Innovation in cleaner production through waste recycling assessment and optimisation

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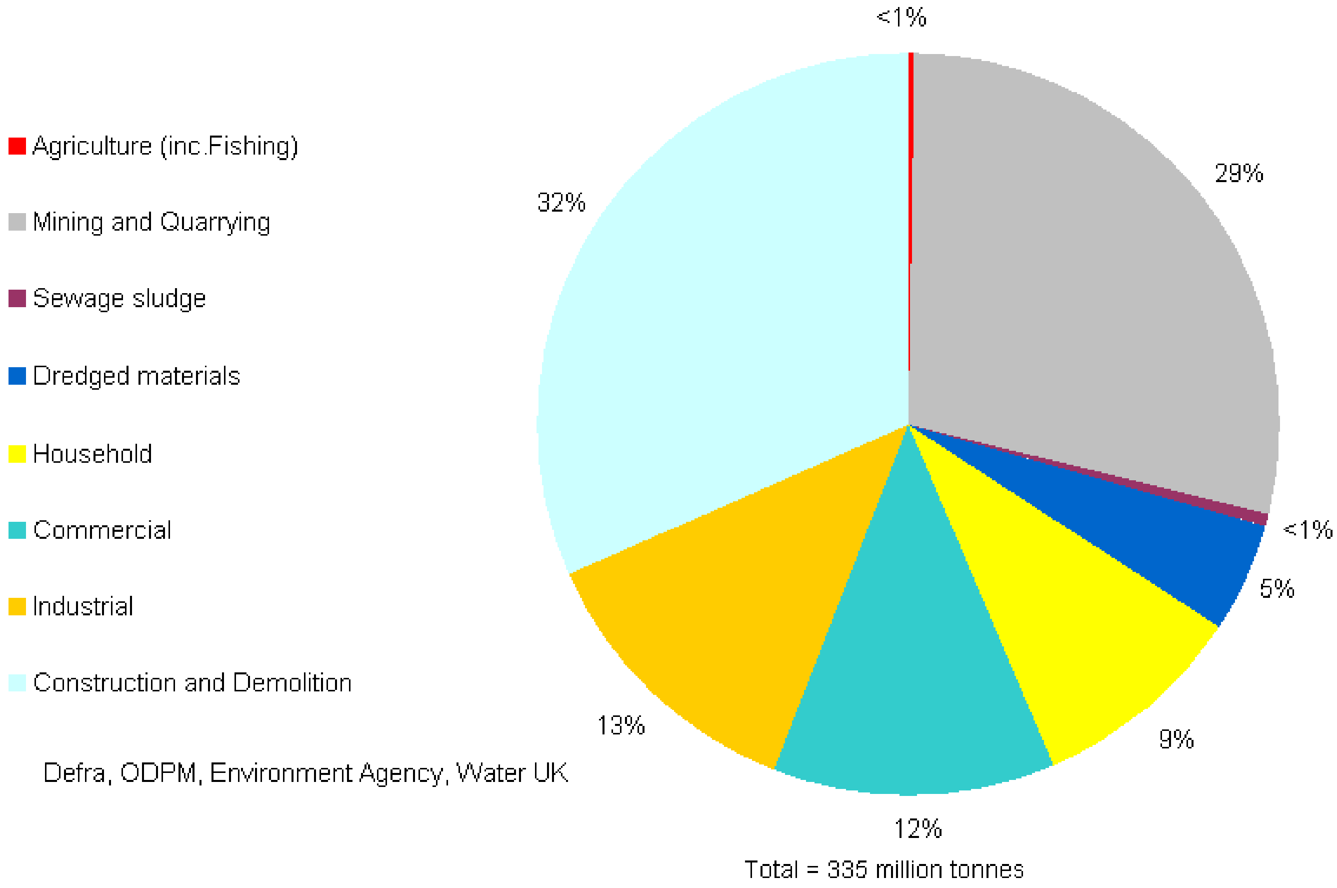
Overview

