Pre-sorting of Residual Waste

Approaches to maximise recycling and emissions performance

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Report For

North London Waste Authority

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Executive Summary

The North London Waste Authority (NLWA) is exploring opportunities to reduce the volume of residual waste and increase recycling through the extraction of recyclates from the waste before it is taken to Edmonton for energy recovery. There are some potential drivers for investing in the pre-sorting of residual waste, including any combination of the following:

1. Moving towards a circular economy and reduce resource use though recycling;
2. Reducing the carbon impacts of residual waste;
3. Minimising the cost of residual waste treatment.

This report seeks to understand the approaches taken internationally to recover recyclable materials from the residual waste stream, using mixed waste sorting (MWS) facilities. A number of plants were selected as case studies to be used as a benchmark for how a NLWA MWS could perform. The following theoretical performance indicators were modelled from these data:

- Materials extracted from the MWS and sent to reprocessors – **42,200 tonnes**
- Reprocessor losses – **9,200 tonnes**
- Amount recycled after reprocessor losses – **33,000 tonnes**
- Land required – **20,000m^2** to **25,000m^2**
- Abated EfW emissions – **61,839 CO_2eq**
- Costs:
    - Capex **£175m** to **£200m** (excluding case studies, based on NLWA RFPF plant)
    - Annual costs (annualised CAPEX and OPEX) **£22.4m to £24.5m** (assuming financing over 15 years)
    - Annual revenues (avoided emissions trading system [ETS] costs and material income) **£5.7m to £11.5m**

These headline values are only indicative and there are many sensitivities, as outlined below and in the report. The findings can, however, help determine whether to develop a full business case and cost benefit analysis, based on primary evidence.

1 Moving towards a circular economy and reduce resource use though recycling

Each MWS facility is bespoke, with the equipment optimised for the residual waste composition. However, composition will change over time when certain policies are implemented. The estimates above cater for the introduction of the Deposit Return System in 2027 which will lower plastic and metal content by taking beverage containers out of the residual waste stream, reducing recycling yields.

Further impacts include mandatory food separation (earmarked for 2026) which should produce a 'cleaner' waste stream, enhancing the efficiency of the sorting process. Extended Producer Responsibility may reduce yields through avoided packaging waste, although the scheme could incentivise the recyclability of the materials, helping to increase efficiency in the plant.

As well as such policy impacts, the volatility of the material prices means we had to factor in losses due to some recyclates not finding an end market, and in some cases rejoining the disposal route to thermal treatment or landfill.

2 Reducing the carbon impacts of residual waste

The combustion of waste releases greenhouse gases. By extracting recyclable materials before such treatment, MWS reduces the amount of waste converted to carbon dioxide, thus lowering these emissions. Of particular interest to NLWA is the potential to reduce the non-biogenic carbon emissions – thus reducing charges when waste energy from waste is included in the Emissions Trading Scheme in 2028. We forecast that approximately 61,839 tonnes per annum of CO_2e would be reduced as a result of the MWS facility. Most of this tonnage is plastic and would thus be non-biogenic, helping, potentially, to contribute to ETS savings (depending on the method used to determine those costs, which is still under consultation).

3 Minimising the cost of residual waste treatment

A significant concern is around the potential costs of constructing and operating a MWS facility in North London being much higher than what is suggested by the case studies. By example, NLWA has recently completed the EcoPark Recycling and Fuel Preparation Facility (RFPF). This facility is understood to have cost approximately £150m, with £18m alone being required for the air handling system. This facility did not include material sorting equipment, and we estimate that a MWS designed to a similar specification would be between £175m and £200m. Costs in the construction industry have risen substantially and a project realised in the late-2020s could exceed these estimates.

These figures do not include the cost of land acquisition. Land lease carries a high premium in London compared with the case studies where there is more availability. The footprint could be reduced by more sophisticated multi-level plant designs, but this also increases cost.

If it is necessary to locate the MWS plant outside of EcoPark, this introduces an additional logistical step in handling the waste, or may even involve triple handling, if waste is unloaded at a transfer station before onward transport to the sorting plant, followed by transfer of the fuel output from the sorting plant to Edmonton. The addition and alteration of haulage routes and transfer infrastructure, land search, planning, permitting, and financing, will require significant upfront costs for the NLWA.

Operating costs would, to some extent, be mitigated by income from material sales (including any PRN/PERN and EPR revenues), ETS 'savings' (i.e., allowances which would have been purchased had the recyclates been put into energy-from-waste (EfW)), and potential additional income derivable from the then unused EfW capacity which would result from MWS.

The case studies do not provide assurance that a plant in the UK would be financially viable, after considering the differences between UK and European policy. The trend in constructing MWS facilities in Sweden can partly be attributed to the Climate Leap fund, which provides supporting investment for regional and local initiatives to reduce GHG emissions. Both Swedish case studies identified in this report were granted 25% of capital costs for construction. In Poland, recycling targets and penalties are both high, incentivising municipalities to find solutions for increased recycling.

Future Development Mixed Waste Sorting

Currently in the UK, there is a lack of funding opportunities and investment for similar projects and the waste sector is generally not incentivised to pursue mixed waste sorting solutions.

The drive towards MWS facilities in the UK will depend on the following considerations (among others):

- The evolving design and fee modulation specifics within the new EPR scheme, affecting any material specific EPR payments which may be derived;
- Material specific packaging performance levels relative to targets (which will affect whether MWS is necessary for meeting packaging waste targets);
- The effectiveness of the incoming DRS (affecting how much additional metal and plastic recycling is required from source segregation and from recovery from residual waste);
- PRN pricing;

- The availability of end markets for materials; and
- Future UK ETS carbon prices and the mechanism by which it applies to EfW, as well as the availability of any free carbon credits.

Uncertainty around how and when these schemes are being designed and implemented, as well as how end markets will respond to increased recyclate availability, is currently inhibiting the adoption of MWS in the waste sector. Greater certainty is required to help guide the waste sector in making these investment decisions.

Further down the line, implementation issues will also need to be addressed, in particular the alteration of the Boroughs' haulage routes and transfer infrastructure, land search, planning, permitting, and financing, which will help provide the true costs of commissioning a MWS plant.

This assessment is based on international case studies and prevailing legislative and financial conditions within the associated territories that have been transposed into a North London context to inform conclusions. The indications from the case study information, coupled with logistical challenges for a remote MWS facility, suggest that MWS is not currently practicable for North London. However, many of the factors that underpin the assessment are in flux and may trend towards more favourable conditions for MSW separation in the future – most notably after EPR for packaging is embedded and the UK ETS is extended to EfW. Additionally, the decommissioned Edmonton EfW facility could potentially offer strategic land for co-locating a MWS facility alongside the new energy recovery facility. Therefore, it is recommended that NLWA keeps this topic open, with a view to developing a more detailed assessment in the future when market conditions are more stable.

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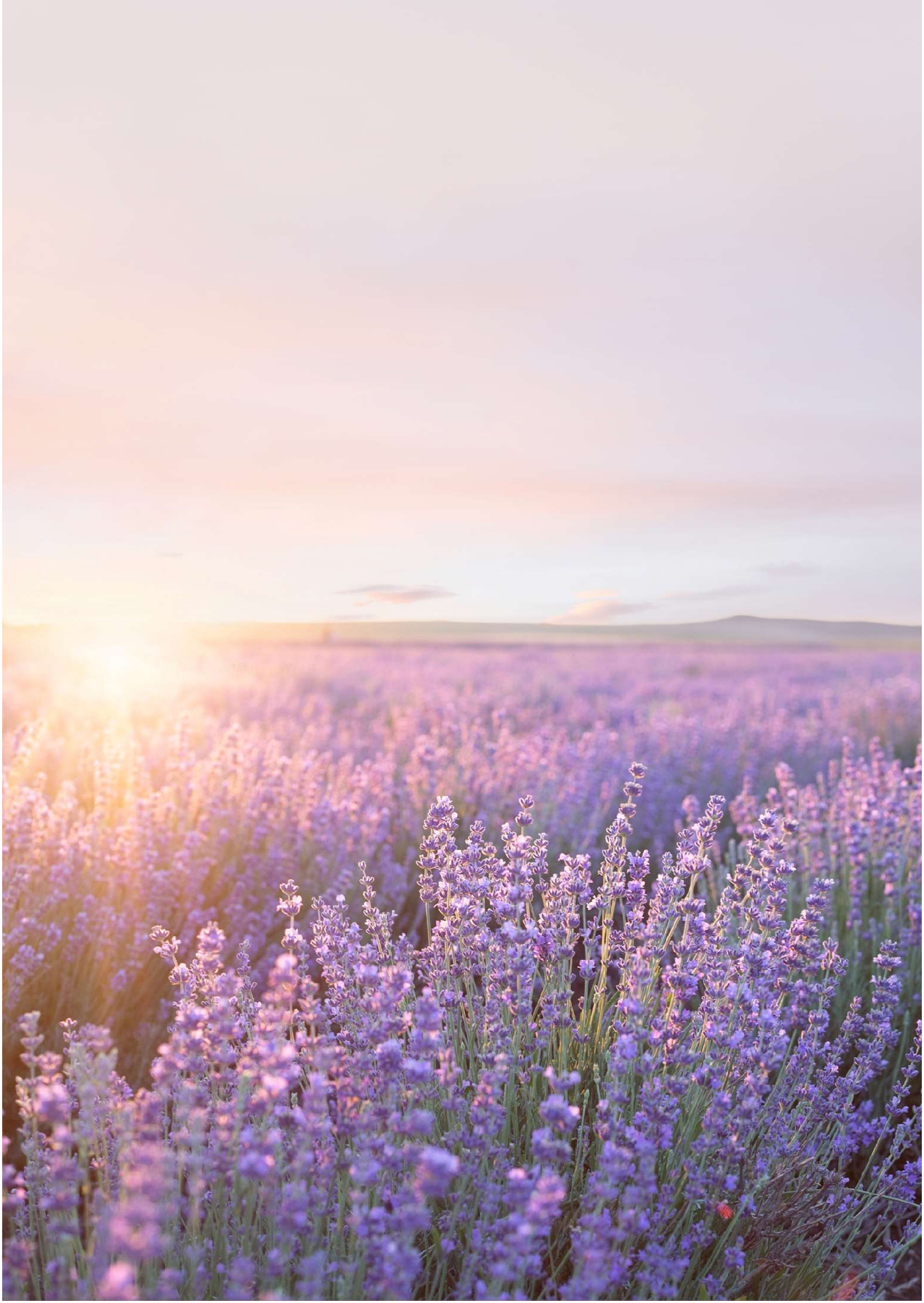


