RAIN RFID: Enabling Circular Business Models with Reusable Cups Case Studies

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Executive Summary

Single-use cups are one of the most visible symbols of the throwaway economy. Billions are produced each year, the vast majority ending their life after a single use in landfill or incineration. Regulation is tightening fast: the EU Single-Use Plastics (SUP) directive is already in force, mandating the elimination of certain disposable items and requiring reusable alternatives at venues and events. The EU Packaging and Packaging Waste Regulation (PPWR) is introducing reuse targets across multiple sectors, with phased requirements rolling in from 2030. In the United States, Extended Producer Responsibility (EPR) legislation is increasingly holding brands and venues accountable for packaging waste.

Reusable cup programmes are the practical response — but reuse without traceability is operationally blind. Without knowing where every cup is, how many times it has been washed, and what the return rate truly is, venues cannot verify compliance, optimise operations, or make the business case for scaling. RAIN RFID solves this by giving every cup a unique, machine-readable digital identity that persists through hundreds of wash cycles, enabling full lifecycle visibility from the moment a drink is poured to the moment a cup is retired.

These case studies show how five venues across Europe and North America are using RAIN RFID-enabled reusable cup systems to reduce single-use plastic waste, automate deposit returns, cut operational costs, and build the data infrastructure that regulatory compliance and genuine circularity both require. The deployments span a Belgian football stadium, two US sports arenas, a UK botanical garden, and a UNESCO World Heritage estate — demonstrating that RAIN RFID-enabled reuse is not a niche experiment but a scalable, cross-sector solution.

At a Glance: Five Deployments Compared

Dimension	STAR / Aucxis	Bold Reuse / Avery Dennison	Eden Project / Re-Universe	Blenheim Palace / Re-Universe	Imperial College / Re-Universe
Venue Type	Football stadium	Sports arenas	Botanical garden & visitor attraction	Heritage estate & visitor attraction	University campus
Location	Antwerp, Belgium	Portland, USA	Cornwall, UK	Oxfordshire, UK	London, UK
RAIN Alliance Member	Aucxis	Avery Dennison	Avery Dennison	Avery Dennison	Avery Dennison
Platform / Partner	STAR by Aucxis	Bold Reuse + ATMA.io	Re-Universe	Re-Universe + Mastercard	Re-Universe + Mastercard

Tag Type	Embedded RAIN RFID in cups	RAIN RFID wash-durable adhesive	RAIN RFID in-mould label	RAIN RFID in-mould label	Heat-resistant waterproof RAIN RFID tag
Deposit Return	Automated via STAR platform	Tracking pilot; data 2026	Reverse vending machine	Reverse vending machine	£2 deposit; automated return station + card tap
Key Metric	98% return rate; 7t plastic/season	917K+ cups diverted; 1M target 2025	220K cups/yr; 12.7t CO_2 avoided	320K cups; 1,150 kg CO_2 in 12 months	55K cups displaced; 2,513.5 kg CO_2; 1,210 kg waste saved
Regulatory Driver	EU SUP directive	EPR laws; sustainability reporting	PPWR	PPWR; food contact regulations	Institutional sustainability targets; PPWR

Case Study 1: STAR by Aucxis — Royal Antwerp Football Club

Reusable Cup Management at a Large European Football Stadium

Overview

Royal Antwerp Football Club (RAFC) — one of Belgium's largest football clubs — implemented the STAR reusable cup system, powered by RAIN RFID, to comply with the EU Single-Use Plastics directive and to elevate both sustainability performance and the fan experience. RAIN RFID tags are embedded in every reusable cup, enabling the STAR platform developed by Aucxis to automate cup tracking, return handling, and deposit refunds at full stadium scale.

The system processes high cup volumes rapidly during peak match-day events, delivering seamless operations, accurate deposit refunds, and a substantial reduction in single-use plastics across the venue.

Sustainability Impact

- 7 tonnes of plastic waste saved per season, replacing over 1,000,000 disposable cups.
- Cup return rates of nearly 98%, significantly exceeding the 90% minimum required under SUP legislation.

- Circular economy enablement through multiple verified reuse and wash cycles per cup.
- 75% reduction in cleanup effort, lowering staff costs and improving overall stadium efficiency.
- Automated data-driven ESG and SUP compliance reporting, replacing manual processes.