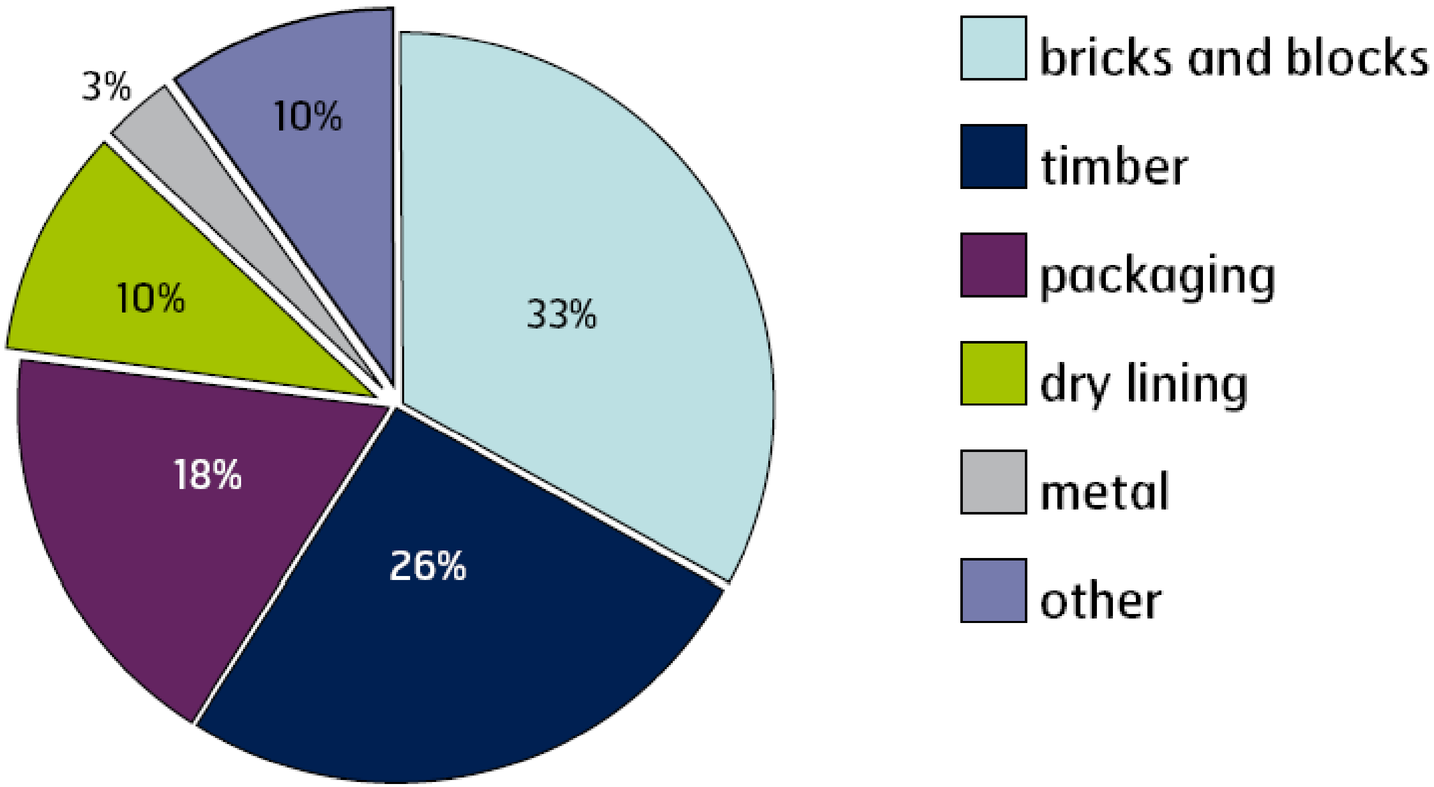
1. Background
2. Project context: **B**uilt **E**nvironment **A**ction on **W**aste **A**wareness and **R**esource **E**fficiency (**BEAWARE**)
3. Performance , Economic and Environmental Recycling Assessment (PEERA) Methodology
4. PEERA Validation
5. Recycling optimisation testing programme

