

Local recycling and manufacturing facilities

A practical community proposal for towns and cities

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Executive summary

We propose a network of visible local facilities where residents and businesses can bring suitable materials, see them converted into useful products, and buy those products locally. The purpose is to retain material value, support paid work, reduce avoidable transport and give communities evidence of what happens to their recycling. Repair and reuse come first; manufacturing follows where the material, equipment and customer demand justify it.

The first investment should be a modest, carefully selected production pilot. The existing concept combines a folding materials room, a separate dry metal bay, solar electricity, a LiFePO₄ battery, a small plastic injector and an electric crucible furnace. Its equipment and installation estimate is £18,285 using prepared plastic feed. Adding a shredder raises the estimate to £20,585; adding the researched HHO station raises it to £26,910. These sums include contingency but exclude several site and business costs. They do not establish that a complete operating business can open for £20,000. [1]

The public benefit becomes credible when the facility publishes its material balance, sells products with traceable batches, reports residual waste destinations and records energy, labour and transport. Residents should be able to see both achievements and unresolved problems. A product made locally is evidence of a particular batch being used; it is not proof that every item collected has been recycled.

Local production can save money and time, but proximity alone does not guarantee either financial or environmental efficiency. Efficient regional plants may use less energy per kilogram and move material in well-loaded vehicles. The proposed network therefore keeps useful work local while retaining specialist regional routes for materials that the local workshop cannot safely or economically process.

The numerical examples in this paper are transparent planning scenarios, not measured pilot results. They show where savings could arise, how jobs might be funded and what evidence is needed. The first funding decision should purchase a demonstrated capability, customer trials and honest monitoring, rather than an unsupported claim of complete recycling or zero harmful residues.

1 Purpose and public value

A recycling service is easier to trust when its results are visible. Many people see a bin collected but cannot follow the material through sorting, processing, export, sale or disposal. We propose shortening that gap: a local receiving point connected to a workshop, a public product catalogue and a small shop or collection counter. The shop makes recovered material tangible and provides income, while the reporting system accounts for material that does not become a local product.

The facility should be designed around a practical question: what useful item can this particular local material become, with a buyer willing to use it? This reverses the practice of accumulating material first and searching indefinitely for an outlet. It also creates feedback between manufacturers, repairers, residents and product designers. If a product is hard to repair or separate, the workshop can document the problem and ask suppliers to change it.

The social objective is local participation in solving waste problems, supported by fair paid work. A council, cooperative, community enterprise or private operator with transparent contractual duties could run a facility. Ownership alone does not establish performance. The same measures should apply to each: material yield, environmental impact, useful sales, working conditions, costs and independently checked destinations.

What the present system actually does

The case for improvement does not depend on claiming that all recycling is buried. Defra reports that the UK household-waste recycling rate was 44.5% in 2024, including metal recovered after incineration. For the different measure of all local-authority-collected waste in England, 5.5% went to landfill, 50.3% to incineration and 41.2% was sent for recycling in 2024/25. These measures have different scopes and should not be combined as one total. [2,3]

Recycling collections can contain rejected material, and intermediate facilities can send residues elsewhere. A local proposal should obtain actual weighbridge records, transfer information and final reprocessor evidence before alleging wrongdoing or claiming a particular disposal route has been avoided. It should also distinguish material sent for recycling from material successfully reprocessed and sold.

The public offer

Residents would have clear written guidance on accepted materials, scheduled drop-off or shared collection, visible product examples, published prices and a route for repairs or product returns. Businesses could supply consistent offcuts and order repeat components. Schools and community groups could observe suitable demonstrations from a separate visitor area. Public access must not put visitors beside machinery, hot metal or stored chemicals.

The ambition is an accessible service: written and online enquiries, clear pictorial labels, step-free customer access where practicable, predictable opening times and quieter tasks alongside noisy workshop work. Participation should not depend on making a telephone call or being able to lift a heavy bag.

2 Materials and scientific identity

The first-stage UK materials register contains 111 polymer records, 97 metal and associated-material records, 29 name mappings and 50 sources. These are overlapping families, subtypes, grades, blends and forms, not 208 separate pure substances. A UK catalogue offer does not establish production origin, available scrap tonnage or the composition of an incoming batch. The register intentionally leaves UK quantities unfilled. Appendix A retains the full name index. [4]

A manufacturing-led vocabulary is useful because it connects waste to engineering specifications. For polymers, record the base chemistry, grade where known, additives, reinforcement, colour, contamination and previous use. For metals, record alloy, specification, product form, condition, coatings and source. Keep trade names and approximate descriptions as aliases rather than replacing the scientific identity.

Plastics are not simply interchangeable carbon-and-hydrogen fractions. Polyolefins such as PE and PP are hydrocarbon polymers, but important families also contain oxygen, nitrogen, chlorine, fluorine, sulphur or silicon. Thermosets and cured rubbers have networks that do not melt back into the original resin. Melting mixed polymers or mixed alloys does not automatically separate their constituents or restore a manufacturing grade. [4]

Material group	Suitable local first step	Boundary
Clean HDPE and PP	Identify, segregate, prepare and mould separately	Control temperature, contamination and product performance.
PET, polyamides and engineering thermoplastics	Collect by known grade; assess drying and processing requirements	Not interchangeable with the initial HDPE/PP settings.
PVC, fluoropolymers, unknown compounds	Identify and retain for appropriate specialist routes	Not part of the starter heater feed.
Thermosets, cured rubber and composites	Repair/reuse; grade-specific specialist recycling	No general remelting route to virgin-equivalent resin.
Aluminium with known alloy history	Reuse first; small controlled remelting trials	Oxidation, dross and alloy contamination affect yield.
Steel, stainless, copper and brass	Repair, cut, sort and consolidate	Melting/refining needs separate capacity and controls.
Batteries, electronic scrap, reactive or toxic metals	Separate approved collection and specialist treatment	Excluded from the starter processing line.

The local feedstock survey should measure kilograms per week, seasonal variation, contamination, present destination, collection route and available price for each stream. Material already sold into effective recycling is a different opportunity from material currently disposed of. Diverting the former locally may change who performs the work without increasing the quantity recycled.

3 Recovery methods and realistic local scale

Repair and direct material reuse

Retaining a usable component can avoid the energy, yield loss and labour of remaking it. The workshop should first inspect whether stock can be cleaned, cut, drilled, joined or repaired. Metal sections, fittings and selected plastic components may have greater value as usable stock than as anonymous shredded feed. Safe condition and intended use still need checking; old material is not automatically suitable for a critical load or electrical function.

Mechanical recycling of thermoplastics

The usual sequence is identification, removal of unsuitable components, size reduction, cleaning where required, drying, forming and inspection. Injection moulding suits small repeated parts. Extrusion suits continuous profiles or filling suitable moulds. Compression moulding can produce thicker panels or moulded shapes. The appropriate machine depends on feed, mould dimensions, pressure, cooling and required finish. Precious Plastic publishes examples of these local methods. [5,6]

The starter deliberately uses prepared clean feed because a complete dirty-waste washing and drying line adds water treatment, heat, filtration and labour. This does not eliminate upstream processing: the prepared-feed supplier, energy and transport remain in the cost and environmental assessment. The later shredder option brings only size reduction on site, not automatic washing or polymer identification.

A polymer can lose performance through heat history, oxidation, incompatible mixing or additives. Clean production sprues can be segregated for controlled re-use; repeated processing needs a validated blend and quality limit. Products should be designed for repair, disassembly and another recycling cycle. Adding sand or mixed polymers may improve a particular product property while making subsequent separation harder.

Metals and refinement

Small electric crucible furnaces can support selected metal work, but remelting is not equivalent to refining. Copper in aluminium, an unknown lead addition in brass, or mixed stainless grades do not disappear merely because the material becomes liquid. Start with a consistent known alloy and a defined buyer specification. Record charge mass, cast mass, dross, energy and rejected castings. Keep different alloys and their tools/crucibles suitably segregated.

Use external analysis or a specialist recycler when provenance and composition cannot support the required specification. Low-cost melting must not become a way of hiding uncertain composition inside building products. Steel melting, reactive alloys, electronic-metal recovery and high-purity refining require a separate engineering and commercial assessment.

