

# Recyclability Analysis Report

For Nellie's Free Range



# Table of Contents

1 Foreword

---

2 How paper is made

4 How PET Plastic is made

7 Importance of recycling

9 How Paper is recycled

10 How Plastic is recycled

11 Carton acceptance rate by scheme

12 Carton acceptance rate by population

13 Compostable packaging

15 Conclusions

16 Next Steps

---

17 Sources

18 Annex

# Foreword

Scrapp created this report for Nellie's Free Range, the #1 free-range egg brand seeking more significant insight into its packaging lines. We focused on the following key areas:

- How rPET and Paper are made
- How rPET and Pulp are recycled
- How the composting process works and how compostable packaging fits into that
- Which resources are required to produce and recycle packaging options.



Scrapp is a consumer education company based in Massachusetts and the United Kingdom that specializes in helping brands assess the recyclability and compostability of their packaging. Our primary goal in creating this report for Nellie's Free Range Eggs is to research and discover feasible and sustainable steps that can be made to reduce the environmental impact of their packaging.

At Scrapp, we believe that education is the key to promoting sustainable waste management practices. That's why we've developed a free mobile app and made ourselves available to answer any recycling questions at [enquiries@scrapprecycling.com](mailto:enquiries@scrapprecycling.com).

We're thrilled to be working with Nellie's Free Range Eggs and hope that the insights in this report help them achieve their sustainability goals.

*Michael V Pasciuto*

Michael Pasciuto / Chief Sustainability Officer

*The data used in this report ranged from Life Cycle Assessments to publications from industry trade groups and blogs.*



# How paper is made

## Sourcing and delivery

Paper is typically made from plant materials such as trees, hemp, and bamboo, with trees being the most common source. Paper mills usually get their raw materials from sawmills, using waste materials like sawdust and woodchips. These materials are transported to the paper facilities, sometimes in over 240 truckloads a day. At the mill, the woodchips are first sorted by size to remove any pieces that are too big or small. The unusable pieces are then burned as "hog fuel" to generate sustainable electricity to power the mill's machinery.

The pieces that pass the size test get washed and sent to the digester. Woodchips are made up of approximately 50% water, 25% lignin, and 25% cellulose. Lignin holds the wood together but must be removed to continue the process. Cellulose is desired in the process, so the two must be separated in the digester, which works like a giant pressure cooker. The clean woodchips are placed into the digester with a cooking chemical called white liquor. As steam is introduced into the digester, the heat and pressure increase, dissolving the lignin. This is like using soap to wash glue off of your hands.

Once the process is complete, we are left with a substance called black liquor which is mostly water mixed in with some lignin and white liquor. The black liquor is placed into a recovery boiler where the steam generates electricity, and the water is removed. The substance left behind is now known as green liquor, and is made up of only cooking chemicals and lignin. The green liquor is then treated with lime to extract the cooking chemicals so they can be used again as white liquor in the digesters. This process is known as the "Kraft process", and because it reuses so many materials, it creates very little waste material, making paper cost-effective.

Once we have a recycled batch of white liquor, we can focus on the cellulose fiber in the digester. These fibers are not pure yet and must go through a bleaching station, where they grow whiter until all impurities are removed. This process leaves us with cellulose pulp, which can be sent to tissue mills, paperboard mills, or pulp dryers. There, it's dried, baled, and stored until it's ready to be made into a world-class egg carton.



Water is integral to the pulp-making process. It cools machinery, creates steam, and helps move pulp through the final processes. Water is so essential that it is continuously recycled throughout the mill and recovered at a 90% rate. It takes about 100 liters of fresh water to produce one kilogram of paper. Any water returned to water systems must be filtered, cleaned, and tested before leaving the mill.

Once the pulp is ready for further processing, it's loaded into transfer molds, where the egg carton shape is pressed into them. These molds are made of bronze or aluminum coated in a stainless steel mesh that allows the pulp to be molded tightly to the molds. You can think of this as a giant cookie cutter or rubber stamp. Like cookies, freshly molded pulp cartons are sent to the oven, where they are cooked at 205 degrees Celsius for about 12 minutes. Once "fully cooked," they are stacked, counted, and compressed before being shipped out for companies to use.