1.0 Introduction

The North London Waste Authority (NLWA) is exploring opportunities to reduce the volume of residual waste in North London and increase recycling across the seven North London boroughs. To this end, NLWA is seeking to understand what approaches are being taken internationally to improve the recovery of recyclable materials from the residual waste stream to reduce residual waste.

NLWA's brief was for the research to analyse the relative successes and challenges of real-world examples of technology or facilities that are already in operation, including 'horizon scanning' to identify planned pre-sort projects and what is expected to be possible in the short-medium-term. NLWA asked to consider 'the feasibility of the identified practices for and relevance to NLWA considering the different legislative landscapes, waste composition, scale of operations and space availability, and domestic markets (commercial viability) for extracted material.'

Although not common practice in the UK at this current time, there are some potential drivers for investing in the pre-sorting of residual waste, including any combination of the following:

- There is a desire to move towards a circular economy and reduce resource use though recycling;
- There is a desire to reduce the carbon impacts of residual waste;
- There is a desire to reduce the cost of residual waste treatment.

For the most part, these are underpinned by a set of underlying legislative and policy drivers and related market-based instruments and initiatives.

2.0 Scoping Considerations

After discussion with NLWA, a number of parameters were established to limit the research to that which aligns with the Authority's objectives, namely:

- Case studies can be drawn from anywhere in the world, including UK and Europe.
- The report addresses household residual (black bag) waste, excluding bulky, hazardous, or any other waste stream.
- Although previous reports commissioned by NLWA on this subject have looked into the possibility of utilising land adjacent to EcoPark, the research was not constrained to processes that could fit on the equivalent land footprint. The assumption is that NLWA would have to acquire the appropriate land to suit their overall objectives, and that the facility would need to be sufficient to process 390ktpa of residual waste.[1]
- Throughout the report we refer to the process involving the extraction of materials that can be processed without the need for thermal treatment, typically involving the capture of plastics, metals, inert material, and organics. This process is referred to in the report as '**mixed waste sorting**' (**MWS**).
- The materials relevant to NLWA's recycling and decarbonisation strategy are the dry recyclates (metals, plastics, glass and paper).

[1] We understand that a figure of 550ktpa has been quoted, but to ensure consistency in the modelling we have taken the figure provided in the compositional data ('NLWA waste comp data for Eunomia'), which amounts to 390ktpa.

- Although referred to as 'pre-treatment' or 'pre-sorting', the research did not assume that recycling infrastructure has to be co-located or dedicated to any particular disposal point or type of disposal (thermal treatment, landfill, aggregates).

3.0 Methodology

Phase 1: Assessment of International Evidence

Phase 1 of the assessment involved finding evidence of sorting residual waste globally, with the aim of identifying relevant cases which are operating successfully or planned to be in operation and have stated performance objectives. This involved three research methods:

- **Task 1: Literature review** – conduct a focussed literature review of the Eunomia knowledge base, secondary literature, and internet keyword search. NLWA kindly provided primary data to complement the evidence base.

- **Task 2: Targeted interviews** – conduct a number of calls with owners and operators of MWS facilities, including UMEA, Stockholm Exergi and ROAF. Their outputs are incorporated in the evidence gathering and modelling sections of the report.

- **Task 3: Analysis of Phase 1 outputs and the development of case studies** – process the data using a thematic analysis and develop the case studies with key indicators, including cost, emissions, and recycling performance. Create a Research Matrix tabulating the research results using indicators to identify datapoints relevant to NLWA.

Phase 2: Relevance and Technical, Environmental and Financial Impacts to NLWA

- **Task 4: Technical and Environmental impacts** – a written assessment of the likely applicability of the technologies identified, considering the forecast impact on waste composition and carbon emissions.

- **Task 5: Financial impacts** – following the assessment of the likely impacts associated with MWS, appraise the key financial impacts. Data for this assessment was derived from NLWA data, the literature review and interviews conducted in Phase 1. Appraise the financial costs and benefits in monetary terms. Develop a high-level financial model that quantifies the possible costs and benefits.

Phase 3: Overall Assessment

- **Task 6: Reporting** – present findings in a written report. Develop conclusions from the analysis, including the feasibility of adopting technologies to pre-sort North London's kerbside household residual waste to improve recycling performance, reduce fossil-carbon emissions and balance financial costs and benefits to the seven boroughs.

4.0 International Case Studies

Although the research was not restricted geographically, it was quickly evident that case studies would be concentrated in certain territories. The use of solid waste management to achieve environmental benefits is at different stages of development throughout the world. The recycling of municipal waste is limited or non-existent in many countries, which wholly rely on dumpsites or landfill. Another group of countries have informal collection systems, bring sites or private collectors, resulting in very low recycling rates.

This leaves countries where recycling collection and processing has been industrialised and driven by public policy to enforce specific targets and standards, resulting in a relatively high capture rate. We have found in previous global research that Europe and East Asia have the heaviest concentration of advanced waste management facilities. In this project we have found the most useful sources which are the best comparators to be European facilities. The predominant method in Europe is the separate presentation of recyclates on the kerbside by residents and businesses, with residual waste mostly sent to landfill or thermal treatment. Some facilities are coming online that sort the residual waste, generating recyclates and a waste derived fuel to be sent for thermal treatment. This model most closely resembles the UK environment and is likely to have similar waste compositional characteristics.

The result is the selection of European case studies. The following case studies were selected as models where certain indicators could be applied to NLWA in the scenario where they build an equivalent facility.

4.1 Case Study 1: IVAR Forus Plant, Norway

Owner / Operator: IVAR

Technology: TOMRA

The IVAR Forus waste sorting plant (WSP) is located in the region of Stavanger, Norway. It is co-located alongside a plastic recycling facility, paper sorting plant and Waste to Energy (WtE) facility which receive feedstock from the WSP. In July 2022, the plant was closed due to a widespread fire that affected 25% of the facility and is currently being rebuilt. Whilst operational, the facility served 12 municipalities and had the capacity to receive 66,000 tonnes of residual household waste per year, although it only processed around 50,000 tonnes per year. The plant is run by IVAR, a municipal facilities operator, and the sorting technology is provided by TOMRA.

Plastics, metals (ferrous and non-ferrous) and paper are sorted from the residual waste stream before the plastic fraction is sent to the IVAR plastics recycling plant. Using near infrared technology, the facility is able to automatically sort five types of plastics (LDPE, HDPE, PP, PET and PS) as well as two mixed plastic fractions (rigid and flexible). LDPE, HDPE and PP fractions are processed into pellets on site, before being sold on for further applications in the manufacturing industry, whilst PET and PS are baled and sold for further treatment at facilities in Central and Eastern Europe.

The paper sorting facility receives mixed paper from households and separates this into four fractions (corrugated cardboard, cardboard/mixed paper, beverage cartons e.g. Tetra Pak and de-ink paper). Paper extracted from the residual waste stream at the WSP (2ktpa) is mixed with the higher quality source sorted paper (14ktpa) and turned into saleable de-ink, ECC, Tetra Pak and carton products. Metals sorted at the WSP are also sold to recycling firms.

Recycled materials account for 16.8wt% of the incoming waste at the WSP, whilst the remaining 83.2wt% is transported to the WtE plant by conveyor belt. The composition of materials extracted from the residual waste stream is provided in Table 4-1.

Table 4-1: IVAR Forus Plant Performance Summary

Indicator	Description	
Waste composition (input)	No data.	
Waste composition (output)	Residual fraction (<60mm)	34%
	Residual fraction (>60mm)	35.1%
	Mix plastic-film	8.9%
	Mixed plastic - rigid	5.3%
	LDPE	6.3%
	PP	1.4%
	HDPE	1%
	PET	0.4%
	PS	0.2%
	Paper, cardboard, carton	3.6%
	Ferrous metals	2.9%
	Non-ferrous metals	1%
Technical considerations, including space requirements	11,000 square meters.	
End markets for recyclates	There is a low economic incentive from the sale of sorted materials and so the largest renumeration comes from the Norwegian producer responsibility schemes for sorting plastic, metal packaging and beverage cartons.	
Impact on carbon emissions	Emission reduction of 33,000 tonnes of CO_2e per year from WtE.	
Recycling rate	16.8% recycling rate.	
Second Order Impacts, including impacts on household waste recycling rates	No data.	
Financial costs	CAPEX = NOK 700 million (£50 million). The gate fee is €40 (£33) higher than for WtE.	