Solvents and chemical recovery

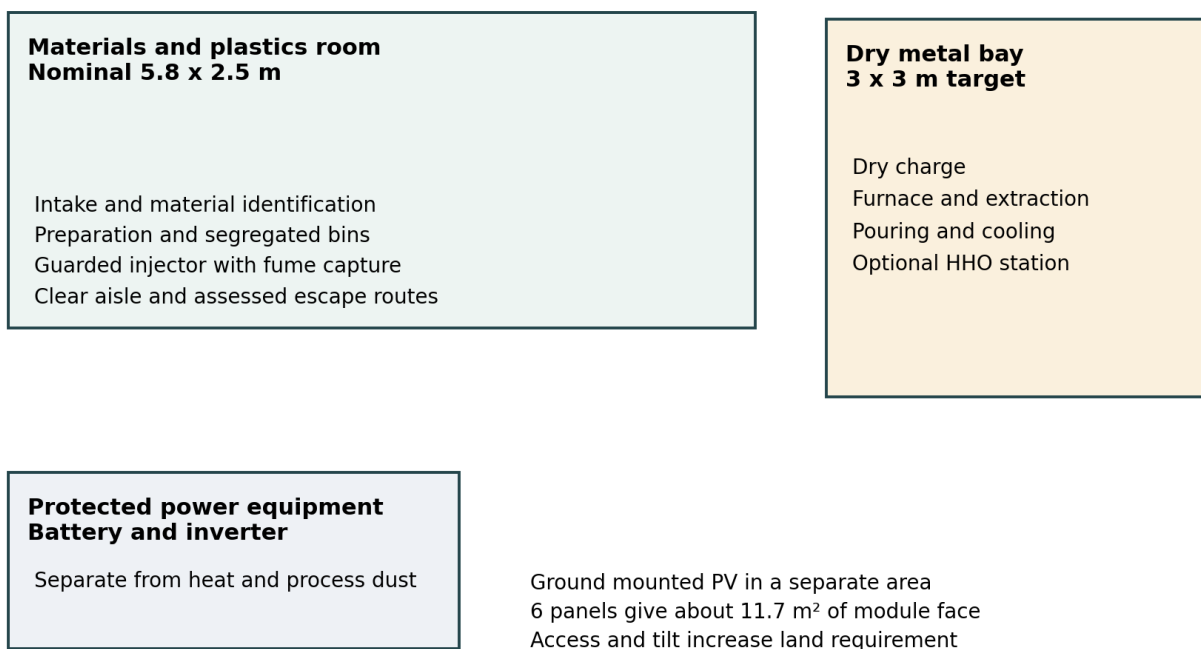
Solvent distillation can recover usable solvent from a suitable segregated contaminated stream. Condensation, appropriate containment and a specification for the recovered solvent are central to the process. The concentrated still bottoms, filters and any degraded compounds remain real outputs. Distillation does not make every contaminant disappear, and a different separation or treatment may be needed for a different mixture. [7]

Selective dissolution can recover some polymers without breaking all their chains; depolymerisation aims to recover chemical building blocks from suitable polymers; pyrolysis makes a variable product mixture requiring further treatment. These routes need material-specific evidence on recovery, energy, solvent losses and product quality. The JRC comparative assessment supports choosing a route according to recovery yield, process impacts, technical compatibility and economics. None is a universal small-workshop solution. [8]

For the first facility, solvent and chemical routes are a later research partnership or a contracted service. Their plant, fire protection, specialist competence, analytical testing and residue treatment are outside the £18,285 starter estimate.

4 Facility design and operation

The physical concept uses a nominal 5.8 × 2.5 m folding room for materials and plastic work, with a separate weather-protected 3 × 3 m target metal bay. The dimensions define an initial procurement arrangement, not approved construction drawings. The final layout must accommodate the actual machine envelopes, clear working routes, public separation, ventilation, fire precautions, accessible entry and assessed floor loads. [1]



Zone separation, foundations, ventilation and anchoring require site-specific design.

Figure 1 Functional arrangement of the starter facility. Solar land area, safe separations and structural details must be determined for the chosen site.

Specify the actual wall, roof and floor construction of an imported shell. A catalogue reference to “workshop” does not establish its suitability for machinery or heating. EPS and mineral-wool options appear together in some listings; order a documented configuration. Do not place a metal foundry inside an unverified residential shell. PV should have its own ground support unless the roof has been structurally verified.

The plastic heater needs capture close to the source. The metal bay needs its own appropriate extraction, a dry charge area, a controlled pouring position and protected cooling space. HSE guidance supports local exhaust ventilation and process-specific control. Rain, wet scrap, damp tools and unsuitable moulds are material hazards around molten metal. A filter catalogue rating cannot substitute for demonstrating capture at the operator position. [9,10,11]

Routine material flow

At intake, staff weigh the batch, identify its source and material, check acceptance criteria and assign a batch number. Unknown or unsuitable material is quarantined or refused. Suitable stock goes first to reuse, then to an approved processing recipe. Finished parts are inspected and labelled before sale. Residues and specialist transfers keep their own weights and destinations. Inventory is reconciled at the end of the reporting period.

The operator should prepare a simple job sheet specifying material identity, maximum accepted contamination, permitted machine settings, required inspection, handling and residue destination. Staff need clear authority to stop a batch that falls outside the recipe. A public demonstration must follow the same process controls as a production batch.

5 Solar power and the HHO option

The reference solar kit has six 430 W panels, a 5 kW inverter and a 5.12 kWh LiFePO₄ battery. Panel capacity is 2.58 kWp; it does not mean continuous 5 kW generation. The supplier listing gives about 11.7 m² of module face area. Mounting, access, tilt, wiring and site conditions add space and cost. Battery charge/discharge limits and low-temperature behaviour need checking for the exact supplied model. [12]

Sequence major loads rather than running every machine together. The design target is no more than about 3.5 kW at one time, subject to the inverter, battery and motor starting tests. Preserve power for extraction and control equipment. A 5 kW inverter label alone does not prove that the battery can continuously supply 5 kW AC or start the shredder.

Illustration	Calculation	Meaning
Battery only	$5.12 \text{ kWh} \times 0.80 \text{ usable fraction} \times 0.90 \text{ conversion} = 3.69 \text{ kWh}$	About 1.1 hours at a 3.3 kW load, before real-world adjustments.
Solar day	$2.58 \text{ kWp} \times 2 \text{ equivalent peak-sun hours} \times 0.80 \text{ net yield} = 4.13 \text{ kWh}$	A scenario, not a forecast for a particular winter day.
Annual solar sensitivity	1,500 / 2,000 / 2,500 kWh generated; 80% used on site; £0.25/kWh displaced	£300 / £400 / £500 annual purchased-electricity savings before maintenance and replacement costs.

The annual yield, self-use and electricity-price values above are assumptions. Obtain a location-specific yield estimate and measure self-consumption. Exported electricity has a different value; curtailed electricity saves no purchase. At an indicative £4,000 solar hardware/mounting/electrical allocation, those gross savings imply roughly 8 to 13 years simple payback before replacement, finance and maintenance. Part of that allocation also serves the workshop, so a solar-only investment assessment needs a separate quote. Existing grid backup or reduced operating hours remains necessary when generation is insufficient.

What HHO can and cannot establish

The researched HHO generator advertises 1,000 litres/hour and approximately 3 kW electrical input, with contradictory power fields elsewhere in the listing. If the gas figure means combined dry hydrogen and oxygen at normal conditions in a two-to-one volume ratio, hydrogen flow is about 0.667 Nm³/hour. At a hydrogen lower heating value of 3.0 kWh/Nm³, that is about 2.0 kW of fuel heat before burner and furnace losses. High flame temperature does not establish metal throughput. [13,14]

HHO is produced using electricity; it is not free energy extracted from water. Direct electric melting avoids the electrolysis-and-burner conversion chain and is the preferred starting point here. The optional HHO unit is advertised for welding/brazing. A supplier must demonstrate the intended aluminium batch, actual electricity use, melting time and metal yield before it is accepted for foundry work.