Role of RAIN Technology

Every reusable cup carries an embedded RAIN RFID tag applied at the point of manufacture. At the point of sale, STAR's POS readers automatically link each cup to the customer's payment transaction — tying the deposit directly to the payer and eliminating fraud. When a cup is returned, STAR COLLECT stations scan even large stacks simultaneously, registering returns instantly without manual counting. The RAIN RFID software then triggers an automatic deposit refund to the original payer's payment method. After washing, a final RAIN RFID quality control check confirms each cup's status before it re-enters circulation

This closed-loop workflow generates continuous data on reuse cycles, inventory levels, cup wear, and high-volume return areas — enabling venues to identify problem zones, optimise staffing, and demonstrate compliance with a verifiable audit trail.

Stakeholders

- Royal Antwerp Football Club (RAFC) — venue operator and programme owner
- Aucxis — RAIN Alliance member; developer and provider of the STAR RAIN RFID platform
- Cup manufacturers and washing service providers
- Payment and POS operators integrated with STAR's deposit refund logic
- Fans and event attendees — primary end users of the reusable cup system
- Regulators — EU SUP compliance and GDPR considerations

Technical Prerequisites

- Durable, washable RAIN RFID tags embedded at cup manufacturing
- STAR POS countertop readers linking cups to payment transactions at point of sale
- STAR COLLECT stations (wall mount, floor mount, chute-based) for bulk return scanning
- STAR Logistics wash station readers for post-wash quality control
- POS integration with deposit and refund logic; GDPR-compliant data handling

Measurable Outcomes

Impact Area	Before RAIN RFID	After RAIN RFID (STAR)
Plastic waste	Millions of single-use cups per season	7 tonnes of plastic saved per season; 1M+ disposable cups replaced

Impact Area	Before RAIN RFID	After RAIN RFID (STAR)
Return rate	No reliable tracking; manual counts	98% cup return rate, exceeding the 90% regulatory requirement
Cleanup effort	Manual cleanup, high staff cost	75% reduction in cleanup effort; lower operational costs
Deposit refunds	Manual, error-prone, fraud risk	Automated, fraud-proof; refunds tied to original payer
Compliance reporting	Manual data collection	Automated ESG and SUP compliance reporting

Case Study 2: Bold Reuse × Avery Dennison — Portland Sports Venues

Smart Reuse Tracking for High-Volume Sports Arenas

Overview

Bold Reuse, a leader in reusable packaging systems for venues and campuses, partnered with Avery Dennison to launch a two-month RAIN RFID pilot programme bringing item-level traceability to its circular cup system at two of Portland's busiest sports venues: the Moda Center (home of the Portland Trail Blazers) and Providence Park (home of the Portland Timbers and Thorns). Together, the venues reach over 2 million people annually. The pilot also covers Bold Reuse's Portland-based wash hub, creating end-to-end visibility from distribution through return and washing.

This deployment goes beyond basic inventory tracking. By capturing item-level metrics on how cups move through the system, where losses occur, and how user behaviour affects return rates, the pilot is designed to generate the operational intelligence needed to make reuse scalable, cost-effective, and verifiable across Bold Reuse's growing national network of venues.

Sustainability Impact

- The Moda Center's existing reuse programme (Rip City Reuse) has already eliminated over 917,000 single-use cups — on track to reach 1 million in 2025.
- Providence Park diverted nearly 115,000 single-use cups from landfill in its first year with Bold Reuse, eliminating over 5,500 pounds of waste.

- RAIN RFID enables 100% item-level auditability — providing the verifiable data required for EPR regulatory compliance and sustainability reporting.
- Pilot data, available from early 2026, will be used to optimise operations, reduce losses, and extend cup lifespans across the venue network.

Role of RAIN Technology

Approximately 15,000 cups were RAIN RFID-tagged for the initial pilot phase. Each cup carries a unique RAIN RFID chip embedded during manufacturing, protected by Avery Dennison's purpose-built tag using an S8029 rubber hybridised acrylic adhesive and 1.2-mil PET over-lamination — engineered to withstand up to 1,000 industrial wash cycles, high heat, and industrial detergents without compromising read functionality.

Fixed RAIN RFID readers installed at key points within the wash service centre, combined with handheld devices used at partner venues, passively collect data throughout the cup lifecycle: cup return versus loss rates, average wash cycles per cup, inventory dwell times, and the percentage of cups retired, rewashed, or damaged. This data flows into Avery Dennison's ATMA.io digital identity platform, enabling continuous operational optimisation.