1. Background

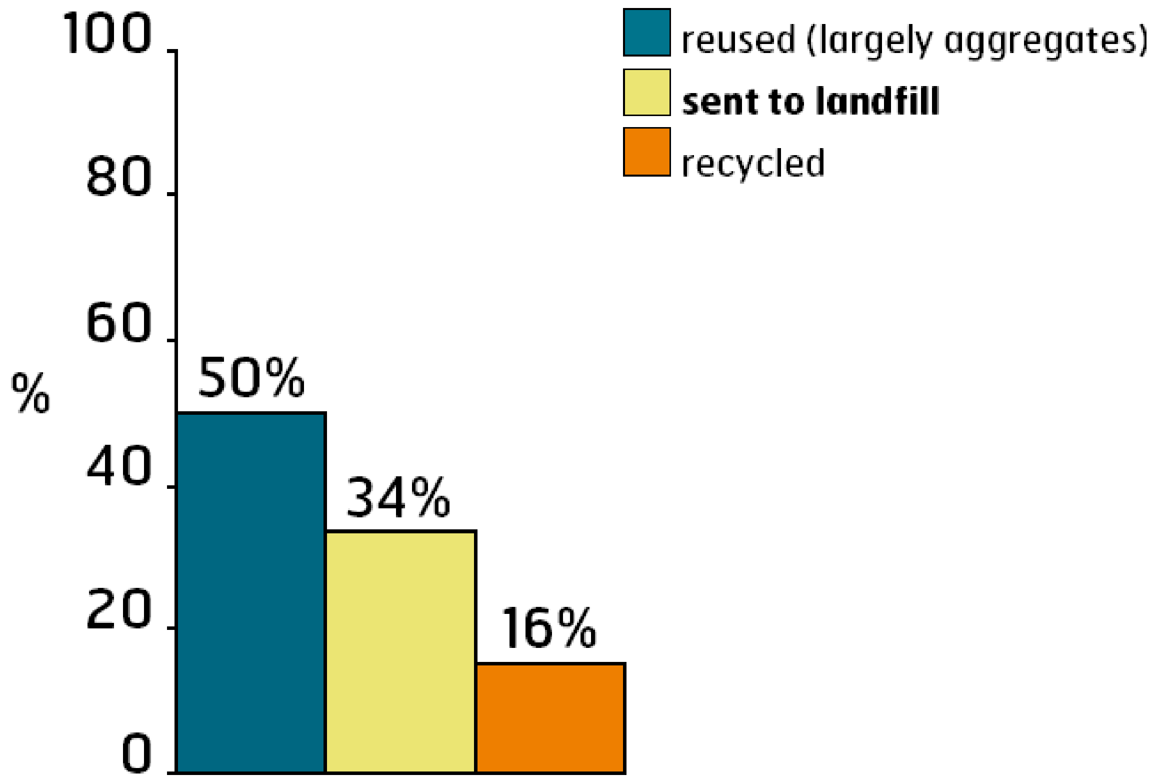


Annual waste arisings by sector in the UK

1. Background: waste streams



1. Background: waste destinations



2. Project Context

be aware

Built Environment Action on Waste Awareness and Resource Efficiency (BEAWARE)

2. Project Context

be aware

- Founding body: Technology Strategy Board (TSB), Department for Business, Innovation & Skills UK
- Project value: £1.7 million
- Duration: 30 months
- Consortium: 14 industrial partners and 2 research institutions: Loughborough University & Building Research Establishment (BRE)

2. Project Context

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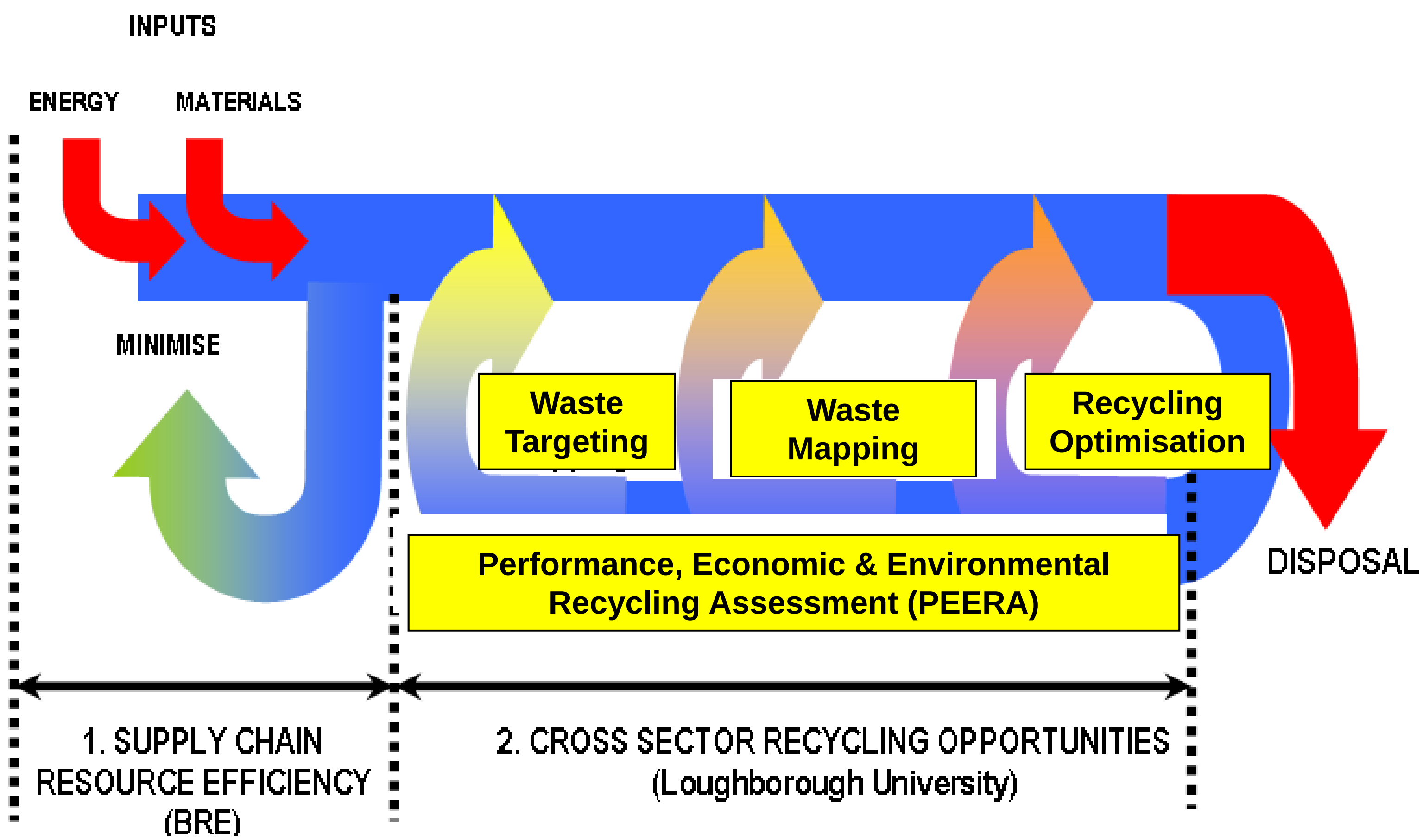