Use a complete supplier-engineered gas system with appropriate control and HHO-specific flashback protection. The concept does not include storage of premixed hydrogen and oxygen or a homemade pressure system. Gas-side components must be matched to the complete installation. Combustion and heated feed still require an emissions assessment; water in the fuel cycle does not prove the entire process harmless. [15]

6 Capital costs and supplier options

The following budget carries forward the workshop design. It is a gross-cash planning estimate for commercial procurement, including VAT allowances and a 15% contingency. The priced machinery is a quote candidate, while installation and specialist controls are allowances. Written delivered and installed quotes are needed before commitment. [1]

Starter item	Allowance
Folding shell delivered and set	£4,000
Separate dry metal bay on suitable existing base	£1,800
Solar kit and delivery reserve	£2,600
PV mounting wiring and electrician	£1,400
Small injector and a basic mould	£1,000
Electric furnace and accessories	£1,000
Separate appropriate extraction systems	£2,600
Process commissioning and initial training	£700
Benches bins basic tools and PPE	£800
Subtotal	£15,900
Contingency at 15%	£2,385
Starter A total	£18,285

Design option	Total	Scope change
A	£18,285	Prepared feed and electric metal trials.
B	£20,585	Add a £2,000 shredder allowance plus contingency.
C	£26,910	Add a further £5,500 HHO station allowance plus contingency; retain electric furnace until HHO is proven.

The estimate excludes land or rent acquisition, new foundations and drainage, utility connection, planning and environmental permissions, major redesign, wages, insurance, stock, continuing consumables, working capital and product certification. A £5,000 budget would require a much narrower activity in an already suitable equipped space; it cannot be represented as this complete facility. An existing building or compatible owned equipment may reduce cash spending, but its condition and compatibility must be verified.

The import calculation assumes \$1 = £0.80 for planning, not a live exchange-rate quotation. A 5% duty provision is a placeholder pending commodity classification. For example, $(\$1,688 \times 0.80 + £1,000 \text{ freight}) \times 1.05 \times 1.20$ gives about £2,961 before the remaining shell unloading and fit-out allowance. Actual duty and VAT treatment must follow the goods, delivery terms and business circumstances. [16,17]

Shortlist from the sourcing exercise

Candidate	Advertised price	Important condition
SG CBOX FC-01 folding shell	US\$1,688 for 1-9 units	Confirm mineral-wool option, dimensions, floor point loads and UK delivery. [18]
Xinyu/Cbox folding shell	US\$1,399 for 1-9 units	Resolve EPS/rock-wool and implausible package-field conflicts. [19]
ALUDREAM expandable shell	US\$3,508 for 1-4 units	Confirm size variant and floor/panel construction. [20]
Shenzhen Borx mini injector	US\$480 for 1-2 sets	20 cm ³ shot; confirm 230 V, heater power, clamp, guards and mould. [21]
Okay Energy HHO unit	US\$4,000 for 1-9 sets	Confirm gas basis and input; obtain material-specific melting trial. [13]
Foshan ESG solar kit	US\$3,800 for 1-4 sets	Configurable contents; fix panel, LiFePO4 and inverter BOM. [22]
UK Photonic Universe KIT2-5K	£2,571.76 including VAT displayed	Confirm delivered terms and exact kit; mounting separately budgeted. [12]
Kwell WT200 shredder	Quote required	Small 1.5/2.2 kW variants; require compatible supply and guarded feed. [23]
HS Walsh TF58B furnace benchmark	£705.95 plus VAT	Gold-furnace benchmark only. Confirm aluminium suitability, volume and power. [24]

These prices were observed during the 10 October 2026 sourcing exercise and may change. They do not include all imported shipping/taxes unless explicitly stated. A furnace advertised as “3 kg” for gold does not hold 3 kg of aluminium. The electric-furnace allowance remains conditional on supplier-confirmed aluminium performance. No purchase or supplier contact is represented by this shortlist.

7 Products that people can buy

The first catalogue should consist of a few useful, repeatable products matched to the actual equipment. Suitable candidates include non-safety-critical knobs, spacers, caps, small repair parts and clearly specified workshop accessories. Identified metal stock can be sold for reuse, and tested small metal castings can be commissioned where specifications permit. Avoid medical, food-contact, electrical protective, structural or other critical uses without the necessary material and product evidence.

Residents should be able to buy directly, order online for local collection, or request a repeat part. Local businesses can place standing orders and return offcuts. Price labels should show the product specification, recycled content basis, batch, intended use, care, repair and return route. They must distinguish an actual recycled-content measurement from a broad environmental claim.

Affordable pricing should come from an efficient process and a planned margin. It should not rely on selling an uncertain product below its safe production cost. A separately funded concession, repair voucher or council procurement agreement can improve access without concealing a subsidy in the workshop accounts. Quality should match the declared purpose even if cosmetic finish differs from a premium industrial product.

Large blocks and construction materials

Three examples clarify the earlier discussion. ByFusion makes ByBlock plastic building products in the United States; its FAQ describes application-dependent fire-retardant requirements. UNICEF documented the Colombian company Conceptos Plasticos, co-founded by Isabel Cristina Gamez, developing modular plastic bricks for classrooms in Côte d’Ivoire. UNEP documented Nzambi Matee and Gjenge Makers in Kenya making plastic-and-sand paving products. These are different processes and products, not evidence that every plastic can enter one unrestricted house-building recipe. [25,26,27]

A local building-material line needs evidence for the whole product system: strength, creep, fire and smoke behaviour, weathering, water, dimensional movement, relevant chemical release, abrasion, fixing details and future recoverability. A small compression test is not a complete building approval. Precise requirements depend on the intended use and UK jurisdiction. The starter budget does not include a certified house-block line.

Precious Plastic provides a built container-workspace precedent and larger machine designs. Its Pro extrusion machine is listed at 5 kW and its sheet press at 15 kW, with 400 V supplies. The listed figures are design information, not an installed plant quote. A 15 kW press cannot be added to the proposed 5 kW inverter supply without redesign. [5,6,28]

8 Jobs and operating economics

The investment can create paid work in receiving and sorting, machine operation, repair, product design, maintenance, quality control, selling and reporting. Several roles can be

combined at pilot scale. The number of sustainable jobs depends on paid demand, throughput, working time and margin. Capital equipment itself does not pay a recurring wage. The ILO identifies both employment opportunities and serious working-condition challenges in recycling; job quality must be part of the design. [29]

A practical initial aim is a paid part-time operator/coordinator, with specialist installation and maintenance bought as needed. Provide training, written procedures, predictable shifts and a route to raise concerns. Do not count volunteer hours as paid jobs, or count every occasional contractor as a new full-time post. Report paid hours, full-time equivalents, pay, training and whether work has been displaced from an existing service.

An example matched to the small injector

The following is a demanding sales and productivity scenario, not a supplier performance rating or forecast. Assume a 15 g saleable part, 20 accepted parts per productive hour, four productive hours on each of 200 days, and all output sold. That produces 16,000 parts or 240 kg a year. The complete shot, including runners, must fit the 20 cm³ machine; mould and material trials must establish whether this cycle is achievable. [21]

Operating assumption	Annual value
Paid time	1,040 hours; 0.5 FTE using a 40-hour full-time week
Production within paid time	800 hours; only 240 hours remain for other duties
Loaded employment cost	£18,000 assumed, including employer costs and paid leave
Other fixed operating costs	£8,000 assumed; site, insurance, energy, maintenance, administration and residue handling
Variable consumables and prepared feed	£0.075 per part = £1,200
Capital replacement provision	£18,285 spread over five years = £3,657
Total annual cost at full output	£30,857 before finance and tax

The £18,000 employment allowance is not a quoted salary package. Recruitment must meet applicable wage rates and employment duties. The published National Living Wage for workers aged 21 and over is £12.71/hour from April 2026. At this illustrative staffing level, extensive metal work, public opening or collections would displace plastic production or require additional paid time; those activities are not assumed to happen without labour. [30]

Retained sales income per part	Annual sales	Annual balance after stated costs
£1.00	£16,000	–£14,857
£1.50	£24,000	–£6,857
£2.00	£32,000	£1,143

“Retained income” means cash available to the operation after any VAT or selling fees that must be remitted. On the stated assumptions the break-even average is about £1.93 per part.

