

2025

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Hard Plastic Waste Management



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1 INTRODUCTION

Hard plastic waste management in the Northern Norway, Sweden, and Finland faces significant logistical and technical challenges due to low population density, long transport distances, and limited recycling infrastructure. In the transition toward a circular plastics economy, one of the most persistent challenges lies not in the recycling technologies themselves, but in the sustainable collection of plastic feedstock—particularly in rural and Arctic regions. While technological solutions for sorting, processing, and recycling hard plastics have advanced rapidly in recent years^{1,2}, these innovations depend on a stable and sufficient flow of collected materials.

In Northern Norway, operators such as [Remiks Ltd](#)³ and [HRS Ltd](#)⁴ manage municipal waste under the national plastic strategy, but hard plastics are often incinerated with energy recovery.

Sweden operates one of the world's most advanced plastic sorting and recycling ecosystems. [Van Werven Ltd](#)'s⁵ plant in Sexdrega is the country's largest hard plastic recycling facility, processing up to 45,000 tons per year of post-consumer HDPE and PP⁶. Additionally, [Stena Recycling Ltd](#)⁷ and [Borealis Ltd](#)⁸ are developing Sweden's first plastic refinery, which will chemically process hard plastics that are unsuitable for mechanical recycling³. These developments are supported by Sweden's '[Fossil-Free Sweden](#)'⁹ roadmap and national plastic strategy.

Finland is a leader in both mechanical and emerging chemical recycling of hard plastics. [NG Nordic](#)'s¹⁰ Riihimäki facility mechanically recycles post-consumer HDPE and PP plastics into granules used in piping, packaging, and construction materials¹¹. [Neste Ltd](#)¹² is expanding the processing capacity of plastic at the Porvoo refinery to 150,000 tons of liquefied waste plastic per year¹³.

Efforts are being made to expand local recycling capacity and reduce reliance on incineration. In northern Sweden, source-separated systems for household plastics are in place, while rigid plastics from construction and industry remain harder to recycle. The launch of [Site Zero](#)¹⁴ in 2023 greatly enhanced national recycling capacity, yet rural areas still rely on energy recovery because of transport and contamination issues. [Finland's Plastics Roadmap](#) emphasizes resource efficiency, emissions reduction, and increased recycling rates¹⁵. Regional initiatives—such as Oulu's free

1 EEA 2024. Waste recycling in Europe. <https://www.eea.europa.eu/en/analysis/indicators/waste-recycling-in-europe>. Accessed November 14, 2025

2 Ellen MacArthur Foundation, The New Plastics Economy: Catalysing action (2017). <https://www.ellenmacarthurfoundation.org/the-new-plastics-economy-catalysing-action>. Accessed November 14, 2025

3 Remiks Ltd website. Accessed November 4, 2025

4 HRS Ltd website. Accessed November 4, 2025

5 Van Werven Ltd website. Accessed November 4, 2025

6 Fossilfritt Sverige. Recycling sector. <https://fossilfrittverige.se/en/roadmap/the-recycling-sector/>. Accessed November 4, 2025

7 Stena Recycling Ltd website. Accessed November 4, 2025

8 Borealis Ltd website. Accessed November 4, 2025

9 Fossil Free Sweden website. Accessed November 4, 2025

10 NG Nordic Ltd website. Accessed November 4, 2025

11 NG Nordic Ltd. Muovien kierrätys. <https://services.ngnordic.com/fi/materiaalien-kierratys/muovien-kierratys>. Accessed November 4, 2025

12 Neste Ltd website. Accessed November 4, 2025

13 Neste. Nesteytetty jätemuovi. <https://www.neste.com/fi-fi/tuotteet-ja-innovaatio/raaka-aineet/nesteytetty-jatemuovi>. Accessed November 4, 2025

14 Interreg Europe. Site Zero and plastic circularity in Sweden. Accessed November 4, 2025

15 Ministry of the Environment 2022. A Plastic Roadmap for Finland 2.0. Reduce, refuse, recycle and replace. Accessed November 4, 2025

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collection point for hard plastics and Pirkanmaa's pilot for mixed plastic collection¹⁶ —demonstrate practical progress toward broader participation and efficiency.