4.2 Case Study 2: Omrin Mixed Waste Sorting Facility, Netherlands

Owner / Operator: Omrin

Technology: TOMRA

The Omrin Mixed Waste Sorting (MWS) facility serves 25 municipalities in the Netherlands, 17 of which are in Friesland, with the others across Groningen, Gelderland and Zuid-Holland. These are a mixture of urban and rural areas, including Schiermonnikoog, the least densely populated municipality in the Netherlands. Separate collection of plastics and metal in the Netherlands is low, with only 2% of target plastics and 6% of cans being source separated in the Friesland region. Mixed waste sorting therefore has a significant role to play in plastic and metal recycling efforts across the country. Paper, organics and glass are sorted through separate collection and so are not targeted through mixed waste sorting. 86% of glass is captured through DRS and kerbside collection, meaning that only 10% is captured through mixed waste sorting. Conversely, only 8% of target plastics are captured through DRS and separate collection and mixed waste sorting is more heavily relied upon for plastic recycling (MWS captures 48% of target plastic).

The Omrin MWS facility receives residual waste and extracts papers, metals, biowastes and plastics for recycling. The sorting facility is co-located with a reprocessing facility that is part owned by Omrin. Biowastes are sent to an anaerobic digestion (AD) facility, which produces gas to grid. All material not sorted for recycling is converted to Refuse Derived Fuel (RDF) and sent to EfW. In 2022, Omrin MWS facility processed 280,000 tonnes of household residual waste.

Table 4-2: Omrin MWS Facility Performance Summary

Indicator	Description	
Waste composition (input)	Target plastics	7%
	Non-target, recyclable plastics	2%
	Non-recyclable plastics	3%
	Cans	2%
	Other metals	2%
	Packaging glass	2%
	Liquid cartons	5%
	Papers	9%
	Organics	28%
	Wood	0%
	Reusable/Recyclable textiles	4%
	Inert	1%
	WEEE	1%
	Nappies	5%
	Other	30%
Waste composition (output)	No data.	
Technical considerations, including space requirements	No data.	
End markets for recyclates	In September 2022, the sale of beverage cartons for recycling was temporarily suspended due to high energy prices. Beverage cartons were therefore temporarily treated through EfW.	
Impact on carbon emissions	Contributes 21.8% to GHG performance in the region.[2]	
Recycling performance	No data.	
Second Order Impacts, including impacts on household waste recycling rates	Contributes 5.2% to recycling rates in the region.[3]	
Financial costs	No data.	

[2] Based on the net benefit of recycling a tonne of material over producing a tonne of material at the primary production stage.
[3] Based on the total MSW entering a recycling operation / all MSW generated in the region.

4.3 Case Study 3: Brista Sorting Facility, Sweden

Owner / Operator: Stockholm Exergi and Sörab

The Brista Sorting Facility is co-located with EfW facilities serving the Stockholm region. This is the first facility of its kind in Sweden and aims to sort plastic and metal that would otherwise be incinerated from the residual waste stream. The facility cost SEK 350 million (£25 million) to build, with 25% of this investment coming from the Swedish EPA's Climate Leap grant. The facility has the capacity to process 140,000 tonnes of material per year, and in 2023 utilised over 70% of its capacity (100,000 tonnes). The plant uses NIR scanning technology to sort plastics from other waste, whilst metals are removed using magnets and eddy current separators. Some municipalities served by the facility sort food waste into green plastic bags which can be sorted from the residual waste using NIR at the plant.

The plastic that is removed from the residual stream is sent to the Swedish Plastic Recycling plant in Motala, the world's largest plastic recycling facility, where it is further sorted into different fractions and recycled into raw material. Sorted metal is also sent for recycling, whilst the organic fraction is sent to an AD facility to be converted into biogas and biofertiliser.

Table 4-3: Brista Sorting Facility Performance Summary

Indicator	Description	
Waste composition (input)	Plastic	18%
Waste composition (output)	No data.	
Technical considerations, including space requirements	No data.	
End markets for recyclates	Sörab does not receive payment for the sorted plastic it sends for recycling, despite efforts to decrease contamination of the plastic and improve the quality of the material.	
Impact on carbon emissions	Plastic gives rise to 60% of emissions from incineration in the Stockholm region. The sorting facility reduces incineration emissions by ~75% (from 400kg CO_2e to 100-150kg CO_2e per tonne of waste incinerated).	
Recycling performance	30% of plastic from the incoming residual stream is removed.	
Second Order Impacts, including impacts on household waste recycling rates	No data.	
Financial costs	CAPEX = SEK 350 million (£25 million) OPEX = SEK 200 (£14) per tonne of waste	

4.4 Case Study 4: Rozenburg WtE Plant, Netherlands

Owner / Operator: AVR

Technology: Banzo

In 2018 the construction of a post-separation plant at the Rozenburg WtE facility was completed. The plant receives household waste from the cities of Rotterdam, The Hague and Utrecht. As has already been discussed in Case Study 2, separate collection of plastics and metal in the Netherlands is low and MWS therefore has a significant role to play in plastic and metal recycling efforts across the country. In 2022 upgrades were made to the optical sensors, however operations were paused in September 2023 due to a fire at the facility. In October 2024 the plant was reopened and is now running at 50% of its technical capacity. The total capacity of the facility is 430,000 tonnes of waste per year.

The MWS technology is designed to remove metals, foils, films, hard plastics and drinks cartons from the incoming residual waste. Each fraction is compressed into bails and sent to recycling companies across Europe for reprocessing. The remaining residual waste is sent by conveyor belt to the Rozenburg WtE facility for conversion into energy.

Table 4-4: Rozenburg WtE Plant Performance Summary

Indicator	Description
Waste composition (input)	Plastic & drink cartons 10%
Waste composition (output)	No data.
Technical considerations, including space requirements	No data.
End markets for recyclates	In 2022 the facility started diverting Tetra Pak into their WtE line as the only buyer of separated Tetra Pak stopped recycling them due to high energy prices and low demand for the recycled material. In 2023, the separation of Tetra Pak was resumed following establishment of a contract with a new partner.
Impact on carbon emissions	24,000 tonnes of CO_2e savings in first year of operation.
Recycling performance	19,200 tonnes of plastics and beverage cartons were separated from the residual waste for recycling in its first year of operations.
Second Order Impacts, including impacts on household waste recycling rates	No data.
Financial costs	No data.

4.5 Case Study 5: Gdańsk Sorting Plant, Poland

Owner / Operator: City of Gdańsk

Technology: TOMRA

In 2022, the Gdańsk Sorting Plant was modernised to automate the separation of materials from the residual waste stream as this was previously done by hand. The upgraded technology allows for the separation of 14 material streams (transparent PET, blue PET, green PET, coloured PET, PET trays, beverage cartons (Tetra Pak), transparent film, coloured film, PEHD, PP, PS, paper, non-ferrous metals and ferrous metals).

The facility has the capacity to sort 160,000 tonnes of residual waste per year, and currently sorts 15,000 tonnes of plastics/metals, 7,200 tonnes of paper and 7,000 tonnes of glass from the residual stream. Through modernisation, the facility has made financial savings on RDF management (£1.6 million per year) and through avoiding penalties for failing to meet recycling targets (£1.1 million per year). Since 2022, local governments in Poland have been obliged to recover 25% of waste for reprocessing, with this target rising to 55% in 2025.

Table 4-5: Gdańsk Sorting Plant Performance Summary

Indicator	Description	
Waste composition (input)	Residual	55.3%
	Organics	19.4%
	Plastic/metal	7.3%
	Paper	5.9%
	Glass	5.9%
	Bulky waste	4.1%
Waste composition (output)	No data.	
Technical considerations, including space requirements	10,000 square meters	
End markets for recyclates	No data.	
Impact on carbon emissions	No data.	
Recycling performance	4.7% recycling rate of plastics and metals.	
Second Order Impacts, including impacts on household waste recycling rates	No data.	
Financial costs	CAPEX = PLN 68.8 million (£13.5 million) [cost of modernising the plant]	

4.6 Case Study 6: Umeå Eco Industrial Park, Sweden

Region: Europe

Organisation: Umeå Energi

Plans are underway for the construction of a MWS facility at the Umeå Eco Industrial Park in Sweden. Currently, construction is expected to be completed by the end of 2027, with an initial investment of SEK 650 million (£48 million). 25% of the investment is being funded by the Swedish EPA's Climate Leap grant. Once completed, the facility will be able to process 250,000 tonnes of waste per year, with a permitted capacity of 400,000 tonnes, roughly 50% of which will come from households.

The sorting facility will be co-located with Umeå Energi's two combined heat and power plants which generate energy from waste and biofuels. The use of sorting technologies will reduce the amount of fossil materials entering these facilities, thus reducing the carbon emissions from combustion by around 30,000 tonnes per year. Projections show that the sorting facility will extract 21,000 tonnes of plastic from the residual stream per year. As a result, Umeå Energi expects to save SEK 35 million (£2.5 million) per year in costs from the reduction in emissions once the ETS comes into place in 2028.

