

**PERFORMANCE AND ECONOMIC WASTE ASSESSMENT (PEWA) METHODOLOGY**

**INTRODUCTION**

A Performance and Economic Waste Assessment (PEWA) methodology was developed part of the government and industry funded “Built Environment Action on Waste Awareness and Resource Efficiency” (BEAWARE) project. The PEWA methodology is a waste mapping and decision support tool to explore waste recycling potential opportunities. It addresses several issues such as: gathering lifecycle data on waste types and quantities; examining disposal and current recycling costs; identifying and addressing reuse and recycling limiting factors (i.e. economic, technical and environmental); ranking waste materials in terms of their recycling potential; and assessing the feasibility of reprocessing routes. The PEWA methodology comprises ten stages, which are summarised below.

**THE PEWA METHODOLOGY STAGES**

<p><b>Stage 1: Waste Targeting</b></p> <p>Waste materials produced within a process or sector are listed, and their lifecycle occurrence (i.e. manufacture, distribution, point of use and end of life) is identified.</p>	<p style="text-align: center;"><b>Waste Targeting</b></p> <p style="text-align: center;">Sector/process <input style="width: 100px;" type="text"/></p> <p><input type="radio"/> Manufacture <input style="width: 150px;" type="text"/></p> <p><input type="radio"/> Distribution <input style="width: 150px;" type="text"/></p> <p><input type="radio"/> Point of use <input style="width: 150px;" type="text"/></p> <p><input type="radio"/> End of life <input style="width: 150px;" type="text"/></p>																								
<p><b>Stage 2: Waste composition</b></p> <p>Information regarding physical and chemical composition of the identified wastes from Stage 1 is then collected. The aim is to identify which materials may be currently classified as hazardous. If hazardous waste materials are identified and are currently disposed of to landfill, it is recommended to focus on the non hazardous waste materials in Stage 3.</p>	<p style="text-align: center;"><b>Waste composition</b></p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 25%;">Waste material</th> <th style="width: 45%;">Waste composition</th> <th style="width: 30%;">Is waste sent to landfill?</th> </tr> </thead> <tbody> <tr><td><input style="width: 60px;" type="text"/></td><td><input style="width: 100px;" type="text"/></td><td><input type="radio"/> Yes <input type="radio"/> No</td></tr> <tr><td><input style="width: 60px;" type="text"/></td><td><input style="width: 100px;" type="text"/></td><td><input type="radio"/> Yes <input type="radio"/> No</td></tr> <tr><td><input style="width: 60px;" type="text"/></td><td><input style="width: 100px;" type="text"/></td><td><input type="radio"/> Yes <input type="radio"/> No</td></tr> <tr><td><input style="width: 60px;" type="text"/></td><td><input style="width: 100px;" type="text"/></td><td><input type="radio"/> Yes <input type="radio"/> No</td></tr> <tr><td><input style="width: 60px;" type="text"/></td><td><input style="width: 100px;" type="text"/></td><td><input type="radio"/> Yes <input type="radio"/> No</td></tr> <tr><td><input style="width: 60px;" type="text"/></td><td><input style="width: 100px;" type="text"/></td><td><input type="radio"/> Yes <input type="radio"/> No</td></tr> </tbody> </table>	Waste material	Waste composition	Is waste sent to landfill?	<input style="width: 60px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input type="radio"/> Yes <input type="radio"/> No	<input style="width: 60px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input type="radio"/> Yes <input type="radio"/> No	<input style="width: 60px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input type="radio"/> Yes <input type="radio"/> No	<input style="width: 60px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input type="radio"/> Yes <input type="radio"/> No	<input style="width: 60px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input type="radio"/> Yes <input type="radio"/> No	<input style="width: 60px;" type="text"/>	<input style="width: 100px;" type="text"/>	<input type="radio"/> Yes <input type="radio"/> No			
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<p><b>Stage 3: Waste prioritising</b></p> <p>Waste prioritising comprises an initial screening process, whereby the main recycling drivers and barriers associated with the listed wastes from Stage 2 are identified and analysed. Based on the findings of recycling benefits and constraints, waste materials are then ranked in terms of their recycling potential and the top waste materials with high recycling attributes are examined and assessed further in Stage 4.</p>	<p style="text-align: center;"><b>Waste Prioritising</b></p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 25%;">Waste material</th> <th style="width: 20%;">Re-use/recycling Drivers</th> <th style="width: 20%;">Re-use/recycling Barriers</th> <th style="width: 35%;">Ranking</th> </tr> </thead> <tbody> <tr><td><input style="width: 60px;" type="text"/></td><td><input style="width: 80px;" type="text"/></td><td><input style="width: 80px;" type="text"/></td><td style="text-align: center;"><input type="checkbox"/></td></tr> <tr><td><input style="width: 60px;" type="text"/></td><td><input style="width: 80px;" type="text"/></td><td><input style="width: 80px;" type="text"/></td><td style="text-align: center;"><input type="checkbox"/></td></tr> <tr><td><input style="width: 60px;" type="text"/></td><td><input style="width: 80px;" type="text"/></td><td><input style="width: 80px;" type="text"/></td><td style="text-align: center;"><input type="checkbox"/></td></tr> <tr><td><input style="width: 60px;" type="text"/></td><td><input style="width: 80px;" type="text"/></td><td><input style="width: 80px;" type="text"/></td><td style="text-align: center;"><input type="checkbox"/></td></tr> <tr><td><input style="width: 60px;" type="text"/></td><td><input style="width: 80px;" type="text"/></td><td><input style="width: 80px;" type="text"/></td><td style="text-align: center;"><input type="checkbox"/></td></tr> </tbody> </table>	Waste material	Re-use/recycling Drivers	Re-use/recycling Barriers	Ranking	<input style="width: 60px;" type="text"/>	<input style="width: 80px;" type="text"/>	<input style="width: 80px;" type="text"/>	<input type="checkbox"/>	<input style="width: 60px;" type="text"/>	<input style="width: 80px;" type="text"/>	<input style="width: 80px;" type="text"/>	<input type="checkbox"/>	<input style="width: 60px;" type="text"/>	<input style="width: 80px;" type="text"/>	<input style="width: 80px;" type="text"/>	<input type="checkbox"/>	<input style="width: 60px;" type="text"/>	<input style="width: 80px;" type="text"/>	<input style="width: 80px;" type="text"/>	<input type="checkbox"/>	<input style="width: 60px;" type="text"/>	<input style="width: 80px;" type="text"/>	<input style="width: 80px;" type="text"/>	<input type="checkbox"/>
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**Stage 4: Waste causes, quantities and value**