Achieving the prerequisite of feedstock quantity remains a major economic bottleneck in many sparsely populated regions – including northern Norway, Sweden, and Finland – which lack adequate plastic collection systems and recycling facilities. Besides lack of efficient collection, rural areas are also challenged with limited market for recycled plastics, which makes it economically challenging for recycling facilities to operate. Arrangement of more efficient and accessible logistics systems could offer a solution to efficiently recycle the plastic waste from rural areas. A flexible collection system – allowing mixed plastics collection – followed with local collection centers for washing and pressing of waste and transportation to centralized recycling facilities is an attractive option to investigate.

Examples of a hard plastic collection pilot

Pirkanmaan Jätehuolto Ltd (Pirkanmaa, Western Finland) conducted a pilot study of mixed plastic waste collection¹⁷. During the pilot, all types of plastic waste - including packaging, rigid plastics, and miscellaneous plastic goods - were collected as a single mixed plastic fraction at the source (households and small businesses). It was noticed that the model could be implemented in a technically feasible manner without compromising the following treatment procedures.

Kiertokaari Oy (Oulu, Northern Ostrobothnia) has conducted several investigations to support the recycling of domestic hard plastic waste. In November 2020 a free 5-day collection trial was arranged at Rusko recycling station¹⁸. According to the results, polypropylene and high-density polyethylene compose the majority of domestic plastic waste. The quantity of impurities was relatively high despite the monitoring. Despite this challenge, the hard plastic collection is now under continuous operation, mainly to increase their recycling rate¹⁹.

¹⁶ Pirkanmaan Jätehuolto 2025. Muoviraportista toteutukseen. Available at <https://pihov.fi/wp-content/uploads/2025/05/Muoviraportti-2025-ladattava.pdf>. Accessed November 4, 2025

¹⁷ Pirkanmaan Jätehuolto 2025. Muoviraportista toteutukseen. Available at <https://pihov.fi/wp-content/uploads/2025/05/Muoviraportti-2025-ladattava.pdf>. Accessed November 4, 2025

¹⁸ Niemistö, E. (2021). Kotitalouksien muovijätteen keräys- ja koostumustutkimus Kiertokaaren toimialueella. Opinnäytetyö, Oulun yliopisto. <https://urn.fi/URN:NBN:fi:oulu-202104137527>. Accessed November 6, 2025

¹⁹ Kiertokaari 2025. Muovituotteiden vastaanotto Oivapisteellä. <https://kiertokaari.fi/muovituotteiden-vastaanotto-oivapisteella/>. Accessed November 4, 2025



Figure 1 Maybe not the most innovative way to collect plastic waste? (Adobe Stock, licensed)

2 INNOVATIONS RELATED TO PLASTIC WASTE COLLECTION

2.1 TOMRA sensor-based sorting systems

Technology principle: Mechanical recycling (shredding, washing, pelletizing)

Scale: Planned up to 90,000 tons²⁰

Developer: [TOMRA Systems ASA](https://www.tomra.com)²¹, Norway

IPR: Patented technologies²²

Cost & Sustainability: Advanced sensor-sorting systems require significant capital investment (machinery, installation, commissioning). For remote or low-volume regions (e.g., rural Arctic regions), the fixed cost per ton can be high, making it harder to achieve economic viability. TOMRA Sorting GmbH (a subsidiary) received a gold medal in the EcoVadis rating for sustainability performance²³.