Table 4-6: Umeå Eco Industrial Park Performance Summary

Indicator	Description	
Waste composition (input from households)	Plastic	21.6%
	Paper packaging	9%
	Other paper	15.6%
	Metal	1.3%
	Textiles	3.4%
	Wood	4.1%
	Glass	1.5%
	Organic	20.3%
	Hazardous	0.1%
	WEEE	0.4%
	Residual	34.6%
Waste composition (output)	No data.	
Technical considerations, including space requirements	20,000 square meters.	
End markets for recyclates	No data.	
Impact on carbon emissions	30,000 tonnes per year reduction in CO_2e from combined heat and power plant emissions.	
Recycling performance	40% of sorted material will be recycled.	
Second Order Impacts, including impacts on household waste recycling rates	No data.	
Financial costs	CAPEX = SEK 650 million (£48 million).	

4.7 Other Notable National and International Developments

As already stated, the case studies explored above have been selected due to equivalence in technical requirements, data availability and policy alignment, however several other examples of mixed waste sorting have been identified through this research and are worth mentioning here.

The European landscape has seen increasing investment in MWS facilities, particularly in the last five years and in several hotspots where carbon taxes have encouraged operators to increasingly divert fossil material for recycling. Notable developments include:

- **Lippe, Germany:** A first-of-its-kind facility has begun operations in Lippe. Trials began in 2023 following an eight-figure investment in the site. Plans are for it to process 70,000 tonnes of household waste per year, removing recyclable raw materials from the residual waste stream to be sent for recycling. However, sorting of mixed waste streams is not currently seen as a general trend in Germany on the basis of high costs for operators and recyclers, combined with low incineration gate fees. Furthermore, capture rates from DRS and kerbside collection here are some of the highest in Europe, meaning the quality of materials extracted from the residual waste stream is low. To this end, processors cannot be guaranteed a set price for the material, and investment in mixed waste sorting presents a risk.
- **Charleroi, Belgium:** VALTRIS sorting centre was modernised in 2021 to increase the range of sorted fractions to 16 different material streams. The robotic sorting solution, Recycleye, was employed to target any recyclable materials, with a priority given to clear PET. The facility is able to process 1,600 items per hour with a purity rate of 92%. Data availability relating to this case study is limited and so it has been discounted from further discussion.
- **Scotland, United Kingdom:** Efforts in MWS, particularly through mechanical and biological treatment (MBT) of residual waste, have faced challenges with producing poor-quality plastics. Many facilities have opted not to separate plastics due to poor market conditions. A major waste operator ran trials of mixed waste sorting at two facilities in Scotland and whilst these indicated an ability to remove 16% of waste from the residual stream, the separated material was highly contaminated and therefore recycling the material was not feasible.

In Scotland, the business case for MWS is challenging due to the primary driver being the avoidance of disposal costs. However, Extended Producer Responsibility (EPR) schemes may change this by introducing performance-linked payments that encourage higher recycling of packaging. In Stavanger, EPR payments for packaging extracted from MWS support the business case. The applicability of this model in the UK will depend on the design of the new EPR scheme and whether MWS is considered a necessary cost for meeting packaging waste targets.

Mixed waste sorting technologies have also been employed outside of Europe, to divert more material away from landfill and to increase recycling. Examples of this include:

- **Cleveland, USA:** The AMP One facility in Cleveland, Ohio is a highly flexible facility able to sort a variety of feedstocks including mixed retail bales, MRF film bales as well as plastic reclaimer and MRF residues. The facility has an annual capacity of 50,000 tonnes and recovers >95% of the material it receives. The technology employed is highly innovative and can adapt its configuration to process multiple infeed types in the course of a production day. In 2023, AMP One avoided nearly 13,000 tonnes of GHG emissions, by diverting materials from landfill to recycling supply chains. Although this facility provides an example of a highly innovative system, this has not been included as a primary case study due to differences in feedstock types and end-of-life treatment of the waste.

- **Mexico City, Mexico:** The Transfer Station and Sorting Plant Azcapotzalco in Mexico City was designed to segregate recyclable materials from the municipal waste stream. The facility receives 1,000 tonnes of material per day, 24% of which is disposed in landfill, 30% is processed into RDF and 6% is recycled, whilst the remaining 40% is comprised of organic residues which is treated through composting.

5.0 Relevance and Impacts to NLWA

Using the evidence identified in Section 4.0, we have sought to outline the key technical, policy and financial considerations associated with a possible investment in MWS technology by NLWA.

5.1 Technical and Policy Considerations

There are a range of technical and policy considerations associated with investment in MWS. These include the following and are covered in more detail below.

- Changes in policy;
- Scale of operations and associated logistics;
- Capture of material for recycling;
- Availability of end markets;
- Direct emissions reduced; and
- Second order impacts.

5.1.1 Changes in English Policy Impacts

English waste and resource policy is increasingly focused on reducing waste and promoting a circular economy. This evolving landscape has significant implications for both the composition and quantity of residual waste generated, irrespective of any specific mixed waste sorting practices implemented at the local level. The key changes in policy are outlined in Table 5.1.

Table 5-1: Overview of Key Changes in Policy

Key Policy Change	Description of Impact	Implications for NLWA
Expanding the UK ETS to include the EfW sector in 2028	Expanding the UK ETS could provide an economic incentive for EfW operators and local authorities to **reduce the quantity** of fossil based residual waste by encouraging the uptake in recycling (e.g. MWS) or diverting the residual waste elsewhere. The reduction in fossil based residual waste may also alter the average **calorific value,** typically lowering it. The scale of the impact will likely be dependent on the cost of UK ETS allowances. The UK ETS is a trading scheme where the price of UK ETS allowances varies on a fortnightly basis and therefore the strength of this impact will vary over time.	Whilst the UK ETS has the potential to drive the investment in MWS facilities, the strength of its impact will be dependent on the price of UK ETS allowances, the availability of free allowances / pace at which free allowances are removed from the market and (for third party waste) the ability to pass through the costs to the waste producers. Local authorities have limited levers at their disposal to change the volume and fossil-carbon content of waste.
Introduction of Simpler Recycling	Simpler Recycling aims to create a more consistent and streamlined recycling system across all local authorities. This involves a core set of recyclable materials being collected from all households, including paper and card, plastic, glass, metal, and food waste. By implementing consistent collections and clearer labelling, the initiative intends to reduce confusion for householders, leading to increased recycling rates and a reduction in residual waste.	The successful introduction of Simpler Recycling is likely to help reduce the quantity of residual waste and change its composition. The configuration of an MWS would depend on which materials are successfully captured for recycling.
Introduction of a Deposit	The Deposit Return Scheme (DRS) in England aims to significantly boost recycling rates and	The DRS scheme is likely to help reduce the quantity of residual

Key Policy Change	Description of Impact	Implications for NLWA
Return Scheme – October 2027	reduce littering by incentivising the return of drinks containers. This initiative is expected to improve the quantity and quality of recycled drinks containers, thus reducing the quantity of residual waste.	waste. The configuration of an MWS would therefore depend on which materials are successfully captured for recycling. NLWA expects DRS to reduce residual waste by 1%, assuming an 85% capture rate. Valuable materials are diverted from residual waste which will somewhat diminish the economics of mixed waste sorting.

Alongside these changes there are also a set of other changes that have a more limited or more gradual impact on the quantity or composition of residual waste.

- In 2023 Defra opened a consultation on the development of policies to achieve the near **elimination of biodegradable waste disposal in landfills** from 2028. Local authorities will have to adapt to the proposed ban, which will see more black bag waste diverted to EfW. NLWA currently diverts nearly all waste from landfill, with only 0.6% of the residual stream going to landfill in 2022/23. Of the biodegradable fraction, only 0.5% was sent to landfill, which acts as a last resort when capacity is not available in its EfW supply chain. It is therefore unlikely that the NLWA will be directly impacted by this policy, as there is no difference between the composition of residual waste going to EfW and landfill.

- The UK's **Extender Producer Responsibility** scheme and its associated payment obligations became law in December 2024. This changes the way recycling is paid for, switching from a tradeable allowance system (PRNs) to a payment methodology for awarding local authority funds to develop their collection and recycling systems. At present the scheme focuses on responsibility rather than recycling performance, so that payment calculation does not reward increases in recycling, as it does in other European countries. However, the intention is to refine the method so that authorities are rewarded for recycling performance, which might contribute to the business case for investment in new sorting infrastructure in the future. In addition, costs to packaging producers will rise significantly, and the introduction of fee modulation will also incentivise recyclable packaging design much more so than currently. This can be expected to improve the recyclability of packaging in the residual waste stream, further contributing to the business case for investment in new sorting infrastructure in the future.

In summary of the above five policy initiatives which are likely to impact the business case for mixed waste sorting, three of them (ETS, EPR and Simpler Recycling) can be expected to improve the performance and economics of mixed waste sorting, while only one (DRS) will worsen the economics.

5.1.2 Scale of Operation and Logistics

A critical consideration of any investment in MWS is ensuring that the facility can be accommodated. NLWA has previously identified a 9m by 60m space available in the Edmonton Reuse and Recycling Facility for sorting activity. The footprint of this space (540 square meters) is significantly smaller than the land take of the case studies identified in this report (ranging from 10,000 to 20,000 square meters). Whilst the implications of this will be detailed in Section 5.1.2.1, it is important to note that the construction of a MWS facility to serve North London would require other options to be considered, such as renting space outside of the authority area.

5.1.2.1 Area of Land Required

It is difficult to give an exact figure for the land required for a MWS plant at EcoPark without detailed specifications of the plant's capacity and technology. The key factors impacting the plant size include:

- **Plant Capacity**: A plant processing larger volumes of waste will naturally require more space.
- **Technology Used**: Different sorting technologies (e.g., mechanical, manual, optical) have varying space needs.
- **Storage and Logistics**: Space is needed for incoming waste storage, sorted material storage, and vehicle manoeuvring.
- **Expansion**: Land may be allocated strategically for further expansion of the facility and developing further process steps.