It is amazing that something as simple as an egg carton goes through such a complex and eco-friendly process. Next time you use an egg carton, take a moment to appreciate the sustainable journey it took to get to your home!



# How PET Plastic is Made

## What is PET Plastic

Polyethylene terephthalate (a.k.a. PET & Plastic Number 1) is the plastic resin used to make most drink bottles, produce clamshells, meat trays, and other food packaging. rPET, the plastic resin used to make Nellie's Free Range egg cartons, is the same as PET but made of 100% recycled materials.

## How PET plastic is made

When producing PET resins for commercial use, the chemicals ethylene glycol (EG) and either dimethyl terephthalate (DMT) or terephthalic acid (TPA) are used. DMT and TPA are both solid compounds, with DMT having a melting point of 140°C (284°F) and TPA sublimating, meaning it goes directly from a solid phase to a gaseous phase.

In both processes, an intermediate compound called bis-(2-hydroxyethyl)-terephthalate (BHET) is first produced. The processes also yield either methanol (DMT process) or water (TPA process). BHET is then heated with a catalyst under reduced pressure until it polymerizes, producing PET resins.

The DMT process, which creates methanol, requires additional methanol recovery and purification operations to ensure that no methanol makes it into the final product. Methanol is a volatile chemical that can be harmful to both people and the environment. Since the TPA process does not produce any methanol, newer plants tend to prefer it. As a result, we'll focus on the TPA process in this report.

## PET/TPA Process

To make this process more understandable, we've broken this down step by step.

- 1 Raw materials, such as Terephthalic acid (TPA) and Ethylene glycol (EG), are brought on-site and stored separately. TPA is typically stored in silos in powder form, while EG is stored in tanks.
- 2 TPA and EG, along with catalysts, are mixed in a tank to form a paste. Ethylene glycol is sprayed through slots around the vent line for proper mixing. Kneading elements are used to create a homogenous paste that is then recycled into the mix tank and fed into esterification vessels using gear pumps to control flow. This ensures consistent quality and reduces the likelihood of defects.

- 3 BHET is produced inside the esterifier, with water and some leftover glycol being the only by-products of the TPA process. Heat from the esterification process causes the water and glycol to become vapor and escape out of the vessels.
- 4 Vapors from the esterifier are vented to a reflux or distillation column and cooled with a heat exchanger. As the vapors cool, they condense into liquid form, with glycol condensing at a higher temperature than water. Liquid glycol is recovered and returned to the primary esterifier for reuse.
- 5 Water vapor is cooled, condensed, and directed to the wastewater treatment system. The compounds formed in the primary esterifier, along with remaining reactants, are pumped into the secondary esterifier for a second reaction.
- 6 The secondary esterifier produces mainly water vapor, which is vented to a spray condenser. The resulting condensate is sent to a central ethylene glycol recovery unit (12). The condensate water is cooled and then recycled.
- 7 BHET from the secondary esterifier is then transferred to the polymerization reactors.
- 8 During polymerization, the BHET monomers are linked together to form a long molecular chain, creating PET resin. The process involves removing any remaining ethylene glycol from the chamber to speed up the reaction.
- 9 Excess or unreacted glycol released during polymerization is collected and sent to a spent ethylene glycol spray for recycling. It undergoes another round of distillation to remove impurities before being reused.

Once the virgin PET is produced, it's time to give it a new life as a range of useful products. From bottles and cups to produce containers and clamshells, this versatile material can be shaped into all sorts of handy items. PET is also recyclable in some communities, where it is then repurposed to create rPET which is used to create Nellie's Free Range egg cartons.