20 TOMRA SYSTEMS ASA. <https://www.tomra.com/plastic-feedstock/our-plants>. Accessed November 4, 2025

21 TOMRA SYSTEMS ASA website. Accessed November 6, 2025

22 TOMRA SYSTEMS ASA. TOMRA Patents. <https://www.tomra.com/tomra-patents>. Accessed November 4, 2025

23 Recycling inside 2024. TOMRA Sorting GmbH Receives Gold Medal in EcoVadis Sustainability Rating. <https://recyclinginside.com/recycling-technology/separation-and-sorting-technology/tomra-sorting-gmbh-receives-gold-medal-in-ecovadis-sustainability-rating>. Accessed November 4, 2025

2.2 AMP Smart Sortation™

Technology principle: AI based sorting²⁴ technology, reconfigurable in real time to target specific plastic types, as well as fiber, metals, and more.

Scale: ca. 62,000 tons

Developer: [AMP Ltd](#)²⁵, Colorado, US

IPR: Patented technologies

Cost & Sustainability: While cost per ton may drop with AMP's technology, initial capital investment (robotics, sensors, facility retrofit or build-out) remains substantial. The exact amount is not publicly disclosed. For smaller or remote operations (low throughput, dispersed collection) achieving sufficient scale to make the economics viable may be challenging. By increasing the volume and quality of recovered recyclables, the technology supports sustainability goals of reducing landfill, reducing virgin material use, and improving resource efficiency²⁶.

2.3 Vacuum waste collection system

Technology principle: Pneumatic waste collection

Scale: Envac Ltd has operated 1,200 installations across six continents.

Developer: [Envac Ltd](#)²⁷, Sweden

IPR: Patented technologies

Cost & Sustainability: For smaller or rural settings, the high upfront cost may be a barrier unless scaled or shared among communities. Efficient collection of waste would support higher recycling rates. The system allows emission reduction by replacing truck transportation. However, installing underground pipe networks or pneumatic systems over long distances is prone to geological, climate, and logistics challenges.

2.4 Mixed plastic waste collection

Technology principle: Mixed plastic waste collection²⁸

Scale: In total 30 tons of material were collected in 2 months from which ca 55 % was recycled

Developer: [Envac Ltd](#), Sweden

24 AMP Ltd. Our waste sorting technologies. <https://ampsortation.com/technologies>. Accessed November 4, 2025

25 AMP Ltd website. Accessed November 6, 2025

26 Nexa Reports. AI Revolutionizes Recycling: AMP Robotics Solves Financial Sustainability Crisis. <https://www.nexareports.com/news/article/ai-revolutionizes-recycling-amp-robotics-solves-financial-sustainability-crisis-80229>. Accessed November 4, 2025

27 Envac Ltd website. Accessed November 6, 2025

28 Pirkanmaan Jätehuolto 2025. Muoviraportista toteutukseen. Available at <https://pjhoy.fi/wp-content/uploads/2025/05/Muoviraportti-2025-ladattava.pdf>. Accessed November 4, 2025

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IPR: -

Cost & Sustainability: Mixed plastic waste collection model is both environmentally sustainable and economically viable when implemented through coordinated producer–municipality cooperation. It simplifies sorting for households, reduces emissions from incineration, and provides consistent feedstock for emerging recycling industries. The main economic challenge remains optimizing transport and ensuring fair cost distribution, but pilots show strong potential for scale-up.



Figure 2 Hard plastic grounds. What to do with this? (Adobe Stock, licensed)

3 TECHNOLOGIES FOR HARD PLASTIC WASTE RECYCLING

3.1 NG Nordic (Fortum) Riihimäki

Technology principle: Mechanical recycling (shredding, washing, pelletizing)²⁹

Scale: Industrial-scale facility in Riihimäki, Finland (ca. 20,000–30,000 t/a estimated)

Developer: [NG Nordic](#)³⁰ (ex. Fortum Recycling & Waste), Finland

IPR: Owns process integration and facility-specific recycling configurations

Cost & Sustainability: Efficient for post-consumer hard plastics; uses clean energy where available; low emissions and high reuse rates

3.2 Neste

Technology Principle: Chemical recycling (pyrolysis and liquefaction of mixed plastics)³¹