Stakeholders

- Bold Reuse — reusable packaging systems operator and programme lead
- Avery Dennison — RAIN Alliance member; provider of RAIN RFID tags, readers, and ATMA.io data management platform
- Moda Center / Portland Trail Blazers — venue partner
- Providence Park / Portland Timbers and Thorns — venue partner
- Fans and event attendees — end users of the reusable cup system

Technical Prerequisites

- RAIN RFID tags purpose-built for wash durability: S8029 adhesive + 1.2-mil PET over-lamination, rated to 1,000 wash cycles
- Fixed RAIN RFID readers at wash hub service centre checkpoints
- Handheld RAIN RFID devices for venue-level cup tracking
- ATMA.io digital identity platform for data aggregation, analytics, and reporting
- Partnership model: Avery Dennison provides tags, hardware, and software; Bold Reuse covers labour and operating costs

Case Study 3: Eden Project × Re-Universe — Reusable Coffee Cups

How Smarter Payments Are Turning Reusable Cups into Smart Savings

Overview

The Eden Project — an educational charity and world-famous botanical garden in Cornwall, UK, attracting approximately one million visitors annually — has implemented a RAIN RFID-enabled reusable coffee cup programme in partnership with Re-Universe, a UK-based digital platform specialising in deposit return and reuse schemes. All hot drinks across the Eden Project's cafés are served in smart cups with embedded RAIN RFID chips, creating a seamless, cashless deposit return experience for visitors.

The programme was designed to solve a specific operational challenge: early reusable cup initiatives were found to take too long to process, frustrating customers and reducing return rates. By deploying standalone reverse vending machines with RAIN RFID readers and near-instant contactless deposit refunds, Re-Universe made returning a cup as fast and frictionless as discarding a disposable one.

Sustainability Impact

- Estimated to keep 220,000 cups out of local landfill per year, potentially avoiding up to 4 tonnes of waste and 12.7 tonnes of CO_2 annually.
- Eden Project saved approximately £25,000 on single-use cup costs in 2024 alone.
- Reusable cups break even against the cost of single-use alternatives after just 10 uses; individual cups can withstand up to 1,000 commercial wash cycles.
- Reduces energy usage and waste management costs compared to single-use cup disposal.
- Supports compliance with EU PPWR reuse targets for food service packaging.

Role of RAIN Technology

When a visitor purchases a hot drink, the RAIN RFID chip in the cup is activated and linked to their payment transaction. When the visitor finishes their drink, they return the cup to an onsite reverse vending machine. The machine's built-in RAIN RFID reader logs the return instantly, and the customer taps their card, phone, or contactless wearable against the terminal to receive their deposit refund — typically before they step away from the machine.

Avery Dennison supplies the RAIN RFID in-mould label tags used in the cups, which are designed to withstand the heat and pressure of injection moulding and maintain read performance through hundreds of wash cycles. The tags comply with EU regulations on food contact materials, including Commission Regulation (EU) 10/2011 and Regulation (EC) 1935/2004.

Stakeholders

- Eden Project — venue operator and programme owner; educational charity and visitor attraction
- Re-Universe — digital deposit return and reuse scheme platform provider
- Avery Dennison — RAIN Alliance member; RAIN RFID in-mould label tag supplier
- Mastercard — payment infrastructure partner enabling near-instant contactless deposit refunds
- Visitors — approximately one million annually

Technical Prerequisites

- RAIN RFID in-mould label tags: compatible with standard injection moulding equipment, rated for food contact (EU 10/2011 and EC 1935/2004 compliant)
- Standalone reverse vending machines with embedded RAIN RFID readers
- Contactless payment terminal integration for near-instant deposit refunds
- Re-Universe digital platform managing deposit tracking, return logging, and refund processing

Case Study 4: Blenheim Palace × Re-Universe × Mastercard

Cutting Cost and Carbon at a UNESCO World Heritage Site

Overview

Blenheim Palace — a UNESCO World Heritage Site and one of England's most visited heritage estates, located in Oxfordshire — demonstrates how organisations can implement circular economy initiatives while simultaneously improving operational efficiency, enhancing visitor experience, and cutting costs. Working with Re-Universe and Mastercard Move, Blenheim has deployed a RAIN RFID-enabled reusable cup scheme built around a cashless deposit return model. The programme began with hot cups, with plans to expand into cold cups and other packaging.