Expert Testimony Evidence

One confidential interview with an operator contact provided useful insights into land take for a mixed waste sort facility in an urban setting adjacent to an EfW facility. The possibility of minimising land take by assuming simplified pre-sort (one grade of plastics) and using other plastics recovery facilities (PRF) providing final processing of the outputs was discussed. Whilst this might achieve land savings it was felt that they would not be that significant. Most existing examples at a throughput rate of 45 tonnes per hour were said to be around **6,000m²** building footprint plus land for roads etc. In these cases, the outside land was deemed not to do much more than provide roadways, depending on design specifics. It is possible to reduce land take for the building further, by layering a number of the processes on top of each other. The further this is applied the more expensive the build would be but if we assume that all moving plant processes remain at ground level and make only use of processing plant being elevated then it was thought reasonable to assume **4,000m²** to **5,000m²** per plant plus outside land, estimated to be another 15%.

This 45 tonnes per hour throughput scenario is equivalent to the annual processing of NLWA's waste if operating on a 24/7 basis. This gives us a **~6,900m²** footprint for a single level building, including 15% for the outside land, but only on the basis for the need for roadways. If we fully account for storage, ancillary infrastructure, loading and unloading, and the turning radius of vehicles, this could be a much larger footprint. We understand from NLWA that an additional 80% was required for the EcoPark Recycling and Fuel Preparation Facility (RFPF). If this was applied to the MWS facility, the land requirement would rise to **~10,800m²** / 37 **tpa per m**². Furthermore, the land take would increase further when taking into account the need for a maximum throughput higher than 45 tonnes per hour, due to the variable rate of waste reception on site, and for downtime.

Case Studies Evidence

The highest land take per tonne was the IVAR facility in Norway, which has an operational capacity of **66,000 tonnes** and is set on an **11,000m²** site, whilst at the other end the Gdansk facility processes **160,000 tonnes** per year on a **10,000m² site**. In the middle of this range is the planned Umea MWS facility, which is expected to be permitted to process **400,000 tonnes** per year and is to be set on a **20,000m²** plot. The data includes the surrounding area used for logistics and material handling.

This range reflects the increasing space efficiency for larger plants as smaller plants need a minimum space when using standard equipment. If the smaller, less space-efficient site at Gdansk is discounted as an outlier, land requirement is between **16tpa per m**² and **20tpa per m**². When applying these factors to NLWA (394ktpa), this would result in a land footprint of between ~**20,000m²** and ~**25,000m²**. This could be lowered if there is multi-level processing on site, although this would incur higher CAPEX costs. Given that the expert testimony example relates to a simpler plant, and the case studies are closer in size to other plants such as the Biffa MRF at EcoPark (250ktpa, 24,000m²) the latter range is more realistic.

5.1.2.2 Logistics

Working from the assumption that land at Ecopark, including the 540m^2 space lying spare at Ecopark is not sufficient to accommodate a sufficiently sized MWS facility, the Authority may need to consider a new plot where a pre-sorting plant can be built, or identify a 3rd party who has a site available. With land at such a premium in the London area this probably requires a new site outside of Edmonton, possibly at a significant distance.

Double handling of residual waste refers to the process of loading, unloading, and reloading waste materials more than once during their journey from collection to final disposal or processing. We understand that currently the Boroughs are sending the household collected waste directly to Edmonton EfW, the Ecopark RFPF site adjacent to Edmonton EfW, and to two other dedicated waste transfer stations. A summary is provided in Table 5-2. The tonnages indicate a roughly 50/50 split between Ecopark/EFW and the dedicated transfer stations at Hornsey Street and Wembley.

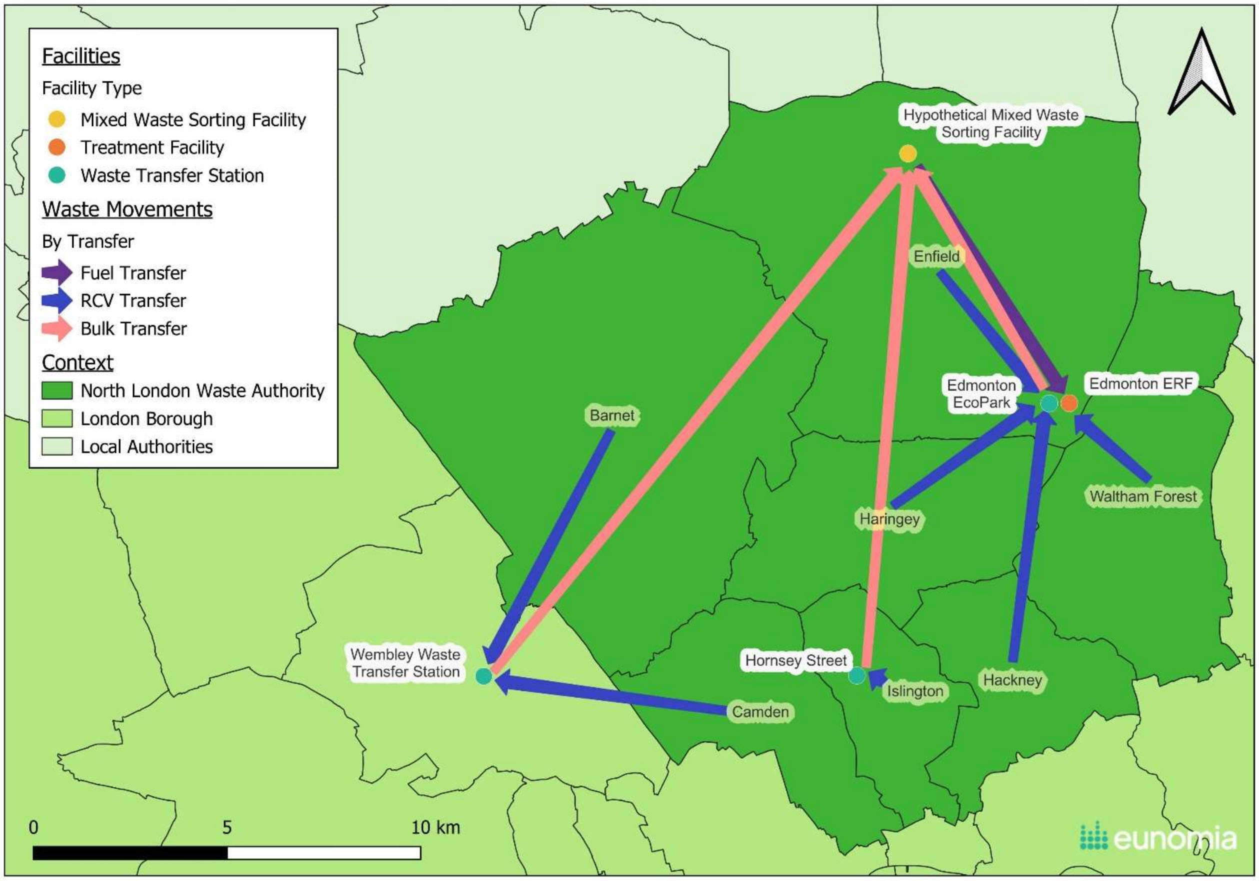
A new residual sorting plant, placed on a separate site, could result in more double handling, or triple handling of the waste (if waste is unloaded at a transfer station before onward transport to the sorting plant, followed by transfer of the fuel output from the sorting plant to Edmonton). Clearly there are many variables within this scenario which would be considered to ensure the most cost-effective solution in terms of logistics. In any case, the costs of transition and implementation of these new arrangements would have to be taken into account in the business case.

Table 5-2: NLWA Transfer Stations Throughput (tonnes)

	First Destination after Kerbside Collection				
Borough	**Direct to Edmonton EfW**	**EcoPark RFPF**	**Hornsey Street WTS**	**Wembley WTS**	**Geron Way WTS**
Barnet	18.3k	456		76.8k (until 2028)	Planned 2028
Camden	174	1.8k	14.9k	44.7k (until 2028)	Planned 2028
Enfield	68k	2.4k			
Hackney	42.2k	20.4k	24.4k		
Haringey	45.5k	4.7k	4.5k		
Islington	26	5.7k	51k		
Waltham Forest	35.7k	18.3k			
Total	**210k**	**54k**	**95k**	**121k**	

Figure 5-1 provides a possible scenario for logistical changes needed if a new sorting plant is positioned in Enfield. This will clearly depend on multiple factors, but the image demonstrates how impactful the changes to transfer routes might be, if the site is required further out of central London due to land costs.

Figure 5-1: Scenario Waste Transfer Routes



5.1.3 Capture of Material for Recycling

A critical consideration is the likely capture rates of materials for recycling from the MWS. Each MWS facility is bespoke, with the selection of equipment configured and optimised to the residual waste composition. It should be noted that the composition of residual waste is not static – and will change over time. Of key importance to NWLA is the introduction of the DRS scheme in 2027. The scheme's success (or otherwise) has the potential to alter the residual waste composition, by taking beverage containers (be that metal or plastic) out of the residual waste stream.

5.1.3.1 Composition Benchmarking

In order to determine the potential diversion rates at a MWS facility in North London, a comparison should be made between the input compositions of the case studies identified. Compositions largely vary due to differing collection systems and the implementation of different policies at a national level.

Table 5-3 summarises the composition of NLWA's residual waste now and in the future when DRS is applied against some of the international examples identified in Section 4.0.