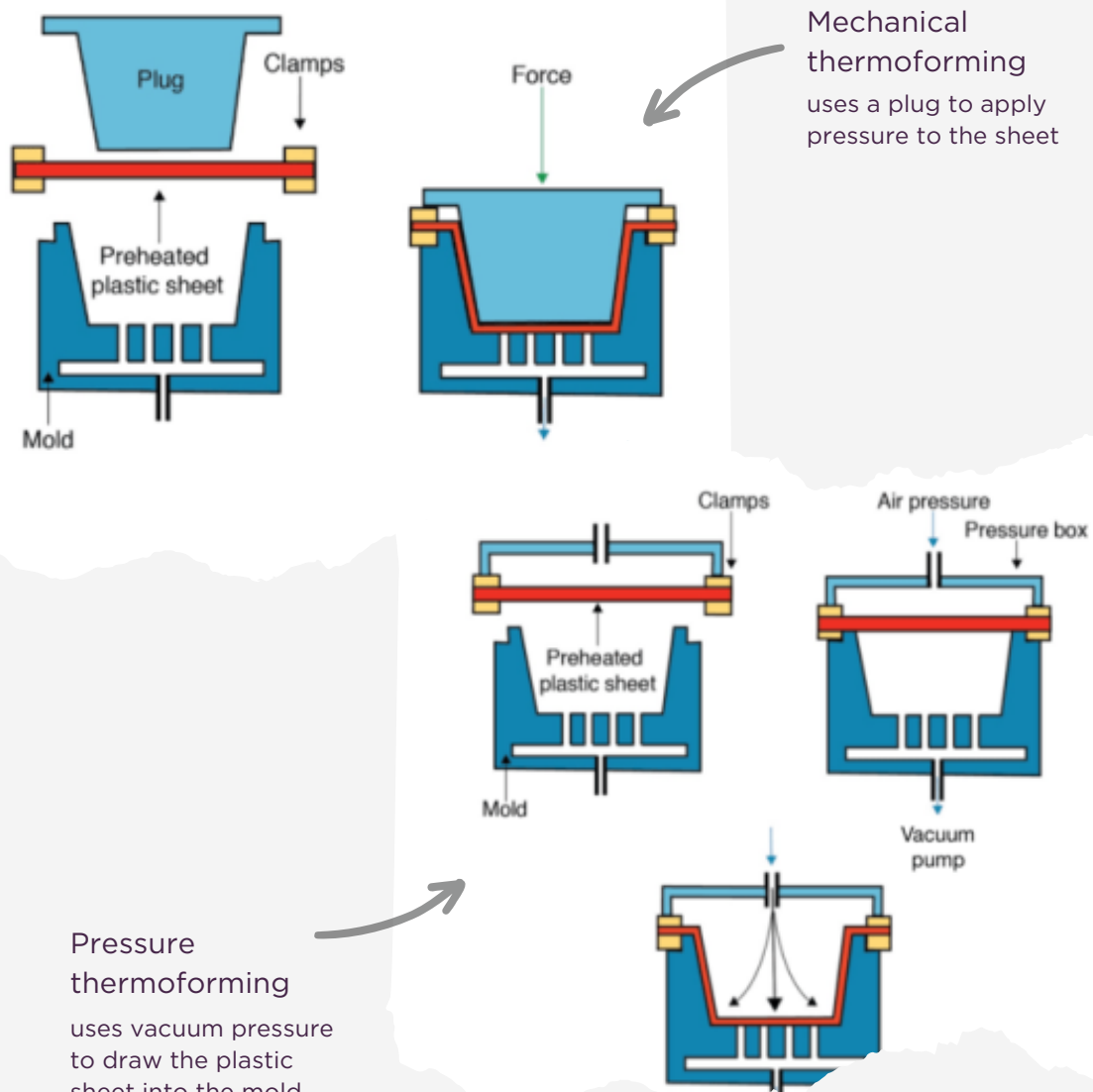




## How Nellie's recycled egg cartons are made

Thermoforming is the process used to create plastic egg cartons. It's similar to the process for making paper pulp packaging. First, rPET plastic sheet or pellets are heated and rolled onto a conveyor belt. The heated rPET sheet is then pressed into a mold and shaped into the desired product. The temperature and mold used depend on the type of plastic, the thickness of the sheet, and the final product. During molding, vacuums hold the plastic in place. Once the cartons are formed, they are dried, cut into individual pieces, and packaged for shipment. Any scrap material is shredded and recycled to make new rPET plastic.

### Types of thermoforming



# Importance of Recycling

Recycling is a crucial step towards reducing waste and preserving our planet for future generations.

At Scrapp, we believe that every effort to recycle counts and we commend individuals and businesses who make this a priority. Despite what you may have heard in the news, recycling is not a myth or a wasted effort. In fact, many materials, such as paper and metal, have robust markets for their recycled forms. While some plastic markets have faced challenges in the past, we are happy to see a recent rise in demand for recycled plastics. We encourage everyone to continue to recycle and support sustainable practices.

