DELIVERABLE REPORT SUMMARY

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Project acronym:	URBANREC
Project Title:	*'New approaches for the valorisation of URBAN bulky waste into high added value RECycled products'*
Funding scheme:	Innovation Project H2020-WASTE-2015. Eco-innovative solutions
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Deliverable nº & name:	D2.5 Definition of final URBANREC demonstrators
Due date of D:	November 30, 2016
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Participant responsible:	13 -COLCHONES DELAX, S.L.
Date of the last version of the Annex I against which the assessment will be made:	3rd May 2016
Project coordinator:	AIMPLAS
Project website address:	www.**URBANREC**-project.eu

Dissemination Level		
PU	Public	√
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

1. Objectives

The main objective of this deliverable is to define the minimum specifications of each product to be developed in the present URBANREC project, in order to analyse and evaluate its industrial application and its possible entry into the market.

Research on non-treated waste streams coming from bulky waste was conducted as well as its optimization by additional grinding and separation technologies for initial trials. These results were used to determine the basis for final specifications and desired characteristic qualities of the products obtained from optimized fragmentation technology (3D cut) and the different valorisation routes such as rebonding, solvolysis, unravel techniques, controlled fibre fractioning and compounding.

This deliverable focuses mainly on defining all the demonstrators that will later be developed:

- FOAM CORE LAYER (by DELAX&AIMPLAS)
- FOAM TOP LAYER (by RAMPF, ICT and EUROSPUMA)
- FOAM MATTRES (BY DELAX)
- ADHESIVES (by RAMPF, ICT and RESCOLL)
- NEEDLE-FELTS (by PROCOTEX&CENTEXBEL)
- FIBRE REINFORCED COMPOSITES (by VANHEEDE&CENTEXBEL)
- WOOD BASED COMPOSITES (by VANHEEDE&IYTE)
- METHYLAL (by BPP)
- INSULATION PANELS MADE OF TEXTILE FIBRES (by PROCOTEX)
- INSULATION PANELS MADE OF PUR FOAM (by RAMPF)

2. Work Progress

The company COLCHONES DELAX, S.L. (hereinafter DELAX), worked internally and together with all the URBANREC partners involved in the development of demonstrators, in order to ask each of them to define the minimum specifications and parameters of the products developed. In some cases, coordination among partners was necessary to define what qualities and characteristics should present each development.

3. Results

As a result, each company specified some minimum parameters and standards for the development of its products.

TOP LAYER OF PUR FOAM and SECONDARY POLYOLS for top layer foam.

Information about the polyol for the Top Layer PU Foam from EUROSPUMA:

PARAMETER	VALUE
OHZ	45-52 mg KOH/g
WATER-GEHALT	0,3 - 0,5 %
VISCOSITY	572 - 800 cSt

QUANTITY FOR THE TRIALS:

- Lab trials: 5 kg.
- Industrial trials: 800-1000 kg.

The foam that makes up the soft coat usually has:

- COMPRESSION: Between 1,1 Kpa and 2Kpa. It's preferable between 1,5 and 2kPa.
- No resilience (no rebound of the steel ball).
- Viscoelastic (with shape memory) and formulated with isocyanate TDI or MDI.
- It must be possible to cut into plates and serve plates between 4,5 and 8 cm in height.
- DENSITY: between 50 Kg / m^3 and 100 kg / m^3.
- With open pore and therefore has some air permeability.
- It must be possible to glue nucleo-plate-cover with hotmelt glues used in DELAX.
- It must recover its original dimension (95%) after the pressing and rolling process (3 months) and lose less than 30% initial compression.
- Dry heat resistance similar to conventional soft and viscoelastic foams.
- It must not smell and must pass the OEKOTEX class 1.
- It may have flame retardant properties or other functional properties as added value.