At only 50% sales, a £2 retained price gives £16,000 revenue and £600 variable cost; fixed costs and replacement provision remain £29,657, leaving a £14,257 shortfall. Machines and an attractive shop cannot substitute for validated demand.

If an equivalent purchased part costs £2.50 on the same tax and delivery basis, a £2 local price saves the buyer £0.50 or 20%; 16,000 purchases would save buyers £8,000. This is a conditional comparison requiring real alternative quotations and comparable quality. Buyer savings are not extra facility revenue and must not be added to the £1,143 operating balance as though both were profit.

Working capital and funding

Six months of the illustrative cash operating costs, excluding the non-cash capital replacement provision, is £13,600. Adding this buffer to starter equipment gives £31,885 before unpriced permissions and site works. Actual cash need depends on the sales ramp, grants, deposits and payment timing. This distinction explains why an £18,285 machine-and-building estimate does not yet fund a staffed enterprise.

The financially stronger route may combine higher-value repairs, business contracts, commissioned moulding, material sales and explicitly funded education. Revenue streams need separate accounts. Waste-service payments are only income if a contract actually pays the facility; a council avoiding some expenditure does not automatically transfer that money. Grants and training contracts can support public benefits, but recurring support must be visible.

9 Time and transport savings

Local work may shorten the interval between a material becoming available and its next useful application. Residents can collect a part nearby, businesses can discuss a specification directly and faults can be returned without a long supply chain. Measure days from receipt to saleable stock, order to delivery, and fault to repair. Processing time, queueing time and customer travel are separate quantities.

A service target might be three working days for an agreed stocked repair part. If a documented alternative actually takes fourteen working days, the saving would be eleven days. Those dates are an example for comparison, not measured delivery performance. Local manufacturing can also be slower if moulds, skilled staff or compatible material are unavailable.

A later town-scale transport example

This example concerns 25 tonnes per year that a future suitably sized local operation could genuinely replace on a distant route. It is not the 240 kg/year injector scenario and is not priced into the starter plant. Assume five dedicated 5-tonne-load journeys, each with an empty return; the distant site is 200 km away and the local site 20 km away. If those five distant journeys really disappear, annual vehicle travel falls from 2,000 km to 200 km, saving 1,800 km.

Assumption	Conditional annual saving
Fuel consumption 0.25 litres/km	450 litres

Assumption	Conditional annual saving
Fuel price £1.50/litre	£675
Driving speed averaged at 45 km/hour	40 driving hours
Paid driver time valued at £20/hour	£800
Other avoidable vehicle cost £0.35/km	£630
Combined stated cost components	£2,105

The numbers are arithmetic assumptions, not haulage quotations. Include loading time, route consolidation, payload, empty returns and all residual-material transport in a real comparison. If a truck still runs for other customers, allocating less material to it may not remove a trip or save the full cost. Fixed vehicle costs are not avoidable simply because kilometres fall.

Resident trips can reverse a transport benefit. For example, 1,000 additional dedicated 8 km round trips by car would create 8,000 car-km. At an assumed 0.07 litres/km, that uses 560 litres, exceeding the 450-litre truck saving in this example. Fuel types and emissions also need separate treatment. Shared collection, walking access, existing journeys and delivery consolidation are therefore design requirements, not minor details.

Savings in driver time can be redeployed, but do not themselves prove a net increase in employment. The facility must separately report jobs created, working hours transferred and any jobs displaced. Nor should the transport savings above be added to the product model when they concern different material volumes and assets.

10 Environmental savings and their measurement

The potential environmental gains are less virgin material extraction, less unnecessary transport, recovery of useful materials, longer product life and reduced leakage to land and water. Solar can reduce purchased electricity. Each gain depends on an actual counterfactual: what would have happened to the same material and what product would otherwise have been bought? A product that nobody needs, or one that fails early, can erase a manufacturing advantage.

A proper comparison must provide the same useful service over the same lifetime. Compare reuse, existing regional recycling, local processing, incineration and landfill where each is a real available route. Include collection, sorting, washing/drying, process heat, electricity, equipment manufacture allocated over use, yield loss, residues, transport, product durability and end of life. Count any genuine virgin-material displacement once. The JRC assessment supports this route-specific approach. [8]

Illustrative carbon sensitivity for the pilot output

The following assumed intensities demonstrate the sensitivity of 240 kg/year of equivalent finished products. They are not measured factors for the proposed facility, not extracted from the government factor tables, and not a claim of verified carbon savings. The boundary is product manufacture and distribution; differences in the original waste treatment, future use and disposal are excluded here and require a full comparison.

Product route	Assumed kg CO2e per kg	Annual kg CO2e	Difference against virgin
Virgin product reference	3.0	720	Reference
Regional recycled reference	1.2	288	432 lower
Local favourable case	0.8	192	528 lower
Local middle case	2.0	480	240 lower
Local unfavourable case	4.0	960	240 higher

Against the assumed regional recycled product, the local favourable case saves only 96 kg CO2e/year; the middle case is 192 kg worse and the unfavourable case 672 kg worse. This is why a local label is not enough. Verified electricity consumption, yields and actual alternative supply are needed to choose the better route. These product calculations must not be added to the separate transport or solar examples if those impacts are already inside the product boundary.

How the operator should make a real claim

Measure imported electricity, on-site generation and use, fuel litres, material inputs, saleable output, rejects and transport. Select appropriate published factors and record their year, geography, units and boundary. The UK government publishes 2026 reporting factors and methodology, but corporate waste-accounting factors are not automatically full avoided-impact factors. In that methodology, some recycling burdens are allocated to the user of the recovered material, so a low waste-disposal number does not describe the whole recycling process. [31,32]

Publish at least kilograms of saleable output per kilogram accepted, kWh per kilogram and per saleable part, litres of fuel, water used, residues by destination and the share of products actually sold. Keep carbon, air pollution, water quality, microplastic loss and habitat effects separate. A lower carbon figure does not excuse an uncontrolled discharge or worker exposure.

Solar panels, batteries, extraction filters and equipment have manufacturing and replacement impacts. Give solar credit for measured displacement of purchased electricity using a stated method; do not label the whole workshop zero-carbon. A low-use oversized plant can have a large equipment impact per useful product. Sharing specialist plant across several towns may improve utilisation.

Capture and the goal of minimal harm

The ambition to capture and reuse outputs is valuable, but it needs an honest material balance. Captured dust, spent carbon, contaminated wash water, solvent still bottoms and aluminium dross remain substances requiring assessment and a destination. Recycling a solvent repeatedly may concentrate contaminants. Some hazardous fractions need controlled destruction or authorised disposal; insisting that every fraction remain in local circulation can spread contamination.

The operational aim should be to prevent release, maximise safe useful recovery and minimise the quantity requiring specialist treatment. Use measured extraction performance,

maintenance and residue records as evidence. Keep hazardous or contaminated streams away from ordinary consumer products. “Nothing harmful remains” is a result requiring analytical evidence, not an automatic outcome of recirculation.

11 Visible recycling and public confidence

Public confidence should rest on information residents can check. Every accepted batch should connect to a documented process or destination. A monthly or quarterly report can show what arrived, what became products, what went to a verified external processor, what remains in stock and what required disposal. Where a downstream destination is awaiting confirmation, label it pending rather than calling it recycled.

An illustrative annual material ledger

Account	Mass
Opening inventory	10 kg
New material received	300 kg
Total to account for	310 kg
Finished products dispatched locally	240 kg
Material transferred to a verified specialist	30 kg
Residues sent to documented treatment/disposal	10 kg
Closing inventory	30 kg
Total accounted for	310 kg

This is an illustrative ledger, not an operating record. Opening inventory plus receipts must equal dispatched products, external transfers, residues and closing inventory, with separately recorded process losses where applicable. Do not count internal regrinding repeatedly as new recycling. Do not claim that inventory is a completed environmental benefit or that all transferred mass has already become new material.

A product passport can be a short label or QR link giving batch ID, base material, recycled-content basis, intended use, limitations, inspection date and return route. If several donors' materials were pooled, describe the pooled batch rather than promising that one person's bottle became one particular item. Public reporting should not disclose personal addresses or sensitive supplier information.