Stage 4 requires further examination of the waste material quantities (including percentages of the total arisings occurring during each lifecycle stage). For each selected waste from Stage 3, mapping information of waste causes and descriptions, quantities and market value, and whether or not waste is segregated at source is collected. Waste is also identified as either a “wet” or “dry”. At the end of Stage 4, the decision process is based on waste materials which are segregated, occur in medium to high quantities, and have a high market value. The use of the terms “high”, “medium” or “low” are subjective and will vary depending on the market value of waste materials.

**Waste descriptions and causes**

Waste material

“Wet waste”  “Dry waste”

	Descriptions	Causes	Rank (quantity)
<input type="radio"/> Manufacture	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="radio"/> Distribution	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="radio"/> Storage	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="radio"/> Point of use	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="radio"/> End of life	<input type="text"/>	<input type="text"/>	<input type="text"/>

**Waste quantities and market value**

Waste material

	Quantity	Market value	Is waste segregated?
	Rating * %	Rating * £/tonne	
<input type="radio"/> Manufacture	<input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
<input type="radio"/> Distribution	<input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
<input type="radio"/> Storage	<input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
<input type="radio"/> Point of use	<input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No
<input type="radio"/> End of life	<input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No

\* High (over 50%), medium (25% - 50%), low (<25%)

**Stage 5: Waste costs and current recycling status**

Quantities of waste currently sent to landfill, re-used or/and recycled are quantified in Stage 5. For wastes which are being disposed of, their landfill locations and potential recovery and recycling routes are examined. For waste materials currently re-used or recycled, information gathering includes whether the recovery process is conducted on-site or off-site, the current reuse or/and recycling locations and applications, and an indication as to whether the application is low-grade or high-grade. Additionally, disposal costs and reuse or/and recycling costs are also studied. These are further divided into categories, including waste handling, transport, landfill tax and reprocessing. From the above information, waste materials which are entirely recovered and used in high-grade applications are not considered further in Stage 6.

**Cost of waste disposal and recovery**

Waste material

**Disposal cost**

% total cost	Collection/handling	Transport	Landfill tax
<input type="text"/>	Rating * <input type="text"/>	Rating * <input type="text"/>	Rating * <input type="text"/>
	% <input type="text"/>	% <input type="text"/>	% <input type="text"/>
	£/tonne <input type="text"/>	£/tonne <input type="text"/>	£/tonne <input type="text"/>

**Recovery cost**

% total cost	Collection/handling	Transport	Reprocessing
<input type="text"/>	Rating * <input type="text"/>	Rating * <input type="text"/>	Rating * <input type="text"/>
	% <input type="text"/>	% <input type="text"/>	% <input type="text"/>
	£/tonne <input type="text"/>	£/tonne <input type="text"/>	£/tonne <input type="text"/>

\* High (must be reduced immediately), medium, low (minor costs)

**Current waste status and destinations**

Waste material

**Quantity sent to landfill**

% total	Recycling potential	Reasons
<input type="text"/>	<input type="text"/>	Characteristics <input type="text"/>
		Potential applications <input type="text"/>
		Landfill locations <input type="text"/>

**Quantity being recovered**

% total	% on-site	% re-used	% off-site	Applications
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
				Destinations <input type="text"/>
				<input type="text"/>

**Stage 6: Re-use/recycling limiting factors**

Factors which may restrict or even prevent re-use or recycling of the selected waste materials are investigated in Stage 6. These are generally classified under four categories: economic, technical, environmental and others (i.e. logistical). The weighting of limiting factors are low (easily addressed); medium (restricts re-use/recycling); and critical (prevents re-use or recycling). Wastes which are not affected by critical limiting factors are then selected to proceed to Stage 7.

