scopes 1, 2 and 3?
- Have the overlaps between one company's downstream activities, and the upstream activities of the next company in the supply chain, been accounted for correctly?
- Does a 'product footprint' cover the full life-cycle of the product up to its 'end of life'… or only part of that life-cycle? See the diagram below for an overview of the full lifecycle of a vinyl record.

To illustrate some of these points:

A pressing plant buys its stampers from a galvanics company which supplies a 'cradle to gate' footprint for different types of stampers. But the 'cradle-to-gate' footprint only covers the emissions 'up to the factory gate' – not for shipping them to the pressing company. Therefore the pressing company must also allow for the shipping emissions in its footprint.

Does a product carbon footprint for a vinyl record only cover the point up to which it leaves the pressing



plant? A full lifecycle footprint would also include the emissions resulting from distribution to record shops, the overheads of the record label managing the release, the record shop emissions, the emissions of the record 'in use', as well as those arising from the ultimate disposal of the record. Hence:

- There is not a single figure for the carbon footprint of a vinyl record.
- Independent, third party verification is essential to ensure that footprinting data is reliable and calculated in accordance with the GHG Protocol.

There is no single carbon footprint of a vinyl record

There are many different supply chains that are used to manufacture a record and get it in the hands of a consumer...

A record label could order lacquers from an independent cutting house, buy its stampers from a galvanics company, and then send the stampers to a small pressing plant, which buys in the printed sleeves and labels. Or it could use a large integrated pressing company which manufactures everything in-house.

The record could be pressed with traditional PVC based on fossil-fuel feedstock, or it could use a new PVC made from a 'bio-attributed' feedstock.

The record may have been pressed in one country, then shipped around the world, either by airfreight or sea freight and distributed to shops. Or a small band could get its record pressed at a local plant, then only distribute the records while on tour…

All these factors will affect the carbon footprint of a particular record release. *Hence why there is not one figure for the footprint of a vinyl record.*

In this first report we are only looking at a very simple supply chain. But we aim to build on this over time with more data from more companies, covering multiple years. This will give everyone a more nuanced picture of how different supply chain choices affect the environmental impact of new vinyl releases. And whether the industry is making progress in reducing that impact.

Independent verification

An independent auditor gives assurance that:

- Any footprinting data presented is complete (covers all scopes).
- The correct emissions factors have been applied to each activity.
- That the boundaries between successive companies in the supply chain have been managed correctly (avoiding omissions, but also double-counting).
- That any product-level footprints have been correctly derived.
- and that is clear if a product footprint only covers part of the lifecycle.

We have used Climate Partner to verify the underlying organisational footprints on which this first report is based. Their statements are included at the end of this report. They have also checked the product-level footprints which we have derived from these organisational footprints.

Our knowledge bank to date

We have verified carbon footprints from three businesses so far:

- **Vinyl Factory Manufacturing Ltd (VFM Ltd).** A pressing plant in London, UK, with eight presses and in-house electroforming of stampers, prroducing nearly 2 million records a year .
- **Stamper Discs.** A stamper manufacturer with 18 fast-plating cells, in Sheffield, UK.
- **Optimum Mastering.** A mastering and cutting house operating a single lacquer-cutting lathe, based in Bristol, UK.

Other members of the VRMA/VA working group have also committed to publishing and sharing verified carbon footprints within a planned timeframe. Four other pressing plants have also started work on collecting data for their carbon footprints.

We are actively seeking more companies across the whole supply chain to join us in this project. Please get in touch!

Our findings so far

The three verified carbon footprints we are reporting on (Vinyl Factory Manufacturing Ltd., Stamper Discs, and Optimum Mastering) give us authoritative data on the emissions generated from vinyl record manufacturing. *The data we present here only covers the supply chain from 'cradle to factory gate'.* At this stage we are not reporting any footprinting of emissions beyond that point – we hope to address this in our next report.

However, we can estimate the emissions arising from shipping vinyl records from the factory gate to different markets, comparing the carbon impact of different types of freight.

We'll start with insights from Vinyl Factory Manufacturing Ltd (VFM Ltd.), which give us the world's first-ever audited data on the carbon footprint of a vinyl record.

The footprints from Stamper Discs and Optimum Mastering then give us insights into the relative contributions of emissions from lacquer manufacture, lacquer cutting and stamper manufacture.

Vinyl Factory Manufacturing Ltd (VFM Ltd.)

Business overview	Stampers and records are manufactured in-house, 8 presses. Lacquers and cutting supplied/bought in. Some printed sleeves and record labels bought in, but also supplied in by customers.
Location	Hayes, London, one site only.
Number of employees	31
Period covered by the footprint	March 2022 to February 2023
Boundaries/scope	Cradle to factory gate
Verified organisational footprint	1,777.715 tonnes CO_2e
Scope 2 electricity emissions	Market-based = 0 tonnes CO_2e Location-based = 182.295 tonnes CO_2e (not included in verified footprint)
No. of records produced	1,706,860
Product split (units)	12" 140g: 705,549 12" 180g: 623,337 12" 200g: 278,560 12" splatter: 37,939 7" : 61,475

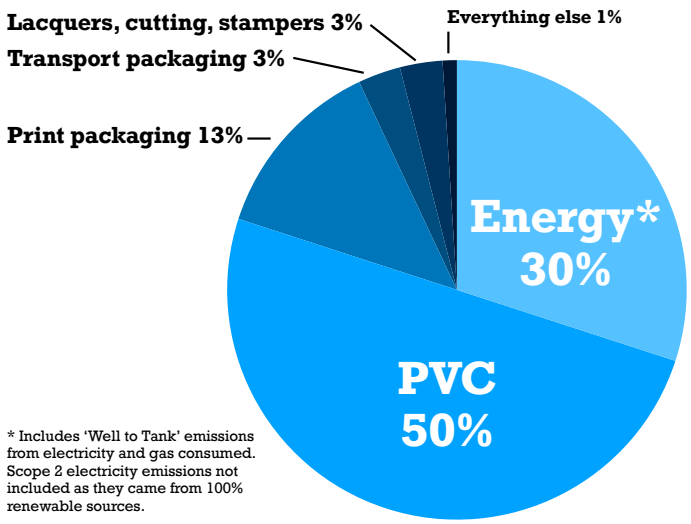
Breakdown of VFM Ltd footprint

At VFM Ltd, much of the packaging for records is supplied in by customers – and according to the GHG Protocol, is therefore not included in the organisational footprint summarised in the table above.

But we do need to include emissions related to this 'supplied-in' print, in order to get a complete picture of the footprint of a vinyl record pressed at VFM Ltd. These additional emissions are estimated to be 190.918 tonnes CO_2e. [1]

Adding these additional emissions relating to 'supplied-in' print gives a revised annual organisational footprint of 1,968.633 tonnes CO_2e.