Publish product prices, paid hours, public subsidy, residue costs and a clear correction history. Invite periodic independent sampling of weights and destinations. Offer supervised open days, a viewing window or photographs of completed production where appropriate. The purpose is to demonstrate the actual work while keeping public access separate from industrial hazards.

Measure confidence through a short baseline and follow-up survey: whether residents understand destinations, believe reports are checkable, know what is accepted and have seen or bought a product. Record response numbers and who responded. An increase in confidence

would be a measured social outcome; it should not be assumed merely because a facility opens.

12 Food waste and wildlife

The broader proposal began with concern about wasted food, habitat loss and the wellbeing of birds and other animals. Those concerns should remain part of the environmental purpose. Food belongs in a separately designed biological-material service, physically separated from metal and plastic operations. It should not be mixed into the starter workshop's feed or budget.

Prevent avoidable surplus and redistribute suitable edible food first. Where permitted and suitable, some former foodstuffs can enter controlled animal-feed routes. Remaining food waste may be treated through appropriate anaerobic digestion or composting. The UK food-waste hierarchy and animal-by-product requirements define important distinctions; ordinary catering scraps cannot simply be assumed suitable for any animal or treatment process. [33,34]

A dedicated wildlife habitat area can support native vegetation, nesting and natural food sources, with species-specific advice. It should be separate from waste receiving and should not rely on indiscriminate scrap dumping. Concentrated feeding can transmit disease, and suitable food varies between species and seasons. RSPB guidance identifies feeding hygiene and aggregation risks; wildlife management should be informed by current ecological advice. [35]

Discharging food waste into the sea is not an appropriate default recycling route. Decomposition consumes oxygen, and excessive nutrient inputs can contribute to hypoxic conditions that harm aquatic life. NOAA describes this mechanism. The objective is to recover nutrients through a controlled, useful route and protect ecosystems, rather than assume that any organic discharge feeds nature without adverse effects. [36]

Biological treatment can provide soil amendments or energy when properly designed, but it has its own contamination, pathogen, odour, methane and nutrient-loss controls. Its benefits and costs must be measured separately. This paper does not add an unpriced food-waste facility to the plastics and metals capital estimate.

13 Permissions and product responsibility

The regulatory route follows the actual feed, activity, quantities, emissions and destination. The detailed waste guidance cited here is for England; Scotland, Wales and Northern Ireland have their own regulators and requirements. Before selecting a site, establish the applicable planning, environmental and waste permissions, drainage arrangements, fire precautions and responsibilities for machinery, products and workers.

The Environment Agency's U9 exemption for using waste to manufacture finished goods explicitly excludes heat treatment of plastics and rubber. T9 concerns specified scrap-metal recovery activities and must not be treated as blanket permission for a melting furnace. A material sold by a supplier as recycled feed also needs a substantiated legal status; calling it a product does not by itself end waste controls. [37,38]

Imported machinery requires the appropriate conformity documentation, English instructions and suitability for its actual installation. A platform badge or a generic CE photograph is insufficient to resolve incompatible voltages, missing guards or contradictory nameplate

information. The installer should test electrical protection and the agreed load sequence; the extraction specialist should commission capture at the source. [39]

A local shop still sells products with an intended purpose. Keep specifications, batch records, test results and a practical return or recall route. Building products and critical components require a separate product-specific review. Insurance, statutory checks and permit charges must be priced for the actual site; the earlier capital budget is not an allowance for every possible approval or test.

14 Delivery plan and decisions to expand

The sequence below is a proposed programme after funding and site access, not a promise that permissions or suppliers will meet a fixed date. Equipment should not be ordered until the material, customer and site questions can support its use.

Stage	Indicative activity window	Evidence required
Local survey and product choice	Weeks 1-4	Measured feedstock; present destinations; customer quotations and sample requirements.
Site and permissions	Start in weeks 1-4; duration depends on approvals	Confirmed site route, utilities, drainage, neighbours, access and regulatory position.
Matched quotations and trials	Weeks 3-8 where practical	Delivered BOM, material trials, power figures, extraction design and installed prices.
Installation and commissioning	After approvals and delivery	Completed physical work; guards, electrical and extraction tests; staff competence.
Controlled paid pilot	First 12 operating weeks	Actual labour, energy, accepted/rejected mass, sales and public ledger.
Expansion decision	After a representative operating record	Repeat buyers, sufficient feed, financed jobs and a demonstrated environmental comparison.

An expansion decision should specify the bottleneck. More incoming plastic does not justify a larger shredder if moulding or sales are already limiting output. A larger press needs a power and product-market case. A solvent recovery module needs its own feed agreement and residue route. Each additional line should have a named competent operator and a funded operating plan.

Procurement acceptance should record exact model, one-unit price, delivered cost, required power, start-up current, English instructions, conformity documents, spares and warranty. For plastic machines, test the intended flake, mould and cycle. For metal/HHO work, measure charge mass, melt time, energy and metal yield. For shells, approve drawings, lifting, deployment, anchoring, weather resistance and point loads.

Town and city networks

Towns can share material specifications, batch labels, mould designs, technical advice and buyer contracts. A city may need neighbourhood receiving and repair points connected to a larger production hub. Shared specialist analysis, washing, alloy control, solvent recovery and accredited product testing can avoid duplicating expensive plant. Consolidated transport should be planned across the network.

Expansion should follow measured feed and demand rather than a fixed population ratio. Ten tiny machines do not automatically equal one efficient production line, and one distant large plant does not automatically provide good local service. Compare the actual alternatives, including utilisation, access and whole-system effects. Communities can take responsibility for useful local work while cooperating with regional specialists.

15 Recommended commitment

Proceed with a measured local pilot built around useful products, transparent destinations and paid work. Treat the existing £18,285 design as an equipment starting point, and secure a separate operating and site budget. Obtain customer trials before purchasing larger machines. Use the public shop, product passports and material ledger to make the facility accountable to the people supplying and buying its materials.

The proposition is practical: communities can retain more useful material, skills and economic activity by participating in repair, recovery and manufacturing. The strength of that proposition will come from demonstrated performance. Publish the savings that are achieved, explain where regional treatment remains better, and expand the lines that produce durable products, fair employment and a net environmental benefit.

Appendix A Material identity index

This index preserves all 208 catalogue records from the 9 October 2026 materials register: 111 polymer and 97 metal/associated-material records. It is not an intake acceptance list, a tonnage estimate or a list of distinct pure substances. Families overlap their subtypes; expanded forms and blends are also represented. Quantities remain unmeasured. [4]

Polymer records

Polyolefins

P001 Polyethylene (PE); P002 High-density polyethylene (PE-HD / HDPE); P003 Low-density polyethylene (PE-LD / LDPE); P004 Linear low-density polyethylene (PE-LLD / LLDPE); P005 Medium-density polyethylene (PE-MD / MDPE); P006 Ultra-high-molecular-weight polyethylene (PE-UHMW / UHMWPE); P007 Cross-linked polyethylene (PE-X / XLPE); P008 Polypropylene (PP); P009 Polybutene-1 (PB-1); P010 Polymethylpentene (PMP).

Ethylene copolymers

P011 Ethylene-vinyl acetate copolymer (EVA); P012 Polyolefin elastomers (POE); P027 Ethylene-vinyl alcohol copolymer (EVOH).

Styrenics

P013 General-purpose polystyrene (PS / GPPS); P014 High-impact polystyrene (PS-HI / HIPS); P015 Expanded polystyrene (EPS); P016 Acrylonitrile-butadiene-styrene (ABS); P017 Acrylonitrile-styrene-acrylate (ASA); P018 Styrene-acrylonitrile (SAN); P019 Methyl methacrylate-acrylonitrile-butadiene-styrene (MABS); P020 Syndiotactic polystyrene (sPS).

Vinyl polymers

P021 Unplasticised polyvinyl chloride (PVC-U); P022 Plasticised polyvinyl chloride (PVC-P); P023 Chlorinated polyvinyl chloride (PVC-C / CPVC); P024 Polyvinyl alcohol (PVOH); P025 Polyvinyl acetate (PVAc); P026 Polyvinyl butyral (PVB).

Acrylics

P028 Poly(methyl methacrylate) (PMMA); P029 Polyacrylonitrile (PAN).