3. Performance, Economic & Environmental Recycling Assessment (PEERA) Methodology

M1. Waste targeting
M2. Waste composition and hazards
M3. Waste prioritising
M4. Waste sources, quantities and value
M5. Waste costs and current recycling status
M6. Re-use/recycling limiting factors
M7. Addressing the limiting factors
M8. Re-use/recycling options
M9. Re-use/recycling requirements
M10. Re-use/recycling costs and market value

3. PEERA Methodology Stage 1

Waste Targeting

Sector/process [ ]

- ○ Manufacture [ ]
- ○ Distribution [ ]
- ○ Point of use [ ]
- ○ End of life [ ]

3. PEERA Methodology Stage 2

Waste composition

Waste material	Waste composition	Is waste sent to landfill?
		○ Yes ○ No
		○ Yes ○ No
		○ Yes ○ No
		○ Yes ○ No
		○ Yes ○ No
		○ Yes ○ No

3. PEERA Methodology Stage 3

Waste Prioritising

Waste material	Re-use/recycling Drivers	Re-use/recycling Barriers	Ranking

3. PEERA Methodology Stage 4a

Waste descriptions and causes

Waste material [ ]

"Wet waste" ○ **"Dry waste"** ○

	Descriptions	Causes	Rank (quantity)
○ Manufacture			
○ Distribution			
○ Storage			
○ Point of use			
○ End of life			

3. PEERA Methodology Stage 4b

Waste quantities and market value

Waste material ____

	Quantity		Market value		Is waste segregated?
	Rating *	%	Rating *	£/tonne	
○ Manufacture					○ Yes ○ No
○ Distribution			£/tonne		○ Yes ○ No
○ Storage			£/tonne		○ Yes ○ No
○ Point of use			£/tonne		○ Yes ○ No
○ End of life			£/tonne		○ Yes ○ No

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

3. PEERA Methodology Stage 5a

Cost of waste disposal and recovery

Waste material ______

Disposal cost

% total cost	**Collection/handling**		**Transport**		**Landfill tax**	
	Rating *		Rating *		Rating *	
	%		%		%	
	£/tonne		£/tonne		£/tonne	

Recovery cost

% total cost	**Collection/handling**		**Transport**		**Reprocessing**	
	Rating *		Rating *		Rating *	
	%		%		%	
	£/tonne		£/tonne		£/tonne	

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

3. PEERA Methodology Stage 5b

Current waste status and destinations

Waste material [ ]

Quantity sent to landfill

% total [ ]

Recycling potential [ ]

Reasons [ ]
Characteristics [ ]
Potential applications [ ]
Landfill locations [ ]

Quantity being recovered

% total [ ]

% re-used [ ]
% on-site [ ]
% off-site [ ]
Applications [ ]
Destinations [ ]

% recycled [ ]
% on-site [ ]
% off-site [ ]
Applications [ ]
Destinations [ ]

3. PEERA Methodology Stage 6

Re-use / recycling limiting factors

Waste material ______

	Description	Rating *		
Limiting factor		○ Low	○ Medium	○ Critical
Limiting factor		○ Low	○ Medium	○ Critical
Limiting factor		○ Low	○ Medium	○ Critical
Limiting factor		○ Low	○ Medium	○ Critical
Limiting factor		○ Low	○ Medium	○ Critical
Limiting factor		○ Low	○ Medium	○ Critical