The scheme replaced a costly reliance on single-use cups with a reusable system that pays for itself rapidly: each reusable cup breaks even against the equivalent single-use cost after just four uses. With return machines streamlining refunds to the visitor's payment card, the experience is designed to be faster and more convenient than simply throwing a cup away.

Sustainability Impact

- 50% reduction in cost spending on single-use cups, with diverted cups avoiding landfill and incineration.
- In a 12-month period, the programme cut 1,150 kg of carbon emissions and kept 320,000 single-use cups out of landfill.
- Each £2.70 reusable cup reaches cost break-even after just four uses (versus £0.35–0.67 per single-use cup).
- The programme generates detailed data insights on operational efficiency, visitor return rates by location, and visitor satisfaction — enabling continuous optimisation.
- Positive visitor feedback: guests specifically mention the reusable cups in visitor surveys, noting alignment with their own environmental values.
- Supports PPWR reuse targets for food and beverage packaging across heritage and visitor attraction sectors.

Role of RAIN Technology

Every reusable cup at Blenheim Palace contains an embedded RAIN RFID chip. The chip provides each cup with a unique digital identity used for data tracking and tracing throughout its usage lifecycle. When a visitor purchases a drink, they pay a £2.70 deposit; the cup's RAIN RFID identity links that transaction to the visitor's payment card. On return to a reverse vending machine, the RAIN RFID reader logs the cup instantly, triggering a near-instantaneous refund to the visitor's payment card — typically before they step away from the machine.

Avery Dennison supplies the RAIN RFID in-mould label tags, designed for compatibility with standard injection moulding equipment, washing durability, hygiene compliance, and food contact regulations (EU 10/2011 and EC 1935/2004). The unique digital identity generated by the RAIN RFID tag also enables granular reporting — measuring operational efficiency, return rates by machine location, and visitor satisfaction.

Stakeholders

- Blenheim Palace — venue operator and programme owner; UNESCO World Heritage Site
- Re-Universe — digital deposit return and reuse scheme platform provider
- Mastercard Move — payment infrastructure enabling cashless, contactless near-instant deposit refunds
- Avery Dennison — RAIN Alliance member; RAIN RFID in-mould label tag supplier

- Visitors — end users and deposit payers

Technical Prerequisites

- RAIN RFID in-mould label tags: compatible with injection moulding; food contact compliant (EU 10/2011, EC 1935/2004)
- Standalone reverse vending machines with RAIN RFID readers for automated cup return and logging
- Mastercard Move payment integration for near-instant, contactless deposit refunds
- Re-Universe platform managing deposit logic, return data, refund processing, and analytics reporting

Case Study 5: Imperial College London × Re-Universe

RAIN RFID-Enabled Reusable Cup Trial on a University Campus

Overview

Imperial College London — one of the world's leading research universities, based in South Kensington, London — has launched a six-month reusable cup trial at The Roastery, one of its on-campus café outlets. The trial, implemented in partnership with Re-Universe, removes single-use cups entirely from The Roastery and replaces them with RAIN RFID-enabled reusable cups on a £2 deposit return model. If successful, Imperial plans to expand the scheme across all campus outlets and extend it to food containers.

The programme addresses a straightforward but significant problem: The Roastery alone issues around 55,000 disposable cups per year. Imperial's existing 30p disposable cup levy already incentivises reusable alternatives, but the Re-Universe RAIN RFID system makes the return process frictionless enough to drive high compliance — a near-instant deposit refund to the customer's payment card before they step away from the return machine.

Sustainability Impact

- 55,000 disposable cups displaced during the trial, saving 1,210 kg of waste and equating to 2,513.5 kg of CO_2 avoided.
- If all disposable cups at The Roastery are eliminated, the programme is estimated to save more than 2 metric tonnes of CO_2e per year.
- Reduces demand for raw materials including paperboard and plastic lining used in single-use cups.
- Closed-loop system: cups are returned, cleaned to food-standard protocols daily, and RAIN RFID-scanned to confirm cleanliness before redistribution — only verified clean cups re-enter circulation.

- Customers save up to £70 per year by avoiding the 30p disposable cup levy — making sustainability directly financially beneficial.
- Reuse rate data and waste diversion metrics support Imperial's institutional sustainability targets and ESG reporting.

Role of RAIN Technology

Every reusable cup in the scheme carries an item-level RAIN RFID tag, giving it a unique digital identity that is tracked throughout its lifecycle. When a cup is issued at the café counter, the RAIN RFID system links the cup to the customer's payment transaction and records the timestamp. When the cup is returned to the automated collection point, the RAIN RFID reader logs the return instantly. The customer taps their bank card against the terminal and receives their £2 deposit refund in moments.