**Re-use / recycling limiting factors**

Waste material

Limiting factor	Description	Rating *
<input type="text"/>	<input type="text"/>	<input type="radio"/> Low <input type="radio"/> Medium <input type="radio"/> Critical
<input type="text"/>	<input type="text"/>	<input type="radio"/> Low <input type="radio"/> Medium <input type="radio"/> Critical
<input type="text"/>	<input type="text"/>	<input type="radio"/> Low <input type="radio"/> Medium <input type="radio"/> Critical
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<input type="text"/>	<input type="text"/>	<input type="radio"/> Low <input type="radio"/> Medium <input type="radio"/> Critical

\* Low = tolerable; Medium = restricts re-use or recycling; Critical = prevents re-use or recycling

**Stage 7: Addressing the limiting factors**

In Stage 7, potential recommendations for addressing the limiting factors and associated timeframes are explored. The limiting factors are classified as E (economic), T (technical), Env (environmental), or O (other); the timeframe may be ST (short-term), MT (medium-terms), or LT (long-term). Waste materials, for which limiting factors could be addressed over a suitable timeframe related to the company’s priorities and resources, through optimisation (i.e. testing programme), are then selected for further investigation in Stage 8.

Addressing the limiting factors		Category				Timeframe		
Limiting factor	Recommendation	E	T	Env	O	ST	MT	LT
<input type="text"/>	<input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="text"/>	<input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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<input type="text"/>	<input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

(E) = economic; (T) = technical; (Env) = environmental; (O) = other  
(ST) = short-term; (MT) = medium-term; (LT) = long-term

**Stage 8: re-use/recycling opportunities**

The re-use and/or recycling routes are investigated in Stage 8, including those currently being pursued. Reprocessing methods are constantly being developed and there may be more profitable, higher-grade applications for waste materials currently reprocessed for low-grade applications. The current and potential re-use and recycling routes for the selected waste material are identified. These may involve onsite recycling waste, same sector, cross sector or pan-industry recycling.

Re-use/recycling opportunities		Sector			Environmental impact		
Re-use	Details	OS	SS	CS	Increase	Neutral	Decrease
Current route	<input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Alternative route 1	<input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Alternative route 2	<input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recycling	Details	OP	SS	CS	Increase	Neutral	Decrease
Current route	<input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Alternative route 1	<input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Alternative route 2	<input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

(OS) = material recovered on-site; (SS) = material recovered within same sector; (CS) = material recovered in different sector (cross-sector)

In addition, reprocessing routes which lead to an overall reduction in CO<sub>2</sub> emissions emanating from the product lifecycle should be identified. Any re-use or recycling routes known to have a negative impact on the environment (i.e. increase of CO<sub>2</sub> emissions) should be discarded.

**Stage 9: re-use/recycling requirements**

Information regarding waste material or recycled product properties is collected. Standards (e.g. impurities content, mechanical strength) may be imposed by waste recycling contractors, or will be detailed in codes and standards such as British Standards and other relevant documents (i.e. Highways Agency specifications for recycled aggregate). Waste materials which comply with the relevant codes and specifications and standards are selected for the final PEWA stage.

Re-use/recycling requirements		Re-use/ recycling route
Waste material <input type="text"/>		
Description of re-use/recycling processes <input type="text"/>		
Essential material properties		Attainable
Physical	<input type="text"/>	Yes <input type="radio"/> No <input type="radio"/>
Chemical	<input type="text"/>	Yes <input type="radio"/> No <input type="radio"/>
Other	<input type="text"/>	Yes <input type="radio"/> No <input type="radio"/>

**Stage 10: Re-use/recycling costs and markets**

For reprocessing the waste material, a detailed investigation needs to be conducted in the last PEWA Stage on the capital and operational costs, the payback period, as well as current market prices and their variations. Capital costs include purchasing machinery and equipment, fees (e.g. consultants’ fees during design and development), buildings (e.g. new, or alterations), overheads (e.g. administrative, licensing), and possibly land being purchased. Operational costs include labour, equipment operations (including fuel consumption), equipment maintenance (e.g. repairs), overheads (e.g. inspections), and possibly rent paid for use of the land. The influence of future environmental legislation on the viability of reprocessing should also be considered. The market for primary and recycled materials should also be investigated, including current market prices, how these have altered during the past few years, and what changes may occur in the near future.