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

3. PEERA Methodology Stage 7

Addressing the limiting factors

Waste material

Limiting factor	Recommendation	Category E	Category T	Category Env	Category O	Timeframe ST	Timeframe MT	Timeframe LT

(E) = economic; (T) = technical; (Env)= environmental; (O) = other

(ST) = short-term; (MT) = medium-term ; (LT) = long-term

3. PEERA Methodology Stage 8

Re-use/recycling opportunities

Waste material

Re-use	Details	Sector			Environmental impact		
		OS	**SS**	**CS**	**Increase**	**Neutral**	**Decrease**
Current route		○	○	○	○	○	○
Alternative route 1		○	○	○	○	○	○
Alternative route 2		○	○	○	○	○	○

Recycling	Details	Sector			Environmental impact		
		OP	**SS**	**CS**	**Increase**	**Neutral**	**Decrease**
Current route		○	○	○	○	○	○
Alternative route 1		○	○	○	○	○	○
Alternative route 2		○	○	○	○	○	○

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

3. PEERA Methodology Stage 9

Re-use/recycling requirements

Waste material ____ **Re-use/ recycling route** ____

Description of re-use/recycling processes

____

Essential material properties

		Attainable	
		Yes	No
Physical		○	○
Chemical		○	○
Other		○	○

3. PEERA Methodology Stage 10: Recycling costs and market value

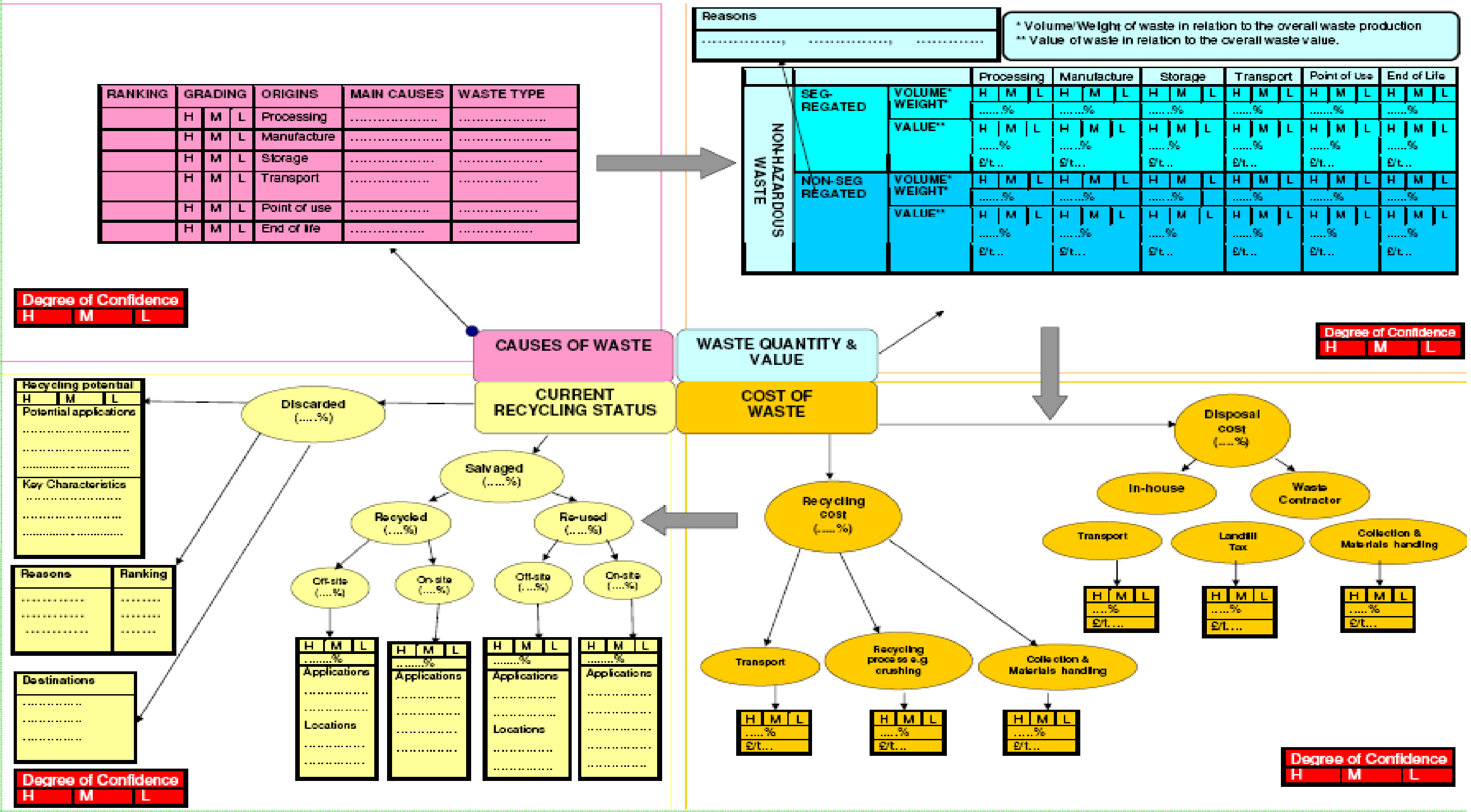
- Capital costs: land, facility, machinery, etc.
- Operational costs: labour, running costs, etc.
- Payback period
- Markets
  - Prices: recycled products vs equivalent non-recycled materials
  - Price variations