A MWS is likely to focus on extracting materials that are:

a) Easiest to capture;

b) Help avoid costs (e.g. UK ETS allowances).
c) Have the potential to represent an economic value through sale for recycling;

We understand that NLWA's target materials would be:

- Plastic film
- Dense plastics
- Glass
- Ferrous metals
- Non-ferrous metals

It is also possible to capture metals at the post-combustion stage from the output bottom ash. The optimum approach would be to extract metal at both pre- and post-treatment stages in order to maximise capture rates, and to benefit from the better economic and recycling performance that is possible by pre-sorting, versus metal extraction from the IBA.

The input composition at the Omrin Facility is closest in comparison to that of North London. The target materials are also likely to be similar due to requirements regarding emission reductions, namely the incoming ETS regulations. Whilst the organic fraction is a lower proportion of the residual stream at the Omrin facility, and therefore the quality of extracted materials is likely to be higher due to lower rates of contamination, the introduction of Simpler Recycling in the UK could bring down to a certain extent the proportion of organics in the North London residual stream. However, difficulties arise in directly comparing this case study to the North London case, particularly when considering availability of end markets for recyclates, as the Dutch facility is co-located with a reprocessing facility that is partly owned by Omrin municipality.

In Gdansk, plastic, metal and glass are separated at source and high recycling targets have incentivised waste management companies to divert more material into recycling in order to avoid penalty fees. However, the organic fraction is considerably lower than for North London, meaning contamination levels are likely to be lower. This makes it difficult to draw comparisons around possible end markets for target materials. The remaining examples in Sweden and the Netherlands (Umea, Brista, Rozenburg) are even less comparable, most likely due to differences in separate collection systems with these countries. Currently, it is difficult to draw any robust conclusions around comparability with other case studies due to the rapidly changing policy and waste management landscapes that impact the input composition, and therefore the benefits received, at these facilities.

Likely NLWA target materials have been outlined in blue in Table 5-3 (dashed outlining for glass is related to the typically poor economics for glass recovery from mixed waste sorting which can impact the business case for this [unless EPR demands high levels of recycling which then provides a target linked income stream]), whilst materials commonly separated at the kerbside in the corresponding municipalities are highlighted in green.

Table 5-3: Composition of Residual Waste Streams

<table>
<tr><th>Material</th><th>NLWA</th><th>NLWA (with 80% DRS capture)</th><th>Omrin, Netherlands</th><th>Brista, Sweden</th><th colspan="2">Rozenburg, Netherlands</th><th>Gdansk, Poland</th><th>Umea, Sweden</th></tr>
<tr><td>Paper</td><td>10.32%</td><td>10.49%</td><td>9%</td><td></td><td colspan="2"></td><td>5.9%</td><td>9%</td></tr>
<tr><td>Card & cardboard</td><td>5.77%</td><td>5.86%</td><td>5%</td><td></td><td rowspan="3">10%</td><td></td><td></td><td></td></tr>
<tr><td>Plastic film</td><td>6.52%</td><td>6.63%</td><td>5%</td><td rowspan="2">18%</td><td rowspan="2"></td><td rowspan="2">7.3%</td><td rowspan="2">21.6%</td></tr>
<tr><td>Dense plastics</td><td>7.60%</td><td>6.62%</td><td>7%</td></tr>
</table>

Ferrous metals	2.20%	2.18%	2%				1.3%
Non-ferrous metals	1.44%	0.97%	2%				
Textiles	6.31%	6.41%	4%				3.4%
Sanitary	10.15%	10.32%	5%				
Miscellaneous combustibles	4.90%	4.98%				55.3%	34.6%
Non-combustible inerts	4.71%	4.79%	1%				
Glass	4.11%	4.18%	2%			5.9%	1.5%
Organics	34.56%	35.14%	28%			19.4%	20.3%
HHW	0.26%	0.27%					0.1%
WEEE	0.48%	0.48%	1%				0.4%
Fines	0.66%	0.67%					
Other / undetermined				82%	90%	4.1%	7.8%

5.1.3.2 Capture Benchmarking

There is significant uncertainty associated with the performance of the MWS facilities identified as there is a lack of independent evidence that can verify the performance of the facilities. Table 5-4 summarises the reported capture rates of the selected case studies, with plastics the only datapoint available for comparison. The performance figures are highly variable – Poland's stringent recycling laws may explain the high capture rate at Gdansk.

Table 5-4: Capture Rates of Selected Case Studies

Case Study	Capture Rate % of plastic separated	Capture Rate % total recyclates separated from residual waste	Total Target Materials
IVAR Waste Sorting Plant	82%	16.8%	Plastic; paper; metals; cartons
ROAF, Skedsmokorset, Norway		33% of input *[23% if biowaste excluded]*	Plastics, paper metals, cartons
Omrin MWS Facility	48% of target plastic capture		Plastic; metal; organics; paper
Brista Sorting Facility	30%		Plastic; metal
Rozenburg WtE Plant	*[12x increase in plastic recycling]*	51% *[90% purity]*	Plastic; cartons
Gdańsk Sorting Plant		85%	Plastic; metal; paper/cardboard; organics

Umeå Eco Industrial Park	40% *[estimated]*	Plastic; metal; wood; glass

Table 5-5 summarises the forecast capture rates for each of these material streams, based on existing technologies if implemented today. These are estimated based on the case studies and the capture rates we are aware of from confidential sources.

Table 5-5: Forecast Capture Rate for Target Materials (tonnes)

Target Material	Target Material (Post DRS)	MWS Capture (tonnes)	MWS Capture Rate	Recycling Rate of Captured Material	Weight Recycled
Plastic film	25,382	12,691	50%	67%	8,503
Dense plastics	25,339	12,670	50%	83%	10,516
Glass *(if captured)*	16,014	9,609	60%	80%	7,687
Ferrous metals	8,333	5,000	60%	88%	4,400
Non-ferrous metals	3,721	2,233	60%	86%	1,920
Total target material	**78,791 (inc. glass) 62,776 (exc. glass)**	**42,202 (inc. glass) 32,594 (exc. glass)**	**54% (inc. glass) 52% (exc. glass)**	**78%**	**33,026 (inc. glass) 25,339 (exc. glass)**
Residual Waste	**Residual Waste (Post DRS)**			**Recycling Rate of Residual Waste**	
Total input	**382,938**	*(As above)*	*(As above)*	**9% (inc. glass) 7% (exc. glass)**	*(As above)*

While the current work focusses on the case study information and existing data, given the forward-looking recommendations provided in Section 6.0, we have also considered in the next paragraph alternate capture assumptions for what MWS might achieve in future years.

Using top end optimistic data from Eunomia's report to Scottish Government suggests captures from MWS in the mid 2030's could be as high as 21%, or recycling of 20% after accounting for material losses.[4] However, this report is clear that these 'best-case scenario' figures are reliant on significant improvement in design for recyclability, consequential improvements in sorting and recycling yield efficiencies, and plastic recyclates market improvements to justify the level of pre-sorting efforts implied here (which also implies high-end capex and opex to achieve these levels of capture). Data from the Equanimator 2024 report for Zero Waste Europe which gives a more tempered view of markets for materials suggests a slightly moderated 20% capture, and 15% recycling.[5] This Equanimator report performance is thus of a similar magnitude to the 17% rate of recycling indicated for the IVAR facility in Norway (Section 4.1). While further work is recommended to look into this in more detail, overall, it may not be unreasonable to consider an NLWA MWS facility in the mid-2030s could be recycling around **15%** of inputs if economic conditions are favourable to recycling.

[4] Eunomia (Dec 2022) '*Scottish Government Incineration Review: Opportunities to Decarbonise the Waste Treatment Infrastructure*', Available at link
[5] Hogg (2024) '*Materials or gases? How to capture carbon*', Equanimator Ltd report for Zero Waste Europe. Available at link

5.1.4 Availability of End Markets

Consideration will be given to the end markets available for the various grades and polymers of the sorted material and the commercial viability of materials that could be extracted, bearing in mind NLWA's commitment to process materials in the UK. The end markets for the recyclable materials from MWS have some specific issues and also many similar issues as for separately collected (e.g. kerbside, commingled) materials. These are discussed in the following subsections. There are a wider variety of sorting plants, where sorting mixed waste, or sorting separately collected waste, in both cases some are well designed, use appropriate technology and are run well and can produce appropriate grades of material. Some are not. The following narrative assumes a MWS plant that is well designed, deploys modern sorting technologies and techniques and that it is well run.

5.1.4.1 Glass

From the case study information, only Umeå in Sweden considers targeting glass (and this is not yet built). We are aware that the typically poor economics for glass recovery from mixed waste sorting generally prohibits the business case for doing this. We expect this might only become viable in future if EPR demands high levels of recycling which then provides a target linked income stream.

5.1.4.2 Paper and Card Grades

Whilst there is relatively high demand for old corrugated containers (OCC) from UK mills, there is less demand for mixed papers. Overall, the UK is a substantial exporter of paper grades, which means UK mills will choose feedstocks on their assessment of quality and the price they will pay for those qualities. Paper grades from MWS are typically of lower quality than those produced from separate collections, due to the presence of contaminants such as plastics, metals, and organic matter (MWS papers typically have a higher moisture content and higher levels of biowastes such as food residues, oils, greases etc). They therefore can be stored for shorter periods than separately collected papers and it is unlikely that UK paper reprocessors would have appetite for this material. Therefore, it is unlikely that this material would be a target material for a MWS facility.