Scale: Planned 160,000 tons per annum

²⁹ NG Nordic Ltd. Muovien kierrätys. <https://services.ngnordic.com/fi/materiaalien-kierratys/muovien-kierratys>. Accessed November 4, 2025

³⁰ NG Nordic Ltd website. Accessed November 6, 2025

³¹ Neste. Nesteytetty jätemuovi. <https://www.neste.com/fi-fi/tuotteet-ja-innovaatio/raaka-aineet/nesteytetty-jatemuovi>. Accessed November 4, 2025

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Developer: [Neste Corporation](#)³², Finland

IPR: Multiple patents in pyrolysis oil upgrading and feedstock purification

Cost & Sustainability: High CapEx; potential for circular polymers; reduces reliance on fossil oil

3.3 Van Werven

Technology Principle: Mechanical sorting and granulation of rigid plastics³³

Scale: 45,000 t/a at Sexdrega, Sweden

Developer: [Van Werven Plastic Recycling](#)³⁴

IPR: Operational know-how; focus on high-output efficiency rather than patented processes

Cost & Sustainability: Proven cost-effective at scale; achieves over 85% recycling yield

3.4 Stena Recycling

Technology Principle: Mechanical and pre-treatment for advanced chemical recycling³⁵

Scale: Under development; joint plant expected to process ca. 60,000 t/a

Developer: [Stena Recycling Ltd](#)³⁶ in collaboration with [Borealis Ltd](#)³⁷

IPR: Stena specializes in sorting innovations; Borealis may license chemical conversion processes

Cost & Sustainability: Designed to handle mixed, non-mechanically recyclable plastics; mid to high CapEx

3.5 Borealis

Technology Principle: Chemical recycling using [Borcycle™](#)³⁸ C (closed-loop feedstock regeneration)³⁹

Scale: Refinery-scale chemical recycling under construction (ca. 60,000 t/a capacity)

Developer: [Borealis Ltd](#)

IPR: Borcycle™ trademark and patents in feedstock transformation and purification

Cost & Sustainability: High upfront cost; capable of producing virgin-quality recycled polymers

32 Neste Corporation website. Accessed November 6, 2025

33 Van Werven. Our facilities. <https://www.recyclingplastics.eu/our-facilities>. Accessed November 4, 2025

34 Van Werven website. Accessed November 6, 2025

35 Stena Recycling. Waste plastic recycling, collecting and sorting. <https://www.stenarecycling.com/what-we-offer/material-recycling/plastic/> Accessed November 4, 2025

36 Stena Recycling Ltd website. Accessed November 6, 2025

37 Borealis Ltd website. Accessed November 6, 2025

38 Borealis Ltd website. Borcycle™. Accessed November 6, 2025

39 Uusiouutiset 17.4.2024. Kohti muovien kiertotaloutta – Borealis tekee miljonaainvestoinnin Porvooseen. <https://uusiouutiset.fi/kohti-muovien-kiertotaloutta-borealis-tekee-miljoonainvestoinnin-porvooseen/>. Accessed November 4, 2025

3.6 BEWI

Technology Principle: Mechanical recycling of rigid industrial and marine plastics⁴⁰

Scale: Pilot in Kristiansund, Norway (ca. 5,000 t/a); scalable to 9 sites

Developer: [BEWI Energy Ltd](#)⁴¹ and [NorSea Group Ltd](#)⁴²

IPR: Patent applications in pipeline; modular plant design considered proprietary

Cost & Sustainability: Designed for offshore waste; efficient logistics; potential for local circular loops

⁴⁰ Eumeps. Circularity of EPS: Sweden's First EPS Recycling Hub Opens. <https://eumeps.eu/eumeps-newsroom/news/circularity-of-eps-swedens-first-eps-recycling-hub-opens>. Accessed November 4, 2025

⁴¹ BEWI Energy Ltd website. Accessed November 6, 2025

⁴² NorSea Group Ltd website. Accessed November 6, 2025