This figure of 1,968 tonnes CO_2e, breaks down as follows.



In bound freighting of purchased goods is not included – but these are not expected to be material (i.e. < 2%)

Knowing that VFM Ltd produced 1,706,860 records over the year, we can use the revised organisational footprint of 1,968.633 tonnes CO_2e to calculate that a 'partial' product footprint for a vinyl record, averaged across the 5 product variants above is **1.153 kg CO_2e**. *This product footprint is described as 'partial' because it is only covering the lifecycle up to the factory gate, and also does not include in-bound freighting.*

And to re-iterate, this is not a definitive footprint figure for all vinyl records. It is a figure which reflects the activities at one pressing plant – VFM Ltd – in one particular year. Records produced at other pressing plants and with different supply chain configurations will be different.

Here are some of the reasons why other plants may differ:

- They may buy in stampers rather than electroform them in-house
- have different energy supply arrangements (VFM Ltd uses 100% renewable electricity, but its steam boiler is gas-fired)
- have a different profile of run lengths, and new orders compared to repeat orders (significantly affecting the number of lacquers and stampers consumed)
- use DMMs as masters as well as lacquers
- use a different type of PVC, from a different supplier
- produce more projects with highly elaborate packaging… or alternatively more records with minimal packaging.

We will calculate a product footprint for each of the five product variants (140g compared to 180g, and 200g, 12" splatter, and 7 inch singles) shortly. But first let's briefly discuss the major components of VFM Ltd's footprint.

PVC compound

A total of 354.84 tonnes of PVC were purchased (black and clear). In addition, 25.23 tonnes of black regrind were put back into production.

The PVC used at VFM Ltd is an INEOS fossil-fuel based compound. This has a certified product footprint (cradle to gate) of **2.753 kg CO_2e per kg of compound**.

INEOS are now releasing to the market a 'bio-attributed' PVC, branded ***ECOVIN***. Instead of only using the hydrocarbon naphtha as the feedstock, bio-naphtha, derived from recycled cooking oil, waste industrial gases, and byproducts from the paper and pulp industry is also blended in. The new compound is 'attributed' to the biogenic inputs by a mass balance approach.

There are different formulations of ***ECOVIN***, but all have certified product footprints which are just under 10% of that of the traditional PVC compound.

Other manufacturers are also bringing similar 'bio-attributed' PVCs to the market – but at the time of writing they are not able to supply certified product footprints. Those alternative PVCs that are also attributed to bio-naphtha are likely to show similar dramatic reductions in emissions.

If VFM Ltd had been able to substitute ***ECOVIN*** in place of the traditional PVC, for all the records it pressed in the year, its total footprint (including supplied-in print) would have come down from 1,968 tonnes CO_2e to around 1,089 tonnes CO_2e. And the footprint of a vinyl record (averaged across the five product variants) would have come down from **1.153 kg CO_2e to 0.64 kg CO_2e – a 44% reduction** in the emissions associated with each record.

It is clear that the biggest single step the vinyl record industry can take to quickly reduce its manufacturing emissions is *to press using new 'bio-naphtha attributed' PVCs rather than fossil fuel-based PVCs*.

Energy usage

Manufacturing a vinyl record is energy intensive: particularly the energy – usually gas – used to power boilers to provide steam for the presses. Large amounts of electricity are needed to electroform stampers.

Using a 100% renewable electricity supply is an obvious step – which VFM Ltd have already taken.

The factory used 942,682 kWh of electricity during the year in question. Because this was sourced from 100% renewable sources, there are no Scope 2 emissions for electricity consumption. However, if VFM Ltd *had not been using renewable electricity*, this would have added *another 182.295 tonnes CO_2e* to the annual footprint. [2]

Using renewable electricity has cut the organisational footprint by 8.5%, compared to what it would have been if electricity from fossil-fuel sources had been used.

Expressed another way: if all energy used at VFM Ltd had been from fossil fuel sources, energy would make up 36% of the organisational footprint. Using renewable electricity brings that down to 30%.

Replacing gas boilers with electric or hydrogen boilers is essential. But for almost all pressing plants this will be a difficult, expensive and longer term capital project.

Other significant components of Vinyl Factory Manufacturing Ltd's footprint

We can't use the VFM Ltd data to drill down into the emissions of stamper manufacture, because they don't track the numbers of stampers produced – only all the raw materials and energy needed to produce the stampers they use. But it is worth noting that the portion of VFM Ltd.'s footprint attributable to lacquers/cutting/and stamper manufacture will be lower than many other plants, because they have a high proportion of repeat orders (for which they will have existing metalwork.)

The emissions contribution from lacquers and stampers will be reviewed later in this report in the section presenting the Stamper Discs' footprint.

The other significant component of VFM Ltd.'s footprint which we will discuss here is **product packaging**.

This covers everything that is part of the record as a product: the record label, the outer jacket, and the inner sleeve, and any shrink-wrap protecting the record.

Delving into the detail of each item throws up some unexpected insights. There's a lot of discussion around the use of shrink-wrap. But the emissions from this shrink-wrap are about 8g CO_2e .[3] So it's fairly minor in relation to the overall footprint of a record. And much less significant than other aspects of print and product packaging…

For example, a 3mm/5mm printed jacket will have a footprint of between 0.1 kg and 0.15 kg CO_2e, depending on the weight of board used. [4]

A gatefold jacket will be in the range of 0.2 kg to 0.3 kg CO_2e, [4] again depending on the weight of board used. So using a gatefold jacket for a single release could be adding 10 to 15% to the overall footprint of a record – and is thus 15 to 20 times more significant than the choice about whether to use shrink-wrap!

There's hardly any difference in the footprint of a poly-lined inner sleeve compared to a paper only sleeve – a paper sleeve is around 21g, whereas a poly-lined sleeve is around 24g CO_2e. [5]

Calculating the different footprints of 140g, 180g, 200g, splatter and 7 inch singles

From VFM Ltd's revised organisational footprint, (i.e. with the additional contribution from 'supplied-in' print), we have calculated the different product-level footprints for 12" inch records at 140g, 180g, and 200g weights, 12" splatter, and 7" singles.[6]

PRODUCT	Carbon footprint (kg CO_2e)
12" 140g	1.069
12" 180g	1.223
12" 200g	1.275
12" splatter	1.352
7" single	0.735

Specifying the record weight at 180g increases the carbon footprint by over 14% compared to 140g. It's a 19% increase if you specify 200g, and 26% if you ask for splatter. (Because the PVC puck weight required for splatter is higher.)