To make informed recycling decisions, use Scrapp's free mobile app. And when in doubt, it's better to put an item in the waste bin than to contaminate the recycling bin with the wrong items. Contamination can lead to recyclables being sent to landfills or, worse, ending up in our oceans. We're here to help if you have any questions. Contact us at [enquiries@scrapprecycling.com](mailto:enquiries@scrapprecycling.com)

**Recycle Right,  
Protect our Planet**

NELLIE'S  
FREE RANGE  
EGG CARTON

PI Egg Carton ✓

Paper Label ✓

Scrapp

Download on the App Store

GET IT ON Google Play

# How paper is recycled

Recycling just one ton of paper can save 17 trees, 380 gallons of oil, 3 cubic yards of landfill space, and 4,000 kilowatts of energy! That's a huge impact on the environment. And, did you know that paper can be recycled up to 7 times?

The recycling industry considers paper products as "fiber". That includes materials like corrugated cardboard, office paper, paperboard, and even polyethylene-coated paperboard. Now, have you ever wondered how paper is recycled and made into new products that you use every day? It's an interesting process that involves separating the different components of the paper, cleaning them, and then reusing them to create new products.

## 1 Collecting paper from consumers

Before paper can be recycled, it needs to be collected from consumers through curbside recycling programs or specific locations in communities. These programs can vary in their approach, with some using single stream recycling where paper, metal, and plastic are collected together in one bin, and others using multi-stream recycling with separate bins for each type of material. Once collected, waste haulers transport the materials to Material Recycling Facilities (MRFs) where they are sorted and processed for recycling.

## 2 What happens at the MRF?

At the MRF, the materials collected from consumers are sorted and processed. The MRF can use either manual or mechanical methods to sort the materials into different categories. The fiber materials, like paper, are separated from other materials to remove any contamination and simplify processing for paper mills. This ensures that the paper mills can produce high-quality recycled paper products. Once sorted, the fiber materials are baled and sent to the appropriate paper mill to be recycled into new products.

## 3 How is Paper Recycled at the Paper Mill

Once the collected paper arrives at the paper mill, it undergoes a pulping process in a machine called a pulper. Pulping is essentially like using a giant blender to shred the paper products and mix them with water and other ingredients. This process breaks down the fibers and removes any staples or tape from the pulp. While fiber materials can be recycled together, it's better to have them separated, as this creates a better end product.

After pulping, the stream of fibers is screened for further cleaning, and then dried, rolled or pressed to form new rolls of paper or boxes. This process is similar to how paper is initially made, and can be repeated up to 8 times before the fibers lose their strength and integrity, and have to be composted or sent to a landfill.



# How Plastic Is Recycled

The recycling system is massive and global, and packaging is a crucial part of it. In fact, the materials used to create packaging have their own story to tell. So, let's explore how plastic is recycled and transformed into everyday products.

## 1 Collecting plastic from consumers

To give plastic materials a second life, they must first be collected from consumers. This typically involves curbside recycling programs or designated drop-off locations in communities. These programs can vary in their approach, with some adopting "single stream recycling," where different recyclable materials like paper, metal, and plastic are combined in one bin, while others use "multi-stream recycling," where separate bins are used for each material. After collection, the materials are transported to Material Recycling Facilities (MRFs) to be sorted and prepared for recycling.

## 2 What happens at the MRF?

At the MRF, the collected materials are processed and sorted according to their type, shape, and color. This sorting process is crucial for recycling because it ensures that each material can be processed efficiently and effectively. Plastics, in particular, are sorted based on their resin code, which is indicated by the symbol on the product. The most commonly used resin codes for plastics are shown in the image below. For instance, Nellie's Free Range egg cartons are made from 100% recycled PET plastic also known as rPET (Plastic Type 1). You can find the resin code on the bottom of the egg carton.

### Plastic Resin Codes



Recycling different colored plastics can be a challenge, as they often need to be separated before processing. While some recycling facilities still rely on manual sorting, many advanced communities now use sophisticated machines to sort plastics. These machines utilize a combination of optical scanning, artificial intelligence, and mechanical sorting to ensure that similar materials end up together. Once sorted, the plastics are baled up and sent to the appropriate processing facilities.