After collection, cups are cleaned daily using food-standard protocols. A RAIN RFID scan then verifies each cup's cleanliness status before it is cleared for redistribution — ensuring only compliant cups re-enter circulation. The system also tracks the number of reuse cycles per cup, flags lost or missing cups within a seven-day return window, and generates the reuse rate data needed to support sustainability reporting.

Stakeholders

- Imperial College London — venue operator and programme owner; world-leading research university
- Re-Universe — digital deposit return and reuse scheme platform provider
- Avery Dennison — RAIN Alliance member; RAIN RFID tag supplier
- Mastercard — payment infrastructure enabling near-instant contactless deposit refunds (via Re-Universe partnership)
- Students, staff, and visitors — end users; the university community across South Kensington campus

Technical Prerequisites

- Heat-resistant, waterproof RAIN RFID tags with durable encapsulation for repeated dishwasher cycles; food-safe materials
- Fixed RAIN RFID readers at café counters for cup issuance and transaction linking
- RAIN RFID-enabled automated return stations for bulk cup collection and instant deposit refund triggering
- Asset tracking platform monitoring reuse cycles, return rates, and cup status
- Daily cup collection, washing, and RFID-verified cleanliness check before redistribution
- Food hygiene compliance and data protection requirements for deposit records

Key Themes and Takeaways

1. RAIN RFID Makes Reuse Operationally Viable at Scale

All five deployments demonstrate the same fundamental insight: reusable cup programmes only work at scale when every cup has a persistent, machine-readable digital identity. Without RAIN RFID, operators face manual counting, inaccurate deposit tracking, fraud, and no credible data to demonstrate compliance or business value. With RAIN RFID, high-volume cup scanning becomes automatic, deposit refunds become instantaneous, and return rates become measurable and verifiable.

2. The Business Case Is Proven Across Venue Types

From a football stadium in Belgium to a botanical garden in Cornwall, the economics of RAIN RFID-enabled reuse are consistent. Reusable cups break even after a small number of uses and generate savings that grow with scale. Blenheim Palace cut single-use cup costs by 50% in year one. Eden Project saved £25,000 in 2024. RAFC saved 7 tonnes of plastic per season while reducing cleanup costs by 75%. RAIN RFID is not just an environmental investment — it is an operational efficiency play.

3. Frictionless Consumer Experience Is the Critical Enabler

Early reusable cup programmes failed not because of the technology but because the return process was too slow. Customers will not return cups if it takes longer than discarding them. Near-instant RAIN RFID-triggered deposit refunds — via reverse vending machines at Eden Project and Blenheim Palace, and automated STAR COLLECT stations at RAFC — remove this friction entirely. Making reuse as convenient as disposal is the design principle that drives high return rates.

4. RAIN RFID Generates the Data That Regulation Will Require

The EU SUP directive, PPWR reuse targets, and EPR frameworks all require verifiable data on packaging reuse rates, waste diversion, and compliance. Manual processes cannot credibly provide this at scale. RAIN RFID generates an auditable, item-level data trail automatically — enabling automated ESG reporting, SUP compliance verification, and the operational insights needed to continuously improve programme performance.

5. RAIN Alliance Members Are Providing the Enabling Technology

Across all five cases, RAIN Alliance members are supplying the core technology that makes these programmes possible. Aucxis provides the STAR platform and RAIN RFID infrastructure for venue-scale deployments across stadiums and festivals. Avery Dennison supplies the purpose-built RAIN RFID tags — engineered for wash durability, food contact compliance, and injection moulding compatibility — that power the Re-Universe and Bold Reuse deployments. The breadth of these deployments demonstrates that RAIN RFID-enabled reuse is a mature, proven technology ready for widespread adoption.

About the RAIN Alliance

The RAIN Alliance enables organizations to improve traceability, effectiveness, and sustainability by simplifying, standardizing and accelerating the adoption of RAIN technology through global collaboration and innovation. Its global membership consists of companies and organizations which develop and deploy RAIN technology solutions across many vertical markets.

RAIN is a standards-based wireless technology that enables businesses and consumers to identify, locate and authenticate billions of items connected to the Internet of Things. RAIN technology uses the ISO/IEC 18000-63 protocol (also known as GS1 UHF Gen2).

For more information, please visit therainalliance.org