A 7" single may only have 69% of the footprint of a 12" – but typically you are only getting around 20% to 25% of the music time. *So per minute of music listening, a 7" single results in around 3 times the emissions that if you were listening on a 12".*

The amounts of colouring compounds used to produce coloured vinyl are tiny in relation to the amount of clear PVC – so in practical terms there is little difference in the footprint of a colour vinyl record compared to a clear or black record.

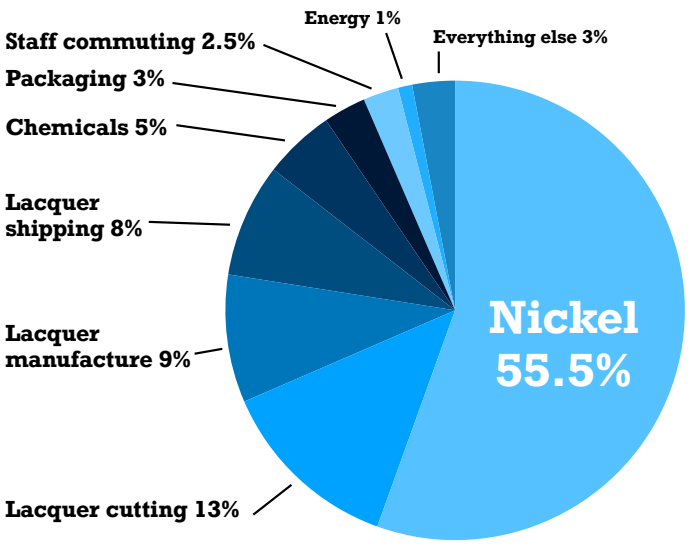
However, few plants try to re-use the 'flash' (the waste PVC trimmed from the edge of a record when it is pressed) from colour and splatter records.

VFM Ltd is an example of a plant which does try to persuade customers to use regrind from colour and splatter records. But almost all this 'mixed' flash goes to waste recycling rather than getting re-used in making new vinyl records, due to very low take up from customers. On the other hand, almost every plant re-uses most of the 'flash' from black records.

So for these reasons, 140g black records are the best choice in carbon footprint terms.

Stamper Discs Ltd

Business overview	Independent supplier of stampers to pressing plants worldwide. 18 fast plating cells.
Location	Sheffield, UK.
Number of employees	9
Period covered by the footprint	March 2022 to February 2023
Boundaries/scope	Cradle to factory gate
Verified organisational footprint	206.012 tonnes CO_2e
Scope 2 electricity emissions	Market based = 0 tonnes CO_2e Location based = 25.381 tonnes CO_2e (not included in verified footprint)
No. of pieces of metalwork produced	12,788
Product split (units)	1-step 12": 1,611 2-step 12": 3,266 3-step 12": 311 Additional 12": 2,968 DMM 12": 226 7/10" 1-step: 3 7/10" 2-step: 226 7/10" additional: 63



Breakdown of Stamper Discs' organisational footprint

85% of the Stamper Discs' footprint comes from nickel and masters (lacquers and Direct Metal Masters [7] – DMMs.)

96% of the masters supplied are lacquers, 4% are DMMs.

The nickel (a highly refined form called Nickel S Pellets, manufactured only in Clydach in Wales) is used to electroform stampers, which are then used by pressing plants to press records. The manufacturer, Vale, has a verified carbon footprint for this product of **32.1 tonnes CO_2e per tonne of nickel.** This has been applied in both the Stamper Discs' footprint above, but also for that of VFM Ltd.

The footprint for lacquers and DMMs is estimated from secondary data, as there are no verified product footprints for these items [8].

The figures for shipping lacquers use emissions factors from the UK government and DHL, (which correspond very closely). The figure for cutting lacquers is derived from the organisational footprint of Optimum Mastering (see next section). Optimum are only one of many cutting houses that ship lacquers to Stamper Discs, but they are representative of most cutting houses around the world in terms of their size and scale.

Significant amounts of electricity are required to electroform stampers. But as with VFM Ltd, all the electricity used at Stamper Discs is from 100% renewable sources. The 1% of the total footprint labelled 'energy' relates to 'well to tank' emissions, and transmission and distribution losses.

The amount of electricity used was 131,250 kWh. If the company had used electricity from fossil-fuel sources this would have added 25.381 tonnes CO_2e to its footprint [9] and energy usage would have been 12% of the organisational footprint – not 1%.

Lacquers versus DMMs?

Using secondary data, we have estimated the cradle-to-gate footprint of a lacquer as 3 kg CO_2e, and that of a DMM as 7 kg CO_2e. [8]

On the face of it, choosing a lacquer looks to be the better environmental choice. However, lacquers are air freighted from Japan to distributors in Europe and the USA. In a scenario where a lacquer is shipped to London, this adds 2.96 kg CO_2e in emissions. [10]

DMM blanks are manufactured at several places in Europe and also in-house by some of the larger European pressing plants. The shipping emissions for DMMs are therefore negligible in comparison. (DMMs are very rarely used in the American market.)

DMMs will also typically have lower associated stamper plating emissions, as stampers from DMMs are always produced as a single plating step.

Taking both these points into account, there is little difference in carbon footprint terms between a lacquer and a DMM. The discussion in the following section also highlights that the master, whether it is a lacquer or a DMM, will only be a comparatively small part of the overall footprint.

Calculating the different footprints of 1 step, 2 step, 3 step and additional stampers [11]

We have used the organisational footprint to calculate the product level footprints of different types of stampers. [12]

PRODUCT	Carbon footprint (kg CO_2e)
1-step stamper 12"	22.07
2-step stamper 12"	33.31
3-step stamper 12"	44.55
Additional/from DMM	11.24

These figures include lacquer manufacture, shipping and cutting – and help give us some insights into the relative contribution (in carbon footprint terms) of the stampers compared to the overall footprint of the record.

Again, we need to caution:

- the figures from other galvanics houses will be slightly different;
- as the scenarios below demonstrate, the choice of stamper type and the run length of the record pressing, will have a big impact on the contribution of the stampers to the overall footprint of a vinyl record.

If a short-run record of 500 copies is pressed using only a pair of 1-step stampers, the overall footprint of the record (cradle-to-gate) is likely to be around 575 kg CO_2e in total. The footprint of the two stampers would be 45 kg CO_2e – circa 8% of the total footprint.

In another scenario of a 5,000 run, produced using one pair of 2-step stampers and four pairs of additional stampers, the overall footprint would be around 5,750 kg CO_2e in total, and that of the stampers, around 155 kg CO_2e – circa 3% of the total footprint.