Polyesters

P030 Poly(ethylene terephthalate) (PET); P031 Glycol-modified PET copolyester (PETG / PET-G); P032 Poly(butylene terephthalate) (PBT); P033 Poly(ethylene naphthalate) (PEN); P034 Glycol-modified PCT copolyester (PCT-G).

Polycarbonates

P035 Polycarbonate (PC).

Polyacetals

P036 Polyoxymethylene (POM).

Polyamides

P037 Polyamide 6 (PA6); P038 Polyamide 66 (PA66); P039 Polyamide 12 (PA12); P040 Polyamide 610 (PA610); P041 Polyphthalamide (PPA); P042 Aromatic polyamides (Aramid).

Engineering polymers

P043 Polyphenylene ether (PPE); P044 Aliphatic polyketone (PK).

Polyaryletherketones

P045 Polyetheretherketone (PEEK); P046 Polyetherketoneketone (PEKK); P047 Polyetherketone (PEK).

Sulphur-containing polymers

P048 Polyphenylene sulphide (PPS).

Sulphones

P049 Polysulfone (PSU); P050 Polyethersulfone (PESU); P051 Polyphenylsulfone (PPSU).

Imide polymers

P052 Polyetherimide (PEI); P053 Polyamide-imide (PAI); P054 Polyimide (PI).

Liquid-crystal polymers

P055 Liquid-crystal polymers (LCP).

Fluoropolymers

P056 Polytetrafluoroethylene (PTFE); P057 Tetrafluoroethylene-hexafluoropropylene copolymer (FEP); P058 Perfluoroalkoxy polymers (PFA); P059 Ethylene-tetrafluoroethylene copolymer (ETFE); P060 Ethylene-chlorotrifluoroethylene copolymer (ECTFE); P061 Polyvinylidene fluoride (PVDF); P107 Polychlorotrifluoroethylene (PCTFE).

Cellulose derivatives

P062 Cellulose acetate (CA); P063 Cellulose acetate butyrate (CAB); P064 Cellulose acetate propionate (CAP); P065 Cellulose nitrate (CN).

Aliphatic polyesters

P066 Polylactide (PLA); P067 Polyhydroxyalkanoates (PHA); P068 Poly(butylene succinate) (PBS).

Copolyesters

P069 Poly(butylene adipate-co-terephthalate) (PBAT).

Starch-based materials

P070 Thermoplastic starch formulations (TPS).

Thermosets

P071 Epoxy resin systems (EP); P072 Unsaturated polyester resin systems (UP); P073 Vinyl ester resin systems (VE); P074 Phenol-formaldehyde resins (PF); P075 Urea-formaldehyde resins (UF); P076 Melamine-formaldehyde resins (MF); P077 Melamine-urea-formaldehyde resins (MUF); P078 Cross-linked polyurethane systems (PUR); P079 Polyisocyanurate systems (PIR); P080 Furan resin systems (Furan); P081 Alkyd resin systems (Alkyd); P082 Allylic resin systems (DAP / DAIP / ADC).

Thermoplastic elastomers

P083 Thermoplastic polyurethane (TPU); P084 Styrene-butadiene-styrene block copolymer (SBS); P085 Styrene-ethylene/butylene-styrene block copolymer (SEBS); P086 Thermoplastic polyolefin elastomer formulations (TPO / TPE-O); P087 Thermoplastic vulcanizates (TPV); P088 Thermoplastic copolyester elastomers (TPC / TPEE).

Rubbers

P089 Natural rubber (NR); P090 Styrene-butadiene rubber (SBR); P091 Ethylene-propylene-diene rubber (EPDM); P092 Chloroprene rubber (CR); P093 Acrylonitrile-butadiene rubber (NBR); P094 Butyl rubber (IIR); P095 Methyl-vinyl silicone rubber (VMQ); P096 Fluorosilicone rubber (FVMQ); P097 Fluorocarbon elastomers (FKM).

Polymer blends

P098 Polycarbonate / ABS blend (PC/ABS); P099 Polycarbonate / PBT blend (PC/PBT); P100 Polycarbonate / PET blend (PC/PET); P101 Polyamide / ABS blend (PA/ABS); P102 PBT / ASA blend (PBT/ASA); P103 Polycarbonate / ASA blend (PC/ASA).

Polymer composites

P104 Glass-fibre reinforced polymers (GFRP / GRP); P105 Carbon-fibre reinforced polymers (CFRP).

Polymer compounds

P106 Mineral-filled / conductive / flame-retarded compounds (Filled polymers).

Elastomers

P108 Polyacrylate rubber (ACM); P109 Ethylene-acrylate rubber (AEM); P110 Hydrogenated nitrile rubber (HNBR); P111 Perfluoroelastomer (FFKM).

Metal and associated material records

Ferrous metals

M001 Iron / commercially pure iron (Fe); M002 Carbon and low-alloy engineering steels (Carbon steel); M003 Free-machining steel EN1A (EN1A); M004 Medium-carbon steel EN8 (EN8); M005 Alloy engineering steels EN19 and EN24 (EN19 / EN24); M006 Tool and die steels (Tool steel); M007 Maraging steels (Maraging).

Stainless steels

M008 Austenitic stainless steels (Austenitic stainless); M009 Stainless steel 304 (304 / 1.4301); M010 Low-carbon stainless steel 304L (304L / 1.4307); M011 Stainless steel 316 (316); M012 Ferritic stainless steels (Ferritic stainless); M013 Martensitic stainless steels (Martensitic stainless); M014 Duplex and superduplex stainless steels (Duplex stainless); M015 Precipitation-hardening stainless steels (PH stainless).

Cast irons

M016 Grey cast irons (EN-GJL); M017 Ductile cast irons (EN-GJS); M018 Austempered ductile iron (ADI); M019 Nickel-alloyed cast irons (Ni-Resist).

Aluminium

M020 Commercially pure aluminium (Al 1xxx); M021 Aluminium-copper alloys (Al 2xxx); M022 Aluminium-manganese alloys (Al 3xxx); M023 Aluminium-silicon wrought alloys (Al 4xxx); M024 Aluminium-magnesium alloys (Al 5xxx); M025 Aluminium-magnesium-silicon alloys (Al 6xxx); M026 Aluminium-zinc alloys (Al 7xxx); M027 Aluminium-lithium alloys (Al-Li); M028 Aluminium casting alloys (Al casting alloys).

Copper alloys

M029 Commercially pure copper (Cu); M030 Copper-zinc alloys (Brass); M031 Free-machining brass (CW614N / CZ121); M032 Copper-tin-phosphorus alloys (Phosphor bronze); M033 Copper-aluminium alloys (Aluminium bronze); M034 Lead copper casting alloys (Lead bronze); M035 Cupronickels (Cu-Ni); M036 Copper-beryllium alloys (Cu-Be); M037 Copper-nickel-zinc alloys (Nickel silver).

Nickel alloys

M038 Commercially pure nickel (Ni 200); M039 Nickel-copper alloys (Ni-Cu); M040 Nickel-chromium high-temperature alloys (Ni-Cr).

Special steels and alloys

M041 Iron-nickel-chromium heat-resistant alloys (Fe-Ni-Cr).

Cobalt alloys

M042 Cobalt-based alloys (Co alloys).

Light metals

M043 Magnesium alloys (Mg alloys).

Titanium

M044 Commercially pure titanium (Ti CP); M045 Titanium grade 5 (Ti-6Al-4V); M046 Other titanium alloys (Ti alloys).

Zinc

M047 Zinc casting alloys (Zn alloys).

Low-melting alloys

M048 Tin-lead soft solders (Sn-Pb); M051 Lead-free tin solder families (Sn lead-free); M052 Tin-rich casting alloys (Pewter).

Joining alloys

M049 Silver-containing brazing fillers (Ag brazing alloys); M050 Copper-phosphorus brazing alloys (Cu-P).

Precious metals

M053 Gold and gold jewellery alloys (Au); M054 Silver and silver jewellery alloys (Ag); M055 Platinum and platinum alloys (Pt).

Platinum-group metals

M056 Palladium (Pd); M057 Rhodium (Rh); M058 Iridium (Ir); M059 Ruthenium (Ru).

Refractory metals

M060 Tungsten and tungsten alloys (W); M061 Molybdenum and molybdenum alloys (Mo); M062 Tantalum (Ta); M063 Niobium (Nb).