### 3 Additional processing after the Residential MRF

Once each type of plastic reaches its designated recycling facility, it undergoes a thorough washing process to remove any food particles and contaminants. This preserves the quality of the material and ensures that the recycled plastic is valuable. After cleaning, the materials are shredded into either flakes or pellets to further eliminate any remaining contaminants. At this stage, the recycled plastic can be downcycled into product additives for items such as decking or sold into the raw materials markets to be recycled into new materials.

*While plastics are often categorized by type, it's important to note that even within the same type of plastic, there can be variations in configurations. For instance, PET plastic can be thermoformed, blow molded, injection molded, and more. This complexity is similar to how there are different alloys of aluminum used for different applications, such as aluminum cans versus airplane parts.*

If the recycled materials aren't sold, they undergo further processing to determine their quality and classification. The materials are separated by density through water flotation and thickness using a wind tunnel. However, not all recycling facilities have the necessary equipment to recycle certain types of plastic, so they may be sent to another facility for extrusion and compounding. The final result is new packaging or products made from recycled materials.

Let's take a look at this process from the point of view of a Nellie's Free Range rPET egg carton.

It all starts on the shelf when the eggs are purchased and brought home safely. Once you've used up all the eggs, the packaging can be recycled at home or the local recycling center. From there, it will be sorted out from other recyclable materials and sent to a processing facility to be shredded into small flakes. After some testing, it will go through more rounds of sorting before being sent to a manufacturer to make more egg cartons and other packaging.

**One Nellie's rPET egg carton can be recycled up to 2 more times.**

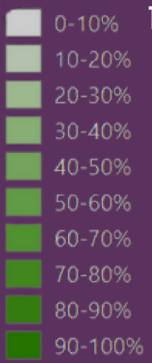
## Average USA Municipal Recycling Rates For Different Cartons

Paper pulp egg carton	Kraft Card egg carton	rPET egg carton
74.05%	72.2%	38.6%

*Before you've even purchased Nellie's Free Range Eggs, the packaging has already been in contact with the recycling industry because it's made of 100% recycled material.*

# Carton Acceptance Rate

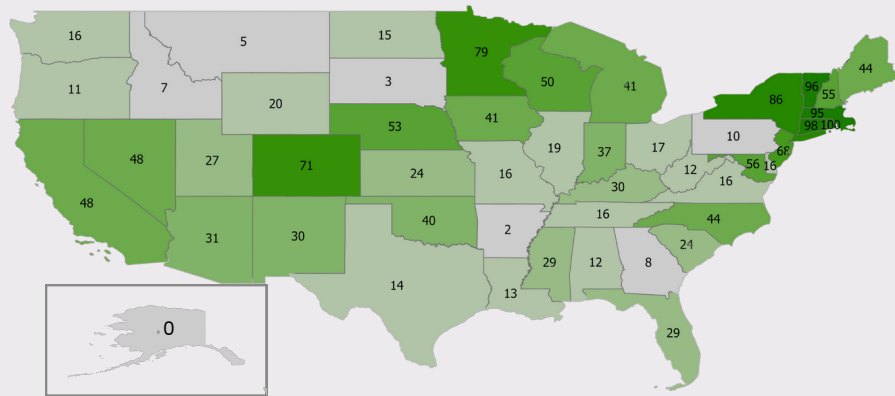
## By Scheme



This first section of maps is based on data from over 24,000 recycling schemes in the country. A scheme can be a municipal curbside collection program, recycling center, transfer station and more. The Acceptance Rate is the amount of communities that can recycle the carton.

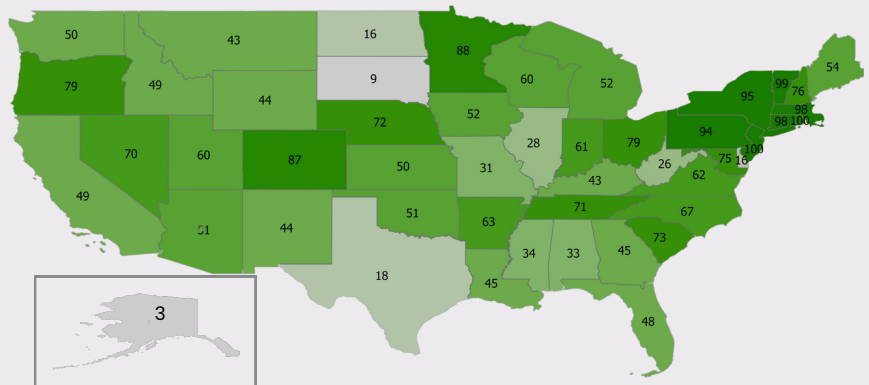
### rPET Plastic

rPET plastic is widely recycled in the Northeast of the USA, but due to the difficulties of recycling thermoform grade plastics it is less widely recycled than its bottle counterparts