If a very long run of 50,000 records was produced with one pair of 3-step stampers, 5 pairs of mothers, and 50 pairs of additional stampers, then the overall

footprint would be around 57,500 kg CO_2e in total. The contribution from the stampers would be 1,325 kg CO_2e in total – circa 2.3% of the overall footprint.

And finally, for a repeat order of 1000 records from existing mothers, where only 2 additional stampers need to be plated, the footprint of the stampers would only be 22 kg CO_2e – circa 2%.

There is a (small) element of double counting in these comparisons, as the figure used for the overall footprint of a record (1.15kg CO_2e, taken from the VFM Ltd data) already includes some emissions from lacquer manufacture, cutting and making stampers. However, VFM Ltd has a significant proportion of repeat orders, so the emissions included in their footprint from lacquers/cutting/stampers will be a smaller element than would otherwise be the case.

But with this caveat, we can say that t*he preparatory stages of pressing a vinyl record (cutting the lacquer and making stampers) will typically be in the range of 2% to 10% of the overall footprint of a record*. It will be at the high end of the range for very short run projects, and at the low end for long run releases and repeat pressings with existing metalwork.

These calculations agree with the data presented earlier from VFM Ltd's organisational footprint, where lacquers/cutting/stampers made up 3% of the total footprint.

Optimum Mastering Ltd

Business overview	Mastering and lacquer cutting studio, with one cutting lathe.
Location	Bristol, UK.
Number of employees	3.6 FTE
Period covered by the footprint	Jan 2023 to December 2023
Boundaries/scope	Cradle to factory gate
Verified organisational footprint	19.082 tonnes CO_2e
Scope 2 electricity emissions	Location based = 4.095 tonnes CO_2e (included in verified footprint)
No. of billable lacquers cut	1,728
Product split (units)	72% of turnover linked to lacquer supply (mastering and cutting)

Optimum also supplies mastering services, but 72% of its turnover comes from supplying cut lacquers.

This footprint includes lacquer manufacture and shipping to Optimum, using the secondary data estimates calculated for the Stamper Discs' footprint. [8]

Stripping out the proportion of emissions relating to mastering, gives a figure of **9.8 kg CO_2e emissions per cut lacquer (cradle to gate)**.

Of this figure, 6.6 kg CO_2e [13] can be attributed to lacquer manufacture and shipping to Optimum, and 3.2 kg CO_2e for Optimum to cut the lacquer.

Beyond the factory gate

We've stressed that the carbon footprint data we've reported above only extends to the **factory gate.**

What happens after that should also be considered if we want to understand the full lifecycle impact of a vinyl record from **cradle to grave**. These include emissions from:

- the operations of record labels and production management companies involved in the supply chain
- distribution of records from the pressing plant to the consumer
- playing the record 'in-use'
- disposal of the record at the end of its life

Looking at these parts of the lifecycle will be the focus of subsequent reports from the VRMA/Vinyl Alliance working group.

In the meantime, it is worth briefly commenting on two of these areas now – distribution and disposal. In both areas, the potential carbon impact is very different from many people's assumptions.

Distribution

The traditional business model for most long-run releases for major artists is that the records are pressed in one plant, and shipped around the world from there. It is common for records to be pressed in Europe for European markets, but also shipped to Australia or the USA. Or for a record to be pressed in the USA and shipped to Europe.

When records are shipped to different continents, it is sometimes by air freight, sometimes by sea freight, depending on the route. (Europe to Australia will almost always be by airfreight, but Europe to the USA, and vice versa, is frequently by sea freight, if the distribution schedule allows.) What is the carbon impact of different means of distribution?

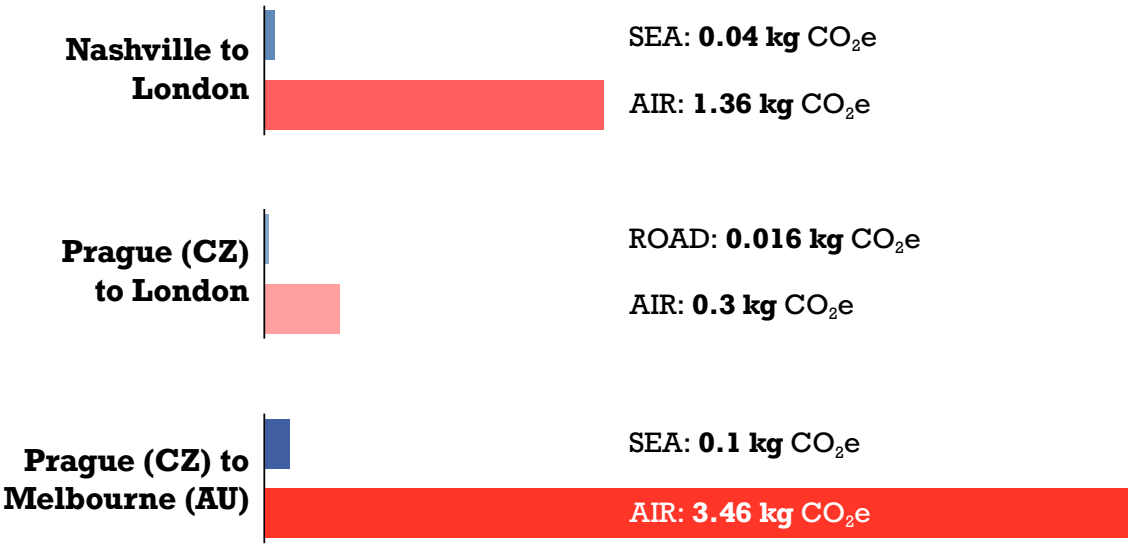
The results may surprise you.

- Shipping a record by air freight from Nashville to London adds **1.36 kg CO_2e** to the footprint of that record – a **118% increase**. [14]
- But the same shipment (Nashville to London) by road and then sea freight adds only **0.04 kg CO_2e** to the footprint of a record – only **a 3 % increase**. [14]
- Shipping a record by air freight from the Czech Republic to Australia adds **3.46 kg CO_2e** to the footprint of that record – a **300 % increase**. [14, 15]
- The same journey by (road and) sea freight only adds **0.1kg CO_2e** – only a **9 % increase.** [14, 15]

How about a shorter distance comparison between road and air freight?

- Shipping a record from Czech Republic to London by air adds **0.3 kg CO_2e** emissions per record – a **26 % increase**. [14]
- But shipping the same route by road adds only **0.016 kg CO_2e** – around a **1% increase**. [14]

Comparative emissions from distributing vinyl records by air, sea and road



WtW emissions per vinyl record

Given that the cradle-to-gate footprint to manufacture the record is only around 1.15 kg CO_2e (based on VFM Ltd data discussed earlier), it's clear that international air freight is the elephant in the room when taking about the carbon impact of vinyl records.