The case study information above reveals capture of cartons occurring in the IVAR, Omrin, Rozenburg and possibly also Gdańsk facilities. This suggests that even where there may not be a market for recovery of papers or card from mixed waste sorting, there may be a market for recovery of cartons (as incentivised by packaging EPR).

5.1.4.3 Metal Grades

MWS plants can produce similar qualities of metal packaging grades to those collected separately. The UK markets for steel packaging and aluminium packaging are well developed and MWS materials would likely be in demand by UK recyclers.

5.1.4.4 Plastic Grades

There are multiple markets within plastic grades that need to be considered separately. As a large generalisation the majority of the potential market issues are the same whether the plastic grades result from separate collection or MWS. A further generalisation from a quality perspective that is reasonable to make is that from a polymer/resin quality perspective there is little difference between separately collected plastics and MWS plastics. However, MWS plastics tend to have higher levels of moisture, dirt biowastes and so forth attached to them than separately collected plastics. In most cases, if a recycler has appropriate wash plant technologies and resin purification processes then MWS plastics can be processed with the similar quality outcomes as separately collected plastics, albeit with potentially higher wash plant and purification costs.

An overarching issue in considering UK markets for plastics is in many cases current business conditions are challenging for recyclers (that is also the case in continental Europe). Businesses in some cases might not survive, and investment decisions may well be delayed until such time as overarching policy issues are addressed to create the right environment for the UK recycling industry to invest in the necessary plants to provide a robust internal UK market. It is beyond the scope of this work to go into the complexities of the existing UK plastic recycling market, and we make a few high-level points with relevance to MWS.

5.1.4.5 Rigid Plastic Packaging Formats

Overall, the UK does not have the capacity to deal with all the rigid plastics currently collected. There are market differences depending on the overall polymers/formats/grades.

- **PET** – PET recycling in the UK is focused on PET bottles, the majority of which are beverage bottles. If the DRS implementation goes as planned, then the majority of PET beverage bottles will disappear from municipal waste. This is a similar situation in MWS plants in some European countries. In these cases, MWS facilities still tend to produce a PET grade but it tends to be proportionally higher in thermoforms (PTTs) and non-beverage bottles. Whilst the UK currently has PET bottle recyclers there is not enough capacity to recycle the existing amounts of PET bottles collected for recycling, and therefore the UK is a significant exporter of PET bottle grades. The UK currently has next to no capacity to recycle PET thermoform rich bales. Some specialist thermoform recyclers have developed processes in Europe to mechanically recycle thermoforms and several big capacity PET depolymerisation plants are currently being built which will have substantial capacities for this type of material. However, we are unaware of any plans for plant development in the UK. It is reasonable to conclude that PET grades from municipal separate collections or MWS would need to be exported to be recycled unless there are substantial investments in the UK.

- **HDPE/PP** – Rigid HDPE and PP plastics recycling capacities exist in the UK, and if current capacities remain then there are options for recycling MWS grades in the UK. As previously stated, it is probably reasonable to conclude that there would be higher levels of moisture, dirt etc. associated with MWS materials and therefore recyclers may pay less for these materials to counteract higher wash plant costs.

- **Other rigids** – There are not many options for recycling rigids of other polymers such as PS without exporting. If exported, then the same issues arise as for HDPE and PP on qualities and values.

5.1.4.6 Flexible Plastic Formats

Flexible plastics that are also MSW include a wide range of polymers, resin formats and multi-layer multi material (**MMML**) formats. As currently collected, flexible plastics require further sorting to extract materials that could be put into recycling markets from those where there are no real recycling options at scale. This at the moment means extracting mono LDPE for sale to recycling outlets. The remainder (predominately PP and MMML structures) are much more challenging to find markets for in the UK at present.

LDPE

Whilst the UK recycling industry has been recycling pre-consumer LDPE for decades there are only a few very small capacity examples of post-consumer LDPE being recycled in the UK. Currently the vast majority of post-consumer films are not separated or collected for recycling. In 2027 it becomes mandatory for local authorities to collect flexible plastics from households using separate collection. This will generate substantially more flexible plastics that will require sorting infrastructure and recycling markets which do not currently exist. Furthermore, there are virtually no real circular solutions in post-consumer flexible at present. The end markets for LDPE are reliant on bin bags and construction films of which there is not a great deal of potential to grow recyclate demand. Some options exist for turning PP films into PP recyclates for less technical moulding into rigid PP structures (not often packaging). There is also unlikely to be any real growth of recycling of films into low technical challenge products such as plastic wood substitutes and so forth. There is likely to be some growth in mechanical recycling capacities but there will almost certainly be a capacity shortfall for some time.

Polyolefins

There is considerable uncertainty on how that capacity gap may be addressed but export markets may be important, and it is also important to consider how the growth of Polyolefin 'chemical' recycling processes might have a role to play. Whilst the basic technology around chemical recycling of polyolefins has been around for decades there are not good examples of plants successfully operating at scale over significant time periods. There is however a large amount of interest in these processes and the petrochemical industry has been investing heavily (when compared to mechanical recycling investments) in these processes.

That does not mean we can rely on these capacities being built in the near future. Last year Shell announced rowing back on a pledge to deliver on chemical recycling targets.[6] They cited feedstock availability, technology development and regulatory uncertainty. Although Shell did not clarify further on the economic viability of these processes the following seems likely for the UK in the near future. Using plastic scrap to make alternative fuels at current crude oil prices is not likely to be economically viable. Similarly, replacing virgin oil in steam cracker processes will not make sense unless there are policies that mean recycled resins are worth significantly more than current virgin prices. This is only likely to be driven by well-designed legislation.

The most typical process is to rely on the pyrolysis treatment of polyolefin scrap to produce a pyrolysis oil. This oil can then be treated and further purified into alternative fuels or potentially can be sufficiently purified to be introduced to steam crackers to produce new chemicals to build new plastics, and so forth. There are a wide range of views from different entities including plant and technology providers on the qualities of inputs that will be acceptable and how much further sorting and cleaning is necessary before being "recycled". However nearly all processes require well sorted material that has a high proportion of polyolefins and relatively low levels of other materials particularly those materials that are problematic in further purification processes. It remains unclear whether the relatively marginal quality differences from MWS films to separately collected films would be at all materials in whether they suited chemical recycling processes.

In summary there is likely to be considerable uncertainty over UK markets for sorted post-consumer films. This is likely to be true from all methods of collection.

5.1.5 Direct Emissions Reduced

The combustion of waste releases greenhouse gases. By extracting recyclable materials before such treatment, MWS reduces the amount of waste converted to carbon dioxide, thus lowering these emissions. Of particular interest to NLWA is the potential to reduce the non-biogenic carbon emissions – thus reducing the potential liability under the UK ETS.

We forecast that the EfW would emit approximately 61,839 tonnes per annum of CO_2e **less** as a result of pre-sorting at the MWS facility. This reduction is due to the removal of plastics from the waste stream and would be of non-biogenic sources.

[6] https://www.pressreader.com/usa/the-guardian-usa/20240718/282136411645616

Table 5-6: Direct Emissions Reduced

Target MWS Material	kg CO_2e / tonne at EfW*	Tonnes Captured for Recycling by the MWS facility	Tonnes of CO_2e Reduced
Plastic film	2,457	12,691	31,178
Dense plastics	2,420	12,670	30,661
Glass	0	9,609	0
Ferrous metals	0	5,000	0
Non-ferrous metals	0	2,233	0
TOTAL		**42,203**	**61,839**

*Source: Eunomia (2020) *Greenhouse Gas and Air Quality Impacts of Incineration and Landfill,* Report to ClientEarth.

5.1.6 Second Order Impacts

Introducing a MWS has the potential to drive several second-order impacts. One key concern is the potential reduction in kerbside recycling participation. If residents perceive that their waste will be sorted regardless of their efforts, they may become less diligent about separating recyclables at home. This could lead to a decrease in the quantity and quality of materials collected through kerbside programmes, potentially impacting recycling targets and revenue from material sales.

5.2 Financial Considerations

In the following sections we have forecast the most likely costs and benefits associated with investment in a MWS facility.

5.2.1 Summary of Costs

5.2.1.1 CAPEX

Based on a review of the case studies, the capital requirements for each facility show a large degree of variation. The range is driven by several factors, including the technology chosen, degree of automation and sophistication incorporated into the system and the quality and durability of the specialised equipment selected. Equipment ranges from shredders, trommels, ballistic separators, magnets, infrared sensors, wind sifters and conveyor. The choice and configuration would be dependent on the target materials.

After excluding IVAR, which has an unexpectedly high cost and land take compared to its capacity, the range of CAPEX identified from the case studies was as follows.

- Min: £84.38/tonne
- Max: £192.00/tonne

- Average (mean): £130.81/tonne

If applied to a 390ktpa facility that would treat NLWA waste, the CAPEX associated with the facility would range from £33m to £75m.

There is however a lack of equivalence to European public policy and strategy, meaning that some of the CAPEX investments quoted in this report must be given context. For example, the Swedish environmental competent authority (Klimatklivet) is offering large 25% grants to developers, with the strategic priority of meeting recycling targets above a financial business case, a policy which is not foreseeable in the UK. Other European countries are also further developed in implementing carbon/ETS/EPR financial penalties such that these drivers are already baked into developers' business cases. These figures were calculated prior to the Covid-19 pandemic and the subsequent cost of living crisis. It is understood that costs in the construction industry have risen substantially and a project realised in the late-2020s is likely to exceed these estimates. Furthermore, these figures do not include the cost of land acquisition – in the context of NLWA, this is likely to be a substantial requirement for CAPEX.