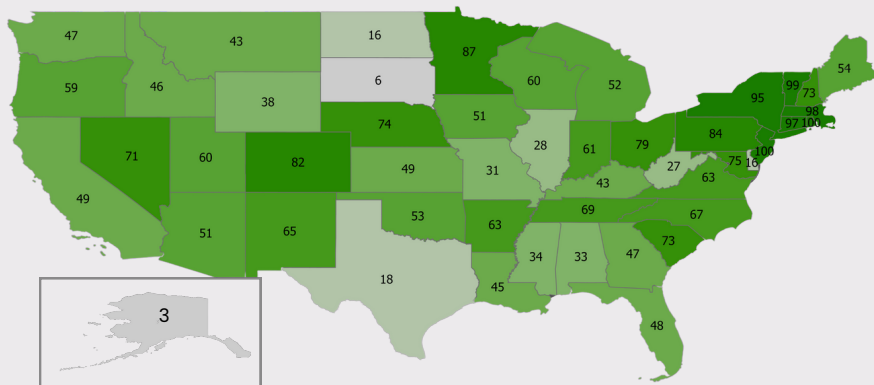
### Paper Pulp

Paper is widely recycled throughout the United States, with almost all states having strong collection programs for paper products. Pulp is less desired than corrugated and other high value fibers but has numerous disposal options.



### Card Pulp Hybrid

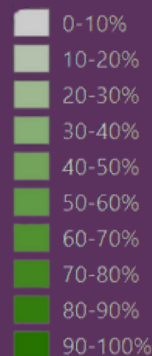
Kraft Card is widely recycled throughout the United States. With almost all states having strong collection programs for paper products. Card is less desired than corrugated and other high value fibers but has numerous disposal options.





# Carton Acceptance Rate

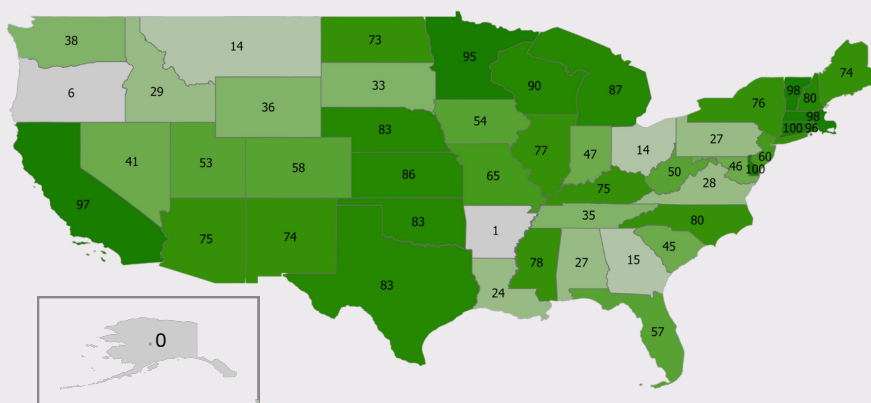
## By Population



These figures are generated to contrast with the scheme acceptance figures. This is access to recycling programs normalized by population. These figures show that even though few programs may exist in some states; these programs account for a majority of the population. The Acceptance Rate is the number of individuals that can recycle the carton.