The inescapable logic is that any major label or artist that is serious about sustainability has to plan their supply chains and distribution schedules to eliminate air freight entirely. International air freight will typically – as a minimum – double the carbon footprint of vinyl record manufacture, and in some scenarios (shipping to Australasia), more than quadruple it. Even regional air freight adds significantly to emissions compared to road freight.

The biggest single opportunity that we have identified to reduce the carbon footprint in *manufacturing* the record is to change to a 'bio-attributed' PVC compound. But this will only cut the footprint of a record by around 0.5kg CO_2e.

The record industry needs to try and switch to these new compounds as soon as possible – but doing so will have relatively little impact on the overall footprint if the records are then still shipped around the world by air.

Disposal at end of life

Plastics like PVC are relatively inert – so if they go to landfill, only small amounts of greenhouse gases are released.

For a record weighing 140g, the landfill emissions from the vinyl record itself will only be 1.2 grammes of CO_2e. [16]

But if that record has a simple 3mm spine printed jacket and this also goes to landfill, the emissions from the disposal of the jacket will be over 90 g CO_2e. [15]

What about recycling? When discussing the carbon impact of recycling, there are often big differences between closed-loop recycling and open-loop recycling. Open loop recycling is where a product is converted back into new raw materials, and closed-loop recycling is where the product is recycled back into itself or a similar product.

Again, UK Government research [17] is surprising… *Open loop recycling* of dense plastics is thought to have a positive value of 205 kg CO_2e per tonne of material. A positive value means that this releases more carbon into the atmosphere relative to using virgin materials.

Closed loop recycling of dense plastic has a negative value of -590 kg CO_2e per tonne of material – i.e. there is a net carbon saving from closed loop recycling compared to using virgin materials.

There is (currently) no way of directing old vinyl records back into PVC compound (closed-loop recycling). Hence the unexpected conclusion that the open-loop recycling schemes that are occasionally available, where records are turned into other plastic products such as pipes or guttering, may not have the clear-cut environmental benefit that people assume they do.

So how bad are vinyl records?

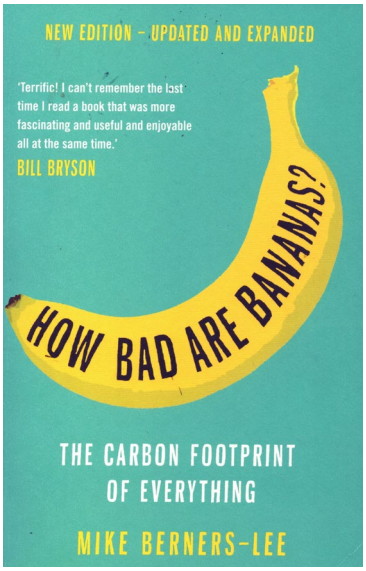
Let's recap on what we now know about the footprint of vinyl records. The data from VFM Ltd gives us a '*cradle to factory gate*' figure of **just over 1 kg CO_2e per record**. It could be almost half that if new PVC compounds are adopted.

We also have enough information to make reasonable estimates about best and worst case scenarios across the *full lifecycle* of a vinyl record.

A low-run record, pressed on a 'bio-attributed' PVC, picked up by a band from its local pressing plant and only distributed at gigs in their local region, might have a lifecycle carbon footprint of between **0.7 to 1.0 kg CO_2e**.

At the other end of the scale: a major label release by a global artist, if pressed on conventional PVC, at a heavier weight, if shipped by airfreight around the world, and if it has extensive bespoke packaging… that could all add perhaps another 4kg CO_2e. We don't yet know what the overheads of the label itself would add to that. The final 'worst case' carbon footprint might be **5 to 6 kg CO_2e per record**.

So if the *full lifecycle* impact of buying a vinyl record is between **0.7 and 6 kg CO_2e**. How does that compare to other everyday activities? The best resource to help us to answer this is Mike Berners-Lee's book (and website), *How bad are bananas - the carbon footprint of everything*.



Shown below are the carbon footprints of some everyday products and activities, compared to vinyl records. These comparisons are not intended to absolve the vinyl record industry from its responsibility to take all possible steps to reduce the environmental impact of how we operate – far from it.

But from the point of view of an individual record buyers, how bad are vinyl records? Not so bad. If we are serious about reducing our personal carbon footprint… then lets start with stopping flying, ditching the car for public transport or bikes, using renewable energy in our homes, and consider changing our diets.

The carbon footprint of vinyl records compared to other products and activities

- 1 pint of cow's milk: **1.1 kg** CO_2e
- A laundry load at 40°C, tumble-dried: **2.2 kg** CO_2e
- 10" pepperoni pizza with cheese: **2.2 kg** CO_2e
- Vinyl record: **0.7** to **6 kg** CO_2e
- 8 oz steak (from UK): **5.8 kg** CO_2e
- 8 oz steak from deforested land in Brazil: **17.8 kg** CO_2e
- Filling up your car with 50 litres of petrol: **178 kg** CO_2e
- Return flight, London to HongKong premium economy class **4,500 kg** CO_2e

Taking action

What are the most effective steps we need to take to reduce carbon emissions from the vinyl record industry? We now have some initial data to answer this question more authoritatively than we've been able to do up till now.

Pressing plants

- Measure and monitor your emissions and verify them against the GHG Protocol. Then develop a plan to reduce emissions.
- Encourage customers to use 'bio-attributed' PVC compounds.
- Switch to zero-carbon electricity, and start planning to replace gas boilers.
- Encourage customers to press only on 140g.

Record labels and artists:

- Ask your suppliers for a verified product carbon footprint. Footprint your own operations and share the data with all your stakeholders, and also develop a plan to reduce emissions.
- Avoid all air freight emissions. If timings are tight, then consider using a pressing plant local to a particular market to avoid the need for air freight.
- Switch to alternative PVCs (once you have seen a verified product carbon footprint).
- Don't produce over-elaborate packaging.
- Don't encourage over-consumption by producing multiple versions of essentially the same record.
- Always choose 140g, not heavier weights or splatter.

Record buyers

- Only buy what you really want.
- Support the second hand market.
- If buying new records, look for ones that have been manufactured using 'bio-attributed' PVC… and let your favourite artists know you expect them to make this switch.

We shouldn't stop implementing some of the other changes that people see as helping make record manufacture more sustainable – such as using recycled board for jackets, making all packaging bio-degradable and getting rid of shrink wrap. But we need to be honest with ourselves, (and record buyers), that these changes barely move the dial compared with those listed above.