4. PEERA Validation: Waste Targeting & Prioritising

1. Background
2. Project Context
3. PEEWA Methodology
4. **PEEWA Validation**
5. Recycling Optimisation Recycling Programme

Recycling Potential Ranking	Cluster 1 PLASTICS	Cluster 2 WOOD / TIMBER	Cluster 3 BRICKS & BLOCKS	Cluster 4 CEMENT & CONCRTE	Cluster 5 'catch all' MANUFACTURING	Cluster 6 – A 'catch all' CONSULTANTS	Cluster 6 – B 'catch all' CONSULTANTS
1	GRP (Glass-reinforced plastic)	Saw dust chips	Spoilt products on site	Unsaleable product	Timber (packaging)	Packaging	packaging (pallets, shrink wrap, bubble wrap, boxes, polystyrene, plastic containers (contaminated), aerosols, plastic/metal wrapping bands, skids, cordex sheets.
2	PVC (Polyvinyl Chloride)	Wood panel off cuts	Demolition wastes	Packaging waste	Glass	Subsoil extraction Spoil (1)	Composites (materials mixed together, materials joined –laminated, product composed of > 1 material) Polymer composites (cladding, door, decking, rooflights & rooftiles, strengthening plates) Laminated composites (worksurfaces, furniture, doors, SIPS, mmc)
3	PE (Polyethylene)	Metal (packaging, incl containers/tins)	Scrubber / exhaust wastes	Factory waste (PPE, kitchen waste, oily waste, fabric waste etc)	Stone washing fines	Timber (Treated)	Plasterboard
4	PU (polyurethane)	WESP Sludge	Packaging	Expired cement	Plastic (packaging)	Plasterboard	Plastics (plastic pipes. Window frames, doors, soffits & fascias, ducting – conduit, rooflights, flooring, temporary materials: plastic covering for floors)
5	PES (Polyether sulphone) / XPS	Plastic waste	Unusable products (factory)	Bypass dust	Plasterboard	Subsoil extraction Spoil (2)	Glass (windows)
6	EPDM (Ethylene Propylene Diene Monomer)	Treated wood			Insulation	Timber (untreated)	
7	PET (Polyethylene Terephthalate)				Air filter fines	Hard Core	
8	PP (Polypropylene)				MDF		
9	Rubber				Steel		

4. PEERA Validation: Waste Mapping (data collection)



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4. PEERA Validation: Waste Mapping (data results)

PLASTICS	WOOD / TIMBER	BRICKS & BLOCKS	CEMENT & CONCRTE	INSULATION
GRP (Glass-reinforced plastic)	Saw dust chips off cuts	Demolition wastes: Concrete bricks	Unsaleable product	Trimmings from insulation
PVC roofing	Wood panel off cuts	Demolition wastes: Clay bricks	Damaged concrete flooring	Plasterboard off-cuts
PVC profile	WESP	Scrubber / exhaust wastes	Intermediate bulk containers (factory waste)	
Polyethylene (PE) packaging		Damaged clay bricks (factory waste)	Cement kiln dust	
			Reject pre-cast concrete units	

4. PEERA Validation (data collection)

A. Material Performance Assessment

- Composition
- Required properties and material for re-use and/or recycling
- Alternative re-use or recycling methods (if any)

B. Economic Assessment

- Capital and operational costs for re-use and/or recycling
- Pay-back period for recycling or re-use investment
- Environmental regulations
- Market value of re-used and/or recycled material, and comparison with the market value of equivalent primary standard products

4. PEERA Validation (material performance & economic assessment results)

PLASTICS	WOOD / TIMBER	BRICKS & BLOCKS	CEMENT & CONCRTE	INSULATION
GRP (Glass-reinforced plastic)	Wood panel off-cuts	Concrete blocks from demolition	Damaged concrete flooring	Trimmings from insulation
PVC profile		Clay bricks from demolition	Reject pre-cast concrete units	Plasterboard off-cuts
		Damaged clay bricks (factory)		