Specialist metals

M064 Zirconium (Zr); M065 Hafnium (Hf); M066 Rhenium (Re).

Alloying elements

M067 Chromium (Cr).

Magnetic materials

M068 Neodymium-iron-boron magnets (NdFeB); M069 Samarium-cobalt magnets (SmCo); M070 Aluminium-nickel-cobalt magnets (Alnico).

Associated materials

M071 Ferrite magnetic ceramics (Ferrite); M072 Polymer-bonded magnetic materials (Bonded magnets).

Technology-metal elements

M073 Lithium (Li); M074 Manganese (Mn); M075 Neodymium (Nd); M076 Praseodymium (Pr); M077 Dysprosium (Dy); M078 Terbium (Tb).

Specialist elements

M079 Gallium (Ga); M080 Germanium (Ge); M081 Bismuth (Bi).

Additional element coverage

M082 Beryllium (Be); M083 Cadmium (Cd); M084 Indium (In); M085 Lead (Pb); M086 Tin (Sn); M087 Vanadium (V); M088 Antimony (Sb); M089 Selenium (Se); M090 Silicon (Si); M091 Tellurium (Te); M092 Osmium (Os).

Ferroalloy feedstocks

M093 Ferrotitanium (Fe-Ti); M094 Ferrozirconium (Fe-Zr); M095 Ferrovanadium (Fe-V); M096 Ferroniobium (Fe-Nb); M097 Ferroaluminium (Fe-Al).

Naming and classification notes

The register retains the scientific relationship behind common names. “Nylon” is a polyamide family; “PVA” may refer to polyvinyl alcohol or be used loosely for polyvinyl-acetate adhesive; EPS is an expanded form of polystyrene; nickel silver is a copper-nickel-zinc alloy. Ferrite magnets are ceramics, despite being indexed

near metallic magnetic materials. An element listed for technology use may be present as an oxide, salt or alloy, not as a pure metal. Material certificates and formulation evidence remain necessary. [4]

Appendix B Measurement specification

Record	Required fields
Feedstock batch	Date, batch ID, supplier/source category, kg, material/grade, evidence, contamination, acceptance decision.
Production batch	Machine, recipe/version, operator hours, electricity/fuel, input kg, good parts and kg, rejects, rework.
Environmental outputs	Water, captured dust, filter changes, solvent losses if relevant, dross/residue mass and authorised destination.
Logistics	Vehicle, fuel, loaded and empty kilometres, payload, incremental customer trips, cancelled journeys and allocation method.
Product and sales	Batch, intended use, tests, units sold, price retained, buyer category, returns, repair and service life evidence.
Employment and public value	Paid hours, FTE definition, pay, training, access arrangements, subsidy, survey method and response count.
Carbon comparison	Functional unit, alternatives, boundaries, factors/version, displacement assumptions, uncertainty and no-double-counting check.

Use calibrated or checked weighing and metering appropriate to the task. Explain moisture changes where wet material is handled. Retain a distinction between measurement, supplier declaration, design target and estimate. Audit trails should allow a reviewer to reproduce the reported totals. Public reports should aggregate personal data while preserving the evidence needed for authorised inspection.

Reproducible calculations

Starter capital = $£15,900 \times 1.15 = £18,285$. With shredder = $(£15,900 + £2,000) \times 1.15 = £20,585$. With HHO = $(£15,900 + £2,000 + £5,500) \times 1.15 = £26,910$.

Pilot units = $20 \text{ accepted parts/hour} \times 4 \text{ hours/day} \times 200 \text{ days} = 16,000$. Product mass = $16,000 \times 0.015 \text{ kg} = 240 \text{ kg}$. Annual model cost = $£18,000 \text{ labour} + £8,000 \text{ overhead} + £1,200 \text{ variable cost} + £3,657 \text{ replacement provision} = £30,857$.

Break-even retained unit price = $£30,857 / 16,000 = £1.929$. Half-sales shortfall at £2 = $£16,000 - £600 - £29,657 = -£14,257$. Six-month cash buffer = $(£18,000 + £8,000 + £1,200) / 2 = £13,600$.

Transport kilometres saved = $5 \text{ trips} \times 2 \times (200 - 20) \text{ km} = 1,800 \text{ km}$. Fuel = $1,800 \times 0.25 = 450 \text{ litres}$. Driving time = $1,800 / 45 = 40 \text{ hours}$. Cost = $£675 \text{ fuel} + £800 \text{ labour} + £630 \text{ other avoidable vehicle cost} = £2,105$.

Solar purchased-electricity savings = annual PV generation $\times$ self-use fraction $\times$ displaced unit price. Product carbon component = finished product mass $\times$ assumed route intensity. Material ledger = opening inventory + receipts – dispatched products – specialist transfers – residues – closing inventory; investigate any unexplained difference.

References

Public sources checked on 10 October 2026 unless the entry states an earlier source-register date. Supplier pages establish advertised details, not independently tested performance. The two preceding project documents provide the design and inventory baseline; new scenarios in this paper are labelled assumptions.

- [1] Project design baseline. Local Recycling Workshop Design and Sourcing 2026-10-10. Eight-page preceding design paper; equipment, layout and estimate.
- [2] Defra. UK statistics on waste. Updated 23 September 2026; household data for 2024. [Open source](#)
- [3] Defra. Local authority collected waste management annual results 2024/25. England; different scope from UK household figures. [Open source](#)
- [4] Project materials baseline. UK Materials Report and UK Materials Inventory 2026-10-09. 208 records, 29 name mappings and 50 original sources; quantities unfilled.
- [5] Precious Plastic. Basic machines. Process examples and manufacturer design specifications. [Open source](#)
- [6] Precious Plastic. Pro machines. Larger extrusion and sheet-press specifications. [Open source](#)
- [7] US Environmental Protection Agency. Guide to Industrial Assessments for Pollution Prevention and Energy Efficiency. Solvent-recovery context; not UK permitting guidance. [Open source](#)
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- [9] Health and Safety Executive. Controlling fume during plastics processing. PPIS13. [Open source](#)
- [10] Health and Safety Executive. Melting and casting metals. FD2. [Open source](#)
- [11] Health and Safety Executive. Safety hazards in the molten metal industries. [Open source](#)
- [12] Eco Wizard Photonic Universe. KIT2-5K listing. Displayed kit price and solar/battery specifications. [Open source](#)
- [13] Okay Energy via Alibaba. 3000W oxyhydrogen welding/brazing unit. Listing 1601620957769; contradictory fields require clarification. [Open source](#)
- [14] Enapter. Electrolyser FAQs. Hydrogen lower heating value. [Open source](#)
- [15] WITT. F53N HHO flashback arrestor. Evidence of gas-specific protection requirements; not a complete system design. [Open source](#)
- [16] GOV UK. Goods sent from abroad: tax and duty. [Open source](#)
- [17] GOV UK. How VAT works: rates. [Open source](#)
- [18] SG CBOX via Alibaba. FC-01 folding shell. Listing 1601581854733. [Open source](#)
- [19] Xinyu Integrated Housing via Alibaba. 20ft folding shell. Listing 1601395156290. [Open source](#)
- [20] ALUDREAM via Alibaba. Expandable shell. Listing 1601423902958. [Open source](#)
- [21] Shenzhen Borx via Alibaba. Mini injection machine. Listing 1600626607348. [Open source](#)
- [22] Foshan ESG via Alibaba. Configurable solar kit. Listing 1600338625008. [Open source](#)
- [23] Kwell. WT200 mini shredder manufacturer listing. [Open source](#)
- [24] HS Walsh. TF58B electric furnace price benchmark. Gold capacity is not aluminium capacity. [Open source](#)
- [25] ByFusion. ByBlock FAQs. Manufacturer application and fire-treatment statements. [Open source](#)
- [26] UNICEF. Recycled plastic brick factory in Côte d'Ivoire with Conceptos Plasticos. 29 July 2019. [Open source](#)