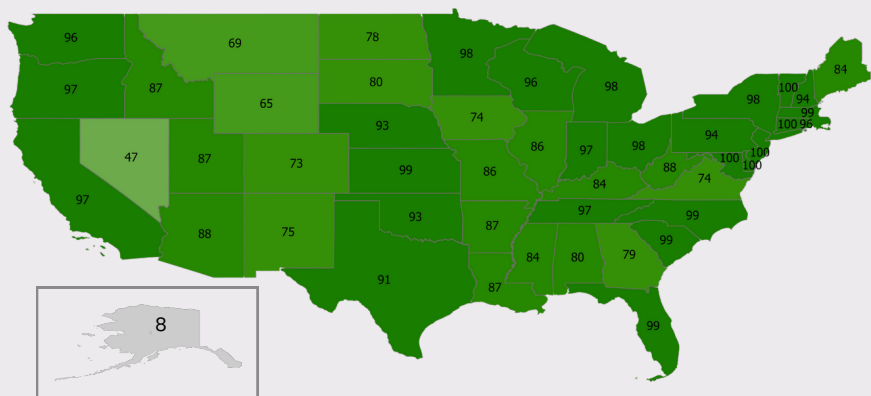
### rPET Plastic

Despite having a low scheme acceptance, these figures show areas that have higher populations have the infrastructure to recycle thermoform grade plastic.



### Paper Pulp

Paper is widely recycled throughout the United States, with almost all states having strong collection programs for paper products. Pulp is less desired than corrugated and other high value fibers but has numerous disposal options.



# Compostable packaging and how it works

## Home & Industrial Composting Process

Unlike traditional packaging, compostable packaging can break down naturally, just like leaves and plants. There are two main types of compostable packaging: Home Compostable and Industrially Compostable. Home Compostable packaging can be composted at home, while Industrially Compostable packaging needs to be brought to special processing facilities. It's important to note that not all packaging labeled as "biodegradable" is necessarily compostable (just like how something being labeled "edible" does not mean it should be eaten), so make sure to check the label and be careful not to place any biodegradable packaging in the compost bin.



Composting is a simple and effective way to reduce waste and nourish the earth. With home composting options like creating a compost pile of leaves, food waste, cardboard, and organic material, it's easy to get started. The key to successful composting lies in factors such as temperature, airflow, water, and a good balance of browns and greens. You can use a variety of composting bins at home, ranging from pallet boxes to tumblers and countertop units. If you're interested in learning about how to compost at home, check out this great tutorial from our sister brand Pete & Gerry's [here](#).

Have you ever wondered what happens to your curbside compost collection after it's picked up? Here's a quick breakdown of the process:

- 1 Compost is collected curbside by the town or a private waste hauler and brought to the facility.
- 2 At the facility, the materials go through a sorting process to remove any non-compostable items, like plastic bags and trash, that can contaminate the compost.
- 3 Food products rich in nitrogen, like leafy greens, garden, and food waste, are mixed to create a nutrient "smoothie" that helps speed up the composting process.
- 4 Once the smoothie is ready, carbon-rich items like leaves, branches, and paper are added to balance the carbon-to-nitrogen ratio.
- 5 The mixture is then placed in long windrows and piles or sealed containers, where it is watered and mixed daily to promote decomposition.

*During this step, compost can be made in a lot of different ways. Large scale/ Industrial composting processes vary, but the primary methods are windrows, in-vessel, and aerated static piles. Windrows are long rows of organic waste, piled about 4-8 feet high and 14-16 feet long, and are aerated to keep the compost pile active. Aerated static piles follow the same procedure as windrows but the waste is placed in the shape of a pile. These two methods can't handle meat, dairy, or bioplastic products because they are vulnerable to pests and require higher temperatures. They also have to be turned routinely to keep airflow and temperature within ideal ranges. On the other hand, in-vessel composting uses a covered drum, trench, or silo that can control temperature, airflow, and other variables. Because the drum is covered, pests can't get in, so meat and dairy can be composted this way. Inside the vessel, the material is turned repeatedly for aeration. Due to this heavily involved process, the compost is ready in just a few weeks but in-vessel composting is more expensive and the vessels need to be artificially cooled to keep the microbial activity in balance.*

- 6 After three to six months, a dark nutrient-rich soil mix is created (compost), which can be sold to farms, gardeners, or hardware stores as an excellent soil additive. Compost is essential for creating regenerative natural soil that supports plants and critters.





# Conclusions

Based on the report's findings, Nellie's Free Range has various sustainable packaging opportunities available to them including:

---

## Opportunity 1

- Changing packaging to be more recyclable & compostable.