Notes

[1] *Calculating emissions from 'supplied in print' at VFM Ltd.* The number of each type of print item purchased by VFM Ltd is known, enabling us to make reasonably accurate estimates of the numbers of items supplied in. In some instances, an informed judgement has had to be used, because, for example, the precise number of records that had printed inserts is not known. Another example is the exact split between single record sets and double record sets, and where gatefold jackets have been used, what proportion were for single records. Where these judgements have been made, they erred on the side of caution, adding 190.918 tonnes of CO_2e for 'supplied in' print, compared to the figure of 77.088 tonnes CO_2e from print purchased by VFM Ltd.

[2] *Calculating Scope 2 electricity emissions if VFM Ltd had not sourced renewable electricity*. The emissions figure is arrived at by using the 2022 DEFRA emissions factor for UK Electricity of 0.19338 kg CO_2e per kWh.

[3] *Shrinkwrap*. VFM Ltd achieve around 6000 records wrapped from a 17.5kg roll, which equates to 3g of shrink-wrap per record. A DEFRA emissions factor of 2.57416 kg CO_2e/kg product has been used, giving a figure of 7.7g CO_2e per record.

[4] *Printed jackets*. The paper board used is by far the biggest element of the footprint of a record jacket. Depending on where the board is sourced from, whether it is coated or uncoated, contains some recycled pulp etc, the emission factor could range from 1kg CO_2e/kg board to 1.8 kg CO_2e. An emissions factor of 1.479 kg CO_2e is given by https://www.researchgate.net/publication/340492627_Life_Cycle_Carbon_Footprint_Analysis_of_Pulp_and_Paper_Grades_in_the_United_States_Using_Production-line-based_Data_and_Integration for board sourced in the US. Adding in 15% wastage for trim in production, and a 15% estimate for all other emissions in production, gives a figure of 158g CO_2e for a 400gsm single jacket, and 316 g CO_2e for a 400gsm gatefold jacket. Some records are printed on much lower weights, sometimes down to 250gsm.

[5] *Inner sleeves*. The estimate for a paper inner sleeve is based on a product weight of 24g and an Emissions Factor of 0.88416 kg CO_2e/kg product (DEFRA), giving a footprint of 21g CO_2e per paper sleeve.. The estimate for a poly-lined inner sleeve is based on a product weight of 20g. We have used an emissions factor of 1.18836 from DEFRA emissions factors for the two materials, based on product weights of each material. This gives a footprint for a poly-lined inner sleeve of around 24g CO_2e per poly sleeve.

[6] *Calculating partial product footprints of different weights and sizes of records*. The only significant difference in manufacturing process to make a record of different weight or a different size, is the amount of PVC used. All 12" sizes have an identical requirement in terms of lacquers and stampers. 7" masters are generally supplied on standard lacquers, and although the stampers use a little less nickel, the plating time is longer that for a 12" stamper. These differences balance each other out and are not significant in terms of the product footprint anyway.

At VFM Ltd, energy consumption in heating and cooling the press moulds is virtually identical, independent of the weight or size of the record. The product-level footprints have been derived by allocating the emissions from PVC usage proportionally over each product type, (based on the puck weight for each weight of record and also the puck weight for a splatter record), and then allocating all other emissions equally by volume of product produced.

[7] *Lacquers and Direct Metal Masters/DMMs*. The record manufacturing process starts with a blank master. A machine called a cutting lathe then 'cuts' the grooves, which once pressed into the finished record, will reproduce the music when played with a stylus. The blank masters are generally 'lacquers', a layer of nitrocellulose coated onto an aluminium base. Alternatively, the master can be a thin layer of copper which has been plated onto a steel base. This type of master is called a 'Direct Metal Master' abbreviated to DMM. The grooves are cut by a lathe

in fundamentally the same way as for a lacquer.

[8] *Calculating footprints for the manufacture of lacquers and DMMs*. Although there are no verified product footprints for lacquers and DMMs, there is a reasonable level of assurance for our estimates, as we know the materials they are manufactured from, and have a good understanding of the manufacturing process.

For lacquers, (manufactured solely by Public Record Co in Japan) we know the amount of aluminium used per base, and the volume of nitrocellulose coated on top. We have used secondary data for the footprints of these two materials, choosing values at the top end of the range for each. We have made reasonable assumptions for the other emissions from the factory, and have reached an estimate of 3kg CO_2e per lacquer (cradle to gate). The emissions relating to the aluminium base are by far the largest component of this.

For DMMs, the manufacturing process is very similar to electroforming a stamper… except that a copper anode is used instead of nickel, and there is a steel base. We have arrived at a reasonable estimate of the footprint of a DMM by using data from Stamper Discs' electroforming operations, but substituting copper for nickel, and including the steel base. This estimate is 7 kg CO_2e per DMM.

[9] *Calculating Scope 2 electricity emissions if Stamper Discs had not sourced renewable electricity.* The emissions figure is arrived at by using the 2022 DEFRA emissions factor for UK Electricity of 0.19338 kg CO_2e per kWh.

[10] *Shipping lacquers by air freight from Japan.* We've assumed weekly shipments of 1000 blank lacquers from Tokyo to Protape/Datastores in London = 1000 x 312g = 312kg plus packaging = 400kg, 0.8 cbm. Using DHL Carbon Calculator, 400kg Tokyo to London = 2,960.08 kg/CO_2e = 2.960 kg CO_2e per lacquer shipped. (WtW)

[11] *Different types of stampers*. A 1-step stamper refers to a stamper that has been directly formed from a lacquer or DMM, and is then used to press a record. A 2-step stamper is where a mother is additionally formed from the 1-step stamper before this is put on press. This 'mother' can then be used at a later date to clone subsequent 'additional' stampers, if needed. A 3-step stamper is where the initial forming from the lacquer of DMM is called a 'father'. It is thicker than a stamper used on press, and is only used to grow one or more mothers. The mother is then used to grow a stamper that is used on press. The reason for these different choices is mainly – but not only – down to run length. A stamper is typically used to press around 1,000 records, and then replaced. So a 1-step stamper can only be used for runs less than 1000. For runs greater than a 1000, a 2 or 3 step process must be used to grow additional stampers. Because a mother can only be used to grow around 10 stampers, for runs over 10,000, a 3 step process is essential – the father can be used to grow up to 10 mothers, each of which can be used to grow up to 10 stampers.