- [27] UN Environment Programme. Building blocks for a greener Nairobi. Nzambi Matee and Gjenje Makers. [Open source](#)
- [28] Precious Plastic. Built shipping-container recycling workspace deployed with Parley. [Open source](#)
- [29] International Labour Organization. Barford and Beales. Decent work opportunities and challenges in recycling. 3 April 2025. [Open source](#)
- [30] GOV UK. National Minimum Wage and National Living Wage rates. April 2026 rates. [Open source](#)
- [31] Department for Energy Security and Net Zero. Greenhouse gas reporting conversion factors 2026. Published 11 June; flat file corrected 31 July 2026. [Open source](#)
- [32] Department for Energy Security and Net Zero. 2026 conversion factors methodology. Material-use and waste-allocation discussion, section 12. [Open source](#)
- [33] Defra and Environment Agency. Food and drink waste hierarchy. [Open source](#)
- [34] Defra and APHA. Supplying and using animal by-products as farm animal feed. [Open source](#)
- [35] RSPB. Keeping garden birds healthy. Feeding hygiene and disease-risk guidance. [Open source](#)
- [36] NOAA. What is a dead zone. Nutrient enrichment, decomposition and oxygen depletion. [Open source](#)
- [37] Environment Agency. U9 using waste to manufacture finished goods. England; heat treatment restriction for plastics and rubber. [Open source](#)
- [38] Environment Agency. T9 recovering scrap metal. England; scope-specific exemption. [Open source](#)
- [39] Health and Safety Executive. Work equipment and machinery introduction. Conformity and supply duties. [Open source](#)

Original materials source register

The following links preserve the original register provenance for Appendix A. They were recorded as accessed on 9 October 2026. Inclusion in a supplier catalogue supports an offer or identity, not verified stock, UK origin or tonnage. The new paper does not turn those catalogue records into measured UK circulation.

- [S01] ISO. ISO 1043-1:2011: polymer symbols. Terminology and abbreviations; full standard not reproduced. [Original source](#)
- [S02] British Plastics Federation. Thermoplastics. Family identification and properties; index contains classification inconsistencies, so not copied as a taxonomy. [Original source](#)
- [S03] British Plastics Federation. Thermosets. Thermoset family coverage; polyurethane abbreviation normalised to PUR, not the index label EP. [Original source](#)
- [S04] Plastribution. Polyolefins. Polyolefin resin supply listings. [Original source](#)
- [S05] Plastribution. Engineering polymers. Engineering resins, blends, elastomers and brand mappings. [Original source](#)
- [S06] Imagro UK. Product portfolio. Names polymers offered through UK warehouses; quantities not independently audited. [Original source](#)
- [S07] Rochling UK. Sheets and blocks. Standard, engineering and high-performance plastics. [Original source](#)
- [S08] Ensinger UK. Material portfolio. Specialist engineering polymers and stock shapes. [Original source](#)
- [S09] Abbey Polymers. Sourcing materials. Engineering resin sourcing offer, not measured sales. [Original source](#)
- [S10] Plastichem. Engineering plastics. Lists engineering and fluoropolymer materials supplied. [Original source](#)
- [S11] Polyflon. Film, tape, sheet and membranes. PTFE and melt-processable fluoropolymer forms. [Original source](#)

- [S12] Butser Rubber. Rubber moulding materials. Elastomer families used in moulding. [Original source](#)
- [S13] BPF. Cellulose acetate compounds suppliers. Directory-level evidence for cellulose acetate compounds. [Original source](#)
- [S14] Solventis. Vinyl acetate monomer. Describes downstream polymers. Does not prove UK sales of each downstream polymer. [Original source](#)
- [S15] Nimac Great Britain. Bioplastic additives and plasticizers. Additives offered for PLA, PHA, PBS, PBAT and starch polymers; does not itself verify resin tonnage. [Original source](#)
- [S16] Scott Bader. UK operations. UK presence and manufacturing context. [Original source](#)
- [S17] Scott Bader. Global product range. Polyester and vinyl ester resin products; precise plant origin is product-dependent. [Original source](#)
- [S18] Ureka. Melamine urea resin adhesive. MUF wood adhesive offer. [Original source](#)
- [S19] Smiths Metal Centres. Technical datasheets. UK offer of named metals, alloys and engineering plastics. Grade listings are not batch certificates. [Original source](#)
- [S20] Aalco. Copper and copper-alloy datasheets. Copper, brass and bronze grade cross-references; specifications need product-level checks. [Original source](#)
- [S21] British Stainless Steel Association. Stainless-steel grade datasheets. EN grade coverage; some standard grades are not practically available. [Original source](#)
- [S22] thyssenkrupp Materials UK. 304 / 1.4301 stainless steel. 304, 304L and common specification mappings; warns standards can differ. [Original source](#)
- [S23] Trent Castings. Grey and ductile iron. Grey, ductile and austempered ductile iron manufacture. [Original source](#)
- [S24] Archibald Young. Iron alloys. Grey, ductile and Ni-Resist cast iron. [Original source](#)
- [S25] ZAMAK. Zinc casting alloys. Indexed manufacturer/supplier listing; full page retrieval failed. [Original source](#)
- [S26] CuP Alloys. Products. Tin-lead solders, silver brazing alloys and copper-phosphorus rods. [Original source](#)
- [S27] Cooksongold. Bullion for jewellery making. Gold, silver, platinum, jewellery alloys, sheet and wire. [Original source](#)
- [S28] Johnson Matthey. PGM trading. Platinum, palladium, rhodium, iridium and ruthenium; bulk precious metals. [Original source](#)
- [S29] Avon Specialty Metals. Superalloy recycling. UK processing offer for Ni/Co/Fe superalloys and named refractory metals. [Original source](#)
- [S30] MTT Supplies and Fabrications. Refractory metals. W, Mo, Ta, Nb, Zr and specialist compositions. [Original source](#)
- [S31] Magnet Expert. Permanent magnet materials. NdFeB, SmCo, Alnico, ferrites and bonded magnets. [Original source](#)
- [S32] Goodfellow. Materials sitemap. UK URL redirected to USA. Used for taxonomy only, not confirmation of UK supply. [Original source](#)
- [S33] ONS. UK manufacturers sales by product: 2025. Release 24 July 2026. Product sales, disclosure gaps, basic steel exclusions from totals. [Original source](#)
- [S34] HMRC. UK Trade Info API. Commodity-level trade, net mass and value. Data extraction not undertaken in this inventory stage. [Original source](#)
- [S35] ONS. Material flow accounts. Release 20 August 2026, data 1990-2024. Broad economy-level flows. [Original source](#)

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- [S37] BGS / CMIC. UK 2024 criticality assessment. 82 candidate materials, 34 assessed critical. Criticality is not recyclability. [Original source](#)
- [S38] BGS / CMIC. Waste and scrap flows in the UK: copper and tungsten. 2025, OR/25/050. Abstract identifies copper recovery opportunities and data gaps. [Original source](#)
- [S39] BGS / CMIC. Future demand and secondary supply for UK net zero technologies. 2026, OR/26/027. Technology-specific modelling, not an all-material census. [Original source](#)
- [S40] BPF. Plastics additives. Additive functions must be stored separately from polymer identity. [Original source](#)
- [S41] BGS. UK 2024 criticality assessment overview. Names relevant specialist elements and national criticality findings. [Original source](#)
- [S42] Ensinger UK. Polyamide-imide. PAI stock shapes and Torlon relationship. [Original source](#)
- [S43] Kuraray. Polyvinyl alcohol. PVOH resin and films; UK downstream sales not separately established. [Original source](#)
- [S44] Cooksongold. Platinum casting grain. 950 platinum casting grain. [Original source](#)
- [S45] Fluorocarbon. PCTFE. PCTFE manufacturing, machining and stock forms; UK location listed. [Original source](#)
- [S46] Ceetak. ACM and AEM. Polyacrylate and ethylene-acrylate sealing compounds. [Original source](#)
- [S47] Ceetak. NBR and HNBR. Hydrogenated nitrile sealing compounds. [Original source](#)
- [S48] Ceetak. FFKM. Perfluoroelastomer sealing compounds. [Original source](#)
- [S49] Avon Metals. Aluminium casting alloys. LM and AA casting alloys; offers remelting of customer scrap. [Original source](#)
- [S50] Avon Metals. Ferro alloys. Ferro-titanium, zirconium, vanadium, niobium and aluminium. [Original source](#)