---

## Opportunity 2

- Minimizing the environmental footprint of packaging by choosing cartons that preserve product integrity while using sustainably sourced materials

---

## Opportunity 3

- Switching to home compostable packaging to eliminate the need for large-scale recycling systems.
- In addition to this Nellie's Free Range can have their paper pulp egg cartons certified for compostability by a neutral 3rd party like TUV Austria & BPI.

---

## Opportunity 4

- Switching label vendors to with recyclable backings to minimize label waste by 50% by utilizing their curbside recyclable label backing.

---

Also, if the egg breakage rate is of significant concern, Nellie's can switch to packaging that preserves the eggs at a higher rate.



# Sources

## PET Made Section

- 1 Reliance Updates. (2016, June 13). Life Cycle of PET [Video]. YouTube. <https://www.youtube.com/watch?v=s62MuviUWYw>
- 2 Environmental Protection Agency, U. S. (1995). AP-42, CH 6.6.2: Poly(ethylene Terephthalate). Organic Chemical Process Industry, 1-13. <https://www3.epa.gov/ttnchie1/ap42/ch06/final/c06s06-2.pdf>

## Plastic Thermoforming Section

- 3 Thermoforming. (2022, October 24). In Wikipedia. [https://en.wikipedia.org/wiki/Thermoforming#Thin-gauge\\_and\\_heavy-gauge\\_\(thick\)\\_thermoforming](https://en.wikipedia.org/wiki/Thermoforming#Thin-gauge_and_heavy-gauge_(thick)_thermoforming)
- 4 Caco, D. (2020, November 1). Thermoforming Common Plastics. LinkedIn. Retrieved December 2, 2023, from [https://www.linkedin.com/pulse/thermoforming-common-plastics-david-caco3-filler/?trk=read\\_related\\_article-card\\_title](https://www.linkedin.com/pulse/thermoforming-common-plastics-david-caco3-filler/?trk=read_related_article-card_title)

## How Paper Pulp is Made Section

- 5 Ian Collier. (2009, October 7). How It's Made Moulded Pulp Containers [Video]. YouTube. <https://www.youtube.com/watch?v=CA9xBSb9NZI>
- 6 naturally:wood (n.d.). What is Wood Pulp. Naturally Wood. <https://www.naturallywood.com/products/pulp-and-paper/#:-:text=To%20make%20pulp%2C%20the%20cellulose,it%20down%20to%20a%20pulp>

## Plastics Recycling Section

- 7 R. T. S. (2020, October 12). The Complete Plastics Recycling Process. RTS. Retrieved January 20, 2023, from <https://www.rts.com/blog/the-complete-plastics-recycling-process-rts/>
- 8 Consulting, 2. (2018). Plastics - Resin Codes. What do they mean? [Photograph]. 2EA Consulting. <https://2ea.co.uk/plastics-resin-codes-what-do-they-mean/>

# Sources

## Paper Recycling Section

- 9 American Forest and Paper Association. (2023, January 20). How Does Recycling Actually Work [Video]. YouTube. <https://www.youtube.com/watch?v=G5Whi2DDNBM>
- 10 American Forest and Paper Association (2021, May 25). The Paper Recycling Process. Retrieved January 20, 2023, from <https://www.afandpa.org/priorities/recycling/paper-recycling-process#:~:text=Here%27s%20the%20recycling%20process%3A&text=It%20starts%20with%20you%20filling,it%20is%20separated%20and%20baled>
- 11 K. (2021, May 25). How is Cardboard Recycled. American Forest and Paper Association. Retrieved January 20, 2023, from <https://www.boxtopia.co.uk/blog/how-is-cardboard-recycled>

## Composting Section

- 12 Mullen, L. (2020, December 10). What is Industrial Composting. Retrieved January 20, 2023, from <https://www.colorado.edu/center/2020/12/10/what-industrial-composting#:~:text=Waste%20is%20mixed%20in%20a,the%20natural%20process%20of%20composting.>
- 13 UrthPact. (2020, September 2). Industrial Composting: What Is It and How Does It Work. Retrieved January 20, 2023, from <https://www.urthpact.com/industrial-composting-what-is-it-and-how-does-it-work/>
- 14 Nelson City Council. (2019, April 25). Beginner's Guide to Composting [Video]. YouTube. <https://www.youtube.com/watch?v=egyNJ7xPyoQ>