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4. PEERA Validation

Selection criteria of resulting waste materials through the validation of PEWA methodology:

- chemically stable & occur in sufficient abundance;
- sorted at source & high landfilling rate;
- do not incur excessive collection; transportation and processing costs;
- can be easily linked with markets for the recycled products; and
- produce results within the BEAWARE project timeframe

Selected waste: Glass Reinforced Plastic (GRP)

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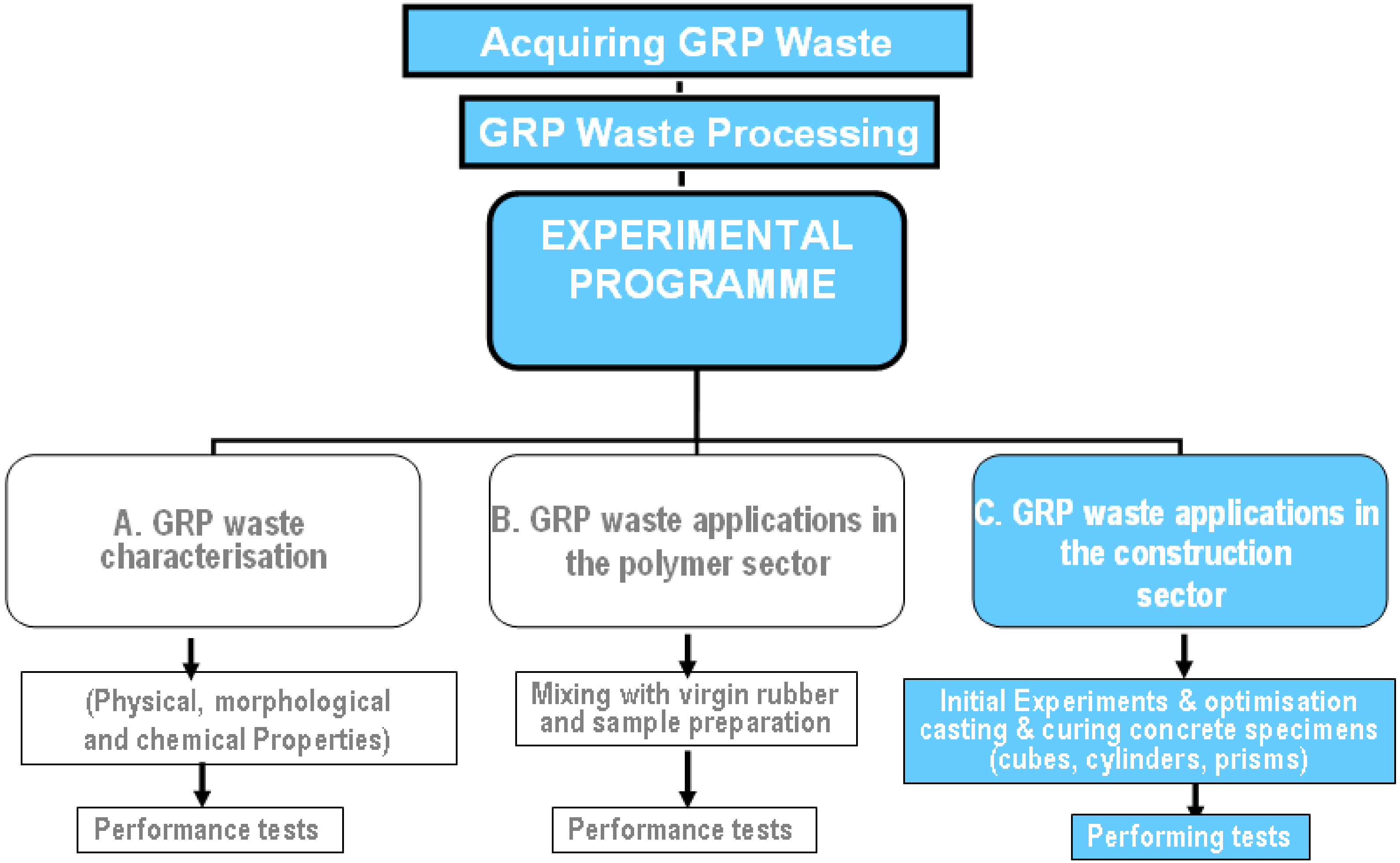
5. GRP Recycling Testing Programme