By example, NLWA has recently completed the RFPF. This facility is understood to have costed approximately £150m, with £18m alone being required for the air handling system. This facility did not include mixed material sorting equipment, and a MWS designed to a similar specification would likely be between **£175m** and **£200m**, annualised at between **£14.6m and £16.7m** based on a 15-year financing period.

5.2.1.2 OPEX

The main operating expenditure is associated with running and maintaining the machinery. Due to limited data availability, a range of OPEX costs could not be identified from the case studies. The singular datapoint available was from the Brista Sorting Facility, which is heavily subsidised by the Swedish government and therefore may not provide a reliable picture of potential costs to North London.

If applied to a 390ktpa facility that would treat NLWA waste, the annual costs associated with the facility would be £5.5m, although this should be regarded as lower than what might expect in the UK. The adjusted figure and rationale are set out in Section 5.2.3.

There is also a high operational and transition cost associated with altering the logistics to cater for a new plant. Whilst this is not quantifiable, it is likely that these costs would be significant due to extra, longer and more complex journeys taking place. These figures do not include the costs associated with transporting waste to and from the MWS facility and therefore are likely to be an underestimate of the true operating costs.

The rising cost of land, labour and insurance prices in London compared to case study locations in addition to the haulage costs are likely to put NLWA above this estimate.

5.2.2 Summary of Revenue and Benefits

Alongside the costs of investing in a MWS facility, there are also potential revenue and benefits associated with development. The key revenue sources are:

1. Material revenue associated with recyclate sales.
2. Reduced UK ETS costs.

5.2.2.1 Material Revenue

As identified in Section 5.1.4, the end markets for recyclates are highly variable and thus the associated material revenues are highly uncertain. There is also variability in specific material streams, materials such as non-ferrous and ferrous metals, are expected to achieve higher values than plastics. Using prices provided by LetsRecycle, we forecast that recycling revenue might equal between **£1.2m-£3.2 per year**. This equates to between **£3-£8/tonne** of residual waste received by the MWS facility. These price estimates are based off recyclates captured at the kerbside, and the quality of materials captured at a mixed waste facility would likely deliver significantly lower material revenue – especially in a scenario where markets for certain grades of plastics are less well developed than they might otherwise be.

Note that this assumption relies on no metal income being received from metals extracted from the IBA (e.g. post combustion).

There is also the possibility that some of the inert materials (e.g. stone and glass) captured by the MWS would need to be sent to landfill – this would represent a small disposal cost at the inert rate of landfill tax. However, for the purposes of this assessment it is assumed that no such material will be captured for the chosen design of the MWS.

While not specifically modelled in the above prices (due to further price uncertainty), materials extracted for recycling can be expected to generate PRN/PERN revenue plus potential payments from the new EPR scheme in future, especially for any materials lagging behind their increasingly onerous material specific packaging recycling targets. While price uncertainty means we have not factored in these revenues, this helps justify also not accounting for the costs of sending inert material to disposal or for the lower revenue from low quality (plastic grade) materials.

5.2.2.2 Avoided UK ETS Allowances

A key driver associated with the use of MWS is the reduction in the need for UK ETS allowances in the future. The carbon emissions of each material when combusted varies significantly, with plastics expressing the greatest impact. Applying the results set out in Table 5-6 the MWS facility might save over 60,000 UK ETS allowances per year. The price of UK ETS will vary; for the purposes of this assessment, we used UK Government modelled values of between £72/UK ETS allowance and £134/UK ETS allowance. Thus approximately £4.5m to £8.3m is forecast to be saved each year.

5.2.3 Summary of the Financial Costs and Benefits

As explored in the earlier sections, there are some significant areas of uncertainty associated with the costs and benefits associated with the MWS facility. Table 5-7 summarises the key elements – demonstrating that the investment is not likely to be financially viable. Capex has been based on NLWA's RFPF plant, rather than the case studies. OPEX is estimated from the case studies, previous studies conducted by Eunomia, and Tolvik's report commissioned for NLWA ('Review of Pre-Treatment Solutions for Residual Waste').

Table 5-7: Summary of the Quantified Financial Costs and Benefits

Element	Annual Cost / Benefit (low-high)	Equivalent Cost / Benefit Per Tonne of Residual Waste sent to the MWS facility (low-high)
Costs		
CAPEX (annualised)	£14.6m to £16.7m	£37 to £43
OPEX	£7.8m	£20
Total Annual Costs	**£22.4m to £24.5m**	**£57 to £63**

Revenues		
Material Sales	£1.2 to £3.2 m	£3 to £8
Avoided UK ETS	£4.5m to £8.3m	£11 to £21
Total Annual Revenues	**£5.7m to £11.5m**	**£14 to £29**

It is worth noting that there are other costs that have not been able to be quantified, primarily these include potential additional transport costs associated with the double handling of residual waste.

6.0 Overall Assessment

To provide a well-established summary business case for a MWS plant is extremely challenging due to the complexity of weaving together the impacts of technical aspects, economics, and markets, overlaid by the predicted effects of UK and international public policy over the long term. At least from the case studies it can be concluded that only with the right support can mixed-waste, post separation residual sorting plants work at the scale required for North London's waste.

The key indicators, to summarise the findings for a MWS plant that processes all of NLWA's household residual waste are:

- Materials extracted from the MWS and sent to reprocessors – **42,200 tonnes**
- Reprocessor losses – **9,200 tonnes**
- Amount recycled after reprocessor losses – **33,000 tonnes**
- Abated EfW emissions – **61,839 tonnes CO_2eq**
- Land required – **20,000m^2** to **25,000m^2**
- Costs:
    - Capex: **£175m** to **£200m** (excluding case studies, based on NLWA RFPF plant)
    - Annual costs (annualised CAPEX and OPEX) - **£22.4m to £24.5m** (assuming financing over 15 years)
    - Annual revenues (avoided ETS costs and material income) - **£5.7m to £11.5m**

The evidence for these findings comes from a combination of testimony and market data. The performance of these plants must be tempered by the difficulty for desk-based and primary research to provide much independent verification of the data – our sources are developers and operators, i.e. those with a vested interest in their success. There is considerable uncertainty in the figures provided above, especially when applied to the specific circumstances of NLWA. A significant concern is around the potential costs of constructing and operating a MWS facility in North London. Whilst the data from this research provide an indication of a range of costs of a potential facility, factors such as haulage costs, additional space requirements, and high costs in North London mean that these figures are likely to be significant.

As described in Section 5.2.2, materials markets are also volatile and it is difficult to predict the effect of measures such as EPR (which may offer future income support for materials that are further away from material specific packaging recycling targets) and variable ETS prices. Moving too quickly towards mixed waste sorting could result in perverse outcomes; if certain recyclates are not attractive to reprocessors they could go back into thermal treatment for the cement industry, or even waste thermal treatment, potentially resulting in a rebound in ETS costs to the authority (if treated within the UK or other jurisdiction with carbon trading scheme exposure). As seen in the Swedish examples, these risks may need to be underwritten by the Government who view these plants as strategic, in terms of meeting environmental targets. Financial viability, as evidenced by the case studies and high-level modelling, is far from certain and initial indications are that this is not achieved.

Uncertainty around revenues also arise when considering the vast differences between the European policy context and the UK's. The trend in constructing MWS facilities in Sweden can partly be attributed to the Climate Leap fund, which provides supporting investment for regional and local initiatives to reduce GHG emissions. Both Swedish case studies identified in this report were granted a 25% investment to construct these facilities. In Poland, recycling targets and the associated penalties for not achieving these targets are both high, also incentivising municipalities to find solutions for increased recycling. Currently in the UK, there is a lack of funding opportunities and investment for similar projects and the waste sector is generally not incentivised to pursue mixed waste sorting solutions.

The drive towards MWS facilities in the UK will depend on:

- The evolving design and fee modulation specifics within the new EPR scheme, affecting any material specific EPR payments which may be derived;
- Material specific packaging performance levels relative to targets (which will affect whether MWS is necessary for meeting packaging waste targets);
- The effectiveness of the incoming DRS (affecting how much additional metal and plastic recycling is required from source segregation and from recovery from residual waste);
- PRN pricing;
- The availability of end markets; and
- Future UK ETS carbon prices, and the availability of any free credits.

Uncertainty around how and when these schemes are being designed and implemented, as well as how end markets will respond to increased recyclate availability, is currently inhibiting the adoption of MWS in the waste sector. Greater certainty is required to help guide the waste sector in making these investment decisions.

Further down the line, implementation issues will also need to be addressed, in particular the alteration of the Boroughs' haulage routes and transfer infrastructure, land search, planning, permitting, and financing, which will help provide the true costs of commissioning a MWS plant.

Overall, within the scope of the existing study (constrained as it is by taking a limited case study approach), it is very challenging to provide firm conclusions. The indications from the case study information, couple with logistical challenges considered for a remote MWS facility, suggest factors not in favour of mixed waste sorting of waste for North London at the current time. However, many of the underlying factors are in a state of flux, all trending towards improved outcomes for mixed waste sorting in future years – most notably after EPR is embedded and the UK ETS is extended to energy from waste. It is also possible at that time that the decommissioned Edmonton EfW facility would provide strategic land for co-locating a MWS facility alongside the replacement EfW plant. Therefore, it is recommended that NLWA keeps this topic open, with a view to a more detailed business case development once these aspects can be better addressed.

Appendix

A.1.0 Research Matrix

See attached Excel document.

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