[12] *Calculating footprints for different types of stampers*. Stamper Discs primarily produces 12" stampers – 7" and 10" stampers only make up 3% of their output. Although 7" and 10" use less nickel to produce than a 12" – which is the biggest single component of our footprint – paradoxically they do require a longer plating time. And in some instances, 7" and 10" are cut onto 14" lacquers, making them identical to a 12" in terms of nickel used. For these reasons the organisational footprint has been attributed as though every stamper was 12". The attribution is as follows. The only significant cost that doesn't fall equally over different pieces of metalwork is the CF for supplied lacquers/DMs. These are only used in relation to the '1st-step' metalwork. So when allocating the organisational CF down to a product level we have separated out the CF associated with lacquers/DMMs and applied this just to the 1st step stamper/metalwork piece. The balance of the organisational CF is then applied equally across all metalwork pieces produced during the year. This gives reasonably accurate product CFs for 1-step, 2-step and 3-step stampers, as well as additional stampers.

[13] *Discrepancy between Optimum figure for lacquer manufacture and shipping and the footprint calculations in footnotes 8 and 10*. Footnotes 8 and 10 estimate the product footprint of a lacquer as 3kg CO_2e, and the shipping to London as 2.96 kg CO_2e. Yet the combined figured derived from the Optimum organisational footprint is 6.6kg CO_2e. The discrepancy is due to an approx 10% wastage rate of lacquers at Optimum. i.e. lacquers purchased but not shipped as they were used for test cuts, or were recut for internal QC reasons.

[14] *Emissions from air freight distribution* are expressed in tonnes/km. It therefore makes little difference (in carbon footprint terms) if a record is part of a shipment of 1,000 or 10,000 records. A single 12" record with a simple jacket weighs about 200g. Add the weight of cardboard boxes and pallets, etc, and a shipment of 1,000 records will total around 250kg in weight. The DHL Carbon Calculator gives a WtW (Well to Wheel) footprint of 3,455 kg CO_2e to ship 250kg from Czech Republic (Prague) to Melbourne – this is 3.46 kg CO_2e per record. Sea freight (shared container) would be 99.06kg CO_2e(WtW) = 0.1 kg CO_2e per record. The next example is Nashville to London. The same shipment has a WtW footprint of 1,357 kg CO_2e, which is 1.36 kg CO_2e per record. But doing this same shipment by road and then sea freight is only 42.74 kg CO_2e (WtW) or 0.04 kg CO_2e per record. Czech Republic to London by air (and road) is 301.77 kg CO_2e (WtW) for the same shipment; and only 16.34 CO_2e (WtW) if transported entirely by road.

[15] *Caveat on comparing pressing in Australia versus pressing in Europe and shipping to Australia*. The air freight emissions from shipping the final records will to a small extent be counterbalanced by the emissions from shipping a slightly greater weight of compound to Australia – as there is no manufacturer of PVC compound in Australia. However PVC compound is shipped by sea freight, which has an emission factor around 70 times less than air freight. (UK Government emissions factors 2023.)

[16] *Emissions from disposal of a record and its printed jacket to landfill*. If we assume the record is 140g of PVC, the UK Government-approved emission factor for landfill disposal of PVC is 8.8 kg CO_2e per tonne of PVC, giving the emissions figure of 1.2g CO_2e. For the printed jacket, assume the weight of board is 90g, The UK government emission factor for landfill disposal of board is 1,041.78 kg CO_2e per tonne of board, giving an emissions figure of 94g CO_2e.

[17] *See Experimental Statistics on the carbon impact of waste from households managed by local authorities in England*, and also *Carbon Waste and Resources Metric* developed by WRAP (Waste Resources and Action Programme) on behalf of the UK Government.

Independent third party verification

We have commissioned a third-party consultancy, Climate Partner, to provide independent verification of the work presented in this Report.

Climate Partner works with a roster of over 6,000 clients, has more than 500 employees, and offices across Europe, UK and the USA.

They have reviewed and validated the three *organisational* footprints for Vinyl Factory Manufacturing Ltd, Stamper Discs, and Optimum Mastering.

Their validation statements for each company are appended on the following pages (referred to as Corporate Carbon Footprint Validation Statements).

In addition, Climate Partner have also been asked to review this Report and check the methodology used to derive the *product* footprints discussed here.

This fourth validation statement is also included.

It provides assurance that the conclusions presented in this report are substantiated by the underlying footprinting data; and that where product footprint data is presented for Vinyl Factory Manufacturing Ltd and Stamper Discs, their organisational/corporate emissions have been fully allocated to the product level.

ClimatePartner

Corporate Carbon Footprint Validation

Validation Outcome

In collaboration with **Vinyl Factory Manufacturing Ltd.**, ClimatePartner conducted an independent validation of its Corporate Carbon Footprint (CCF) calculation of 1,777.71 t CO2e for the reporting year of April 2022 to March 2023.

The validation exercise was conducted in accordance with the Greenhouse Gas Protocol (GHG Protocol). The purpose of the Corporate Carbon Footprint was to derive cradle to gate product carbon footprint data (from resource extraction and raw material acquisition (cradle) to the point of delivery at the factory gate (gate)). Therefore, alongside Scope 1 and 2, only selected upstream scope 3 categories were considered: Purchased Goods & Services, Waste, Business Travel and Employee Commuting (for a complete overview see the Appendix). DEFRA emission factors were used wherever possible to ensure the comparability of the calculations.

Downstream Scope 3 categories were excluded, including Downstream Transportation and End-of-Life emissions, because the purpose of the calculation was to derive product carbon footprints, with a Cradle to Gate focus. To have a more complete Scope 3 calculation, future assessments should address these emissions, and include a scope 3 screening to assess any additional relevant emissions for a more comprehensive view.

In conclusion, ClimatePartner's validation process verified that **Vinyl Factory Manufacturing Ltd.** applied the GHG Protocol methodology appropriately within the scope 3 categories measured. For the included categories, the reported carbon footprint has been calculated following the internationally recognised GHG Protocol standards and reflects best practice.

Appendix

Categories	Status of validation
Scope 1	**Complete.**
Heating	Complete.
Vehicle Fleet	Not relevant.
Refrigerant	Not included, relevance to be determined.
Scope 2	**Complete.**
Electricity	Complete.
Scope 3	**Partially Complete.**
Production materials and consumables	Complete.
Packaging materials	Complete.
Print Products	Complete.
Office Paper	Complete.
Water	Complete.
External data center	Not included, relevance to be determined.
Electronic devices	Not included, relevance to be determined.
Food and drinks	Not included, relevance to be determined.
Inbound Logistics	Not included, but it is relevant.
Waste	Complete.
Flights	Not relevant.
Rail travel	Not relevant.
Rental and private vehicles	Not relevant.
Hotel nights	Not relevant.
Employee Commuting	Complete.
Home office	Not relevant.
Outbound Logistics	Excluded due to focusing on categories which could be translated to Cradle-to-Gate product carbon footprint system boundaries.
Outbound Storage	Excluded due to focusing on categories which could be translated to Cradle-to-Gate product carbon footprint system boundaries.
End of Life	Excluded due to focusing on categories which could be translated to Cradle-to-Gate product carbon footprint system boundaries.