5. GRP Recycling Testing Programme

GRP waste processing

Sieving GRP waste

Fibre content < 5%

Powder content about 95%

5. GRP Recycling Testing Programme

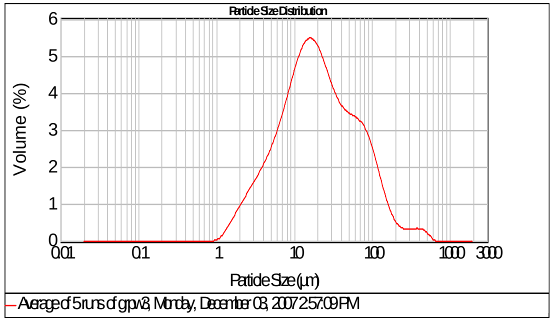
GRP waste characterisation

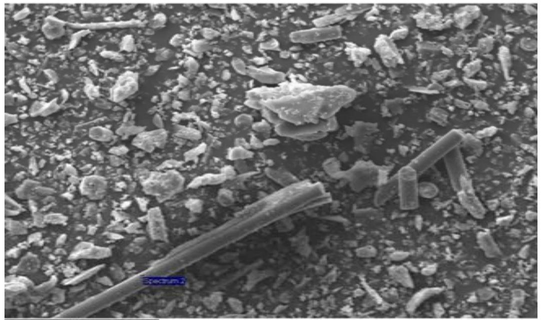
Physical Characterisation

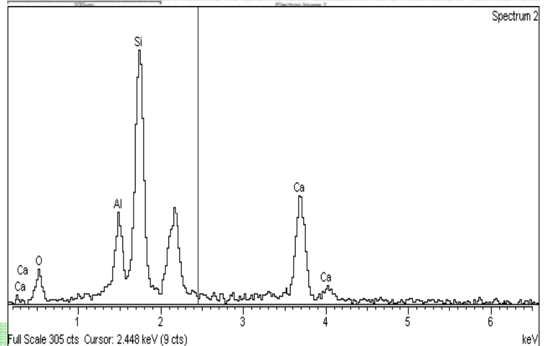
1. Particle size analysis and particle distribution profile
2. Morphological studies

Chemical Characterisation

1. Glass transition temperature
2. Thermal properties
3. Elemental composition
4. Chemical composition and polymer types







5. GRP Recycling Testing Programme

GRP-waste filled rubber composites

Prototype: Anti-vibration pad using 50 % GRP powder

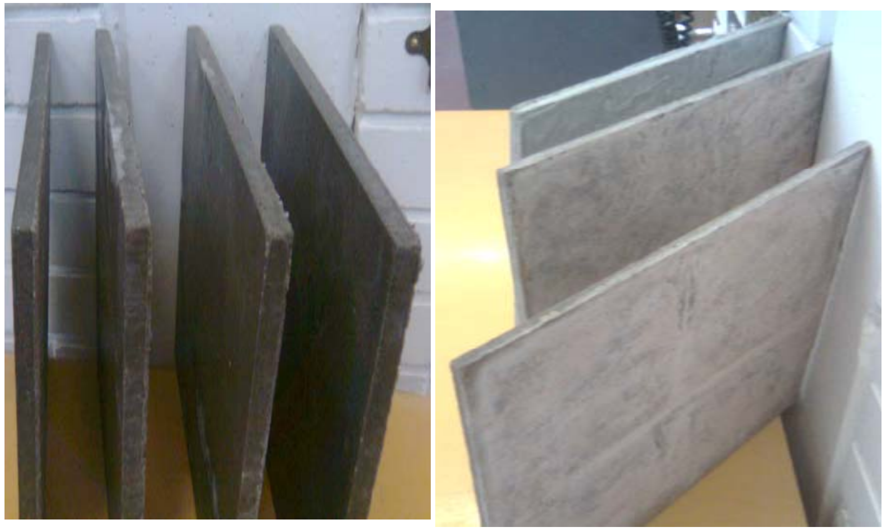
Other application:
- Carpet underlay
- Bearing pads
- Paving drainage pads
- Bridge & concrete expansion joints
- Rubber water stops

Rubber sample for hardness test

5. GRP Recycling Testing Programme

GRP waste filled concrete & cement composites

190 GRP waste powder filled concrete composite specimens



GRP waste fibre filled cement composites
Produced panels: (30x30 cm) 8 &12 mm thick

5. GRP Recycling Testing Programme

Applications: GRP waste filled concrete & cement composites

- Architectural cladding panels
- Precast paving slabs
- Roof tiles
- Precast wall elements
- Light weight concrete
- Concrete blocks

Full compliance tests such as durability and fire properties for specific applications are recommended.

Acknowledgement

- The Technology Strategy Board (UK) for funding this research
- The BEAWARE project partners and their members for their cooperation
- Hambleside Danelaw Rooflights and Cladding Limited (Scotland) for supplying GRP waste samples

Thank you

Any Questions?