ClimatePartner

Corporate Carbon Footprint Validation

Validation Outcome

In collaboration with **Stamper Discs**, ClimatePartner conducted an independent validation of its Corporate Carbon Footprint (CCF) calculation of 206.01 t CO2e for the reporting year of March 2022 to February 2023.

The validation exercise was conducted in accordance with the Greenhouse Gas Protocol (GHG Protocol). The purpose of the Corporate Carbon Footprint was to derive cradle to gate product carbon footprint data (from resource extraction and raw material acquisition (cradle) to the point of delivery at the factory gate (gate)). Therefore, alongside Scope 1 and 2, only selected upstream scope 3 categories were considered: Purchased Goods & Services, Inbound Logistics, Waste, Business Travel and Employee Commuting (for a complete overview see the Appendix). DEFRA emission factors were used wherever possible to ensure the comparability of the calculations.

Downstream Scope 3 categories were excluded, including Downstream Transportation and End-of-Life emissions because the purpose of the calculation was to derive product carbon footprints, with a Cradle to Gate focus. To have a more complete Scope 3 calculation, future assessments should address these emissions, and include a scope 3 screening to assess any additional relevant emissions for a more comprehensive view.

In conclusion, ClimatePartner's validation process verified that **Stamper Discs** applied the GHG Protocol methodology appropriately within the scope 3 categories measured. For the included categories, the reported carbon footprint has been calculated following the internationally recognised GHG Protocol standards and reflects best practice.

Appendix

Categories	Status of validation
Scope 1	**Complete.**
Heating	Complete.
Vehicle Fleet	Not relevant.
Refrigerant	Not included, relevance to be determined.
Scope 2	**Complete.**
Electricity	Complete.
Scope 3	**Partially Complete.**
Production materials and consumables	Complete.
Packaging materials	Complete.
Print Products	Complete.
Office Paper	Complete.
Water	Complete.
External data center	Not included, relevance to be determined.
Electronic devices	Not included, relevance to be determined.
Food and drinks	Not included, relevance to be determined.
Inbound Logistics	Complete
Waste	Complete.
Flights	Complete.
Rail travel	Complete.
Rental and private vehicles	Complete.
Hotel nights	Complete.
Employee Commuting	Complete.
Home office	Not relevant.
Outbound Logistics	Excluded due to focusing on categories which could be translated to Cradle-to-Gate product carbon footprint system boundaries.
Outbound Storage	Excluded due to focusing on categories which could be translated to Cradle-to-Gate product carbon footprint system boundaries.
End of Life	Excluded due to focusing on categories which could be translated to Cradle-to-Gate product carbon footprint system boundaries.

ClimatePartner

Corporate Carbon Footprint Validation

Validation Outcome

In collaboration with **Optimum Mastering**, ClimatePartner conducted an independent validation of its Corporate Carbon Footprint (CCF) calculations of 19.08 t CO2e (including location-based electricity emissions) for the reporting year of January 2023 to December 2023.

The validation exercise was conducted in accordance with the Greenhouse Gas Protocol (GHG Protocol). The purpose of the Corporate Carbon Footprint was to derive cradle to gate product carbon footprint data (from resource extraction and raw material acquisition (cradle) to the point of delivery at the factory gate (gate))). Therefore, alongside Scope 1 and 2, only selected upstream scope 3 categories were considered: Purchased Goods & Services, Inbound Logistics, Waste, Business Travel and Employee Commuting (for a complete overview see the Appendix). DEFRA emission factors were used wherever possible to ensure the comparability of the calculations.

Downstream Scope 3 categories were excluded, including Downstream Transportation and End-of-Life emissions, because the purpose of the calculation was to derive product carbon footprints, with a Cradle to Gate focus. To have a more complete Scope 3 calculation, future assessments should address these emissions, and include a scope 3 screening to assess any additional relevant emissions for a more comprehensive view.

In conclusion, ClimatePartner's validation process verified that **Optimum Mastering** applied the GHG Protocol methodology appropriately within the scope 3 categories measured. For the included categories, the reported carbon footprint has been calculated following the internationally recognised GHG Protocol standards and reflects best practice.

Appendix

Categories	Status of validation
Scope 1	**Not relevant**
Heating	Not relevant.
Vehicle Fleet	Not relevant.
Refrigerant	Not included, relevance to be determined.
Scope 2	**Complete.**
Electricity	Complete.
Scope 3	**Partially Complete.**
Production materials and consumables	Complete.
Packaging materials	Complete.
Print Products	Not included, relevance to be determined.
Office Paper	Not included, relevance to be determined.
Water	Complete.
External data center	Not included, relevance to be determined.
Electronic devices	Not included, relevance to be determined.
Food and drinks	Complete
Inbound Logistics	Complete
Waste	Complete.
Flights	Complete.
Rail travel	Complete.
Rental and private vehicles	Complete.
Hotel nights	Complete.
Employee Commuting	Complete.
Home office	Not relevant.
Outbound Logistics	Excluded due to focusing on categories which could be translated to Cradle-to-Gate product carbon footprint system boundaries.
Outbound Storage	Excluded due to focusing on categories which could be translated to Cradle-to-Gate product carbon footprint system boundaries.
End of Life	Excluded due to focusing on categories which could be translated to Cradle-to-Gate product carbon footprint system boundaries.

ClimatePartner

Validation Statement for the Report

Validation Outcome

ClimatePartner independently validated Stamper Discs, Optimum Mastering and Vinyl Factory Manufacturing Ltd's Corporate Carbon Footprints in accordance with the Greenhouse Gas Protocol. The validation confirmed that all three companies appropriately applied the GHG Protocol methodology for Scope 1, Scope 2 and selected Upstream Scope 3 categories included in the footprints. Downstream Scope 3 emissions were excluded from the calculation and ClimatePartner recommends these be included in the future for a more complete picture. For the included categories, the calculation of the organisational footprint meets expectations without any significant omissions.

For Vinyl Factory Manufacturing Ltd and Stamper Discs, ClimatePartner additionally reviewed the methodology by which product carbon footprints were derived from corporate carbon footprints. For scope 1 & 2 and upstream scope 3 emissions – the equivalent of cradle to gate – the corporate emissions were appropriately allocated to meet the relevant emission boundaries and expectations. To have a complete picture of the product carbon footprints ClimatePartner recommends downstream product emissions are calculated, include distribution & storage, use-phase and end-of-life i.e. cradle to grave.