CORE PUR FOAM

Core PUR foam was obtained from PUR foam waste obtained from bulky waste through a bounding process. Core foam specifications are detailed below:

Density (Kg/m3)	Compression load deflection (CLD) (KPa)	Resilience (%)
20-30	0.9-4.80	45-53

FOAM MATTRES

AIMPLAS laboratory obtained the following results after the analysis of 4 mattress samples supplied by DELAX:

TYPE	SAMPLE NO.	RAW MATERIAL	DESCRIPTION
Raw material	PRO13-0367-01	1	Soft ZMSH – no roll-up
Raw material	PRO13-0367-02	2	Soft ZMSH – roll-up
Raw material	PRO13-0367-03	3	Firm ZH – no roll-up
Raw material	PRO13-0367-04	4	Firm ZH- roll-up
Raw material	PRO13-0367-05	5	Pieces for rebopunding

RESULTS TEST 1: COMPRESSION LOAD DEFLECTION (CLD)

Sample number	CLD 25%R (kPa)	Standard deviation	CLD 40%R (kPa)	Standard deviation	CLD 50%R (kPa)	Standard deviation	CLD 65%R (kPa)	Standard deviation	Date
PRO13-0367-01	3,34	0,03	3,72	0,02	4,23	0,02	6,37	0,03	**25/07/2016**
PRO13-0367-03	5,38	0,04	5,57	0,09	6,02	0,14	9,41	0,08	25/07/2016
PRO13-0367-02	2,61	0,13	2,90	0,13	3,32	0,13	5,28	0,02	09/11/2016
PRO13-0367-04	3,82	0,16	4,02	0,11	4,39	0,05	6,97	0,14	09/11/2016

RESULTS TEST 2: INDENTATION FORCE DEFLECTION (IFD)

Sample number	IFD 25%R (pounds)	Standard deviation	IFD 65%R (Pounds)	Standard deviation	SAG Factor	Standard deviation	Date
PRO13-0367-01	20,5	0,2	31,3	0,2	**1,53**	0,02	25/07/2016
PRO13-0367-03	32,8	1,3	48	1,8	1,46	0,01	25/07/2016
PRO13-0367-02	16,2	0,1	24	0,9	1,49	0,06	09/11/2016
PRO13-0367-04	20,9	0,7	29,6	0,9	1,41	0	09/11/2016

RESULTS TEST 3: IMPACT RESILIENCE DETERMINATION UNE EN ISO 8307 (MAY 2008)

Sample number	Recovery height (mm)	Standard deviation	Recovery height (%)	Standard deviation	Face impact application	Date
PRO13-0367-01	265	4	51,3	0,8	**indistinct**	09/11/2016
PRO13-0367-03	86	5	16,6	1	**white**	09/11/2016
PRO13-0367-02	258	5	49,9	1,0	**indistinct**	09/11/2016
PRO13-0367-04	63	4	12,2	0,7	**white**	09/11/2016

RESULTS TEST 4: APPARENT DENSITY DETERMINATION UNE EN ISO 845 (FEBRUARY 2010)

Sample number	Apparent density	Standard deviation	Date
	kg/m^3		
PRO13-0367-01	**38,29**	**0,29**	**22/07/2016**
PRO13-0367-03	**28,62**	**0,07**	**22/07/2016**
PRO13-0367-02	**38,23**	**0,21**	09/11/2016
PRO13-0367-04	**28,94**	**0,11**	09/11/2016

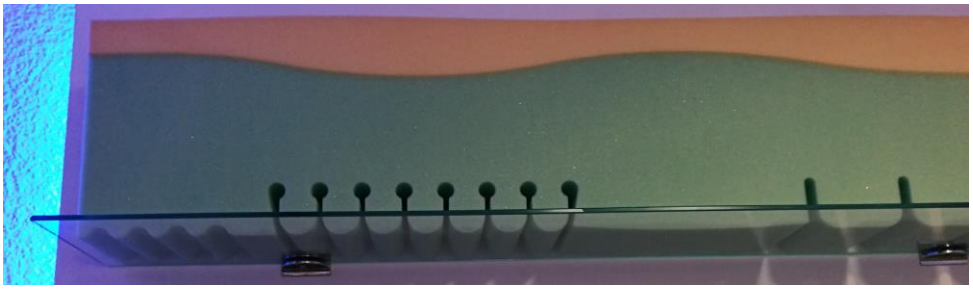

Fig. 1. Sample of a mattress nucleus and top foam layer joined.

ADHESIVES and SECONDARY POLYOLS for adhesives.

RESCOLL concluded the following specifications for Hot Melt for mattress bonding:

PROPERTIES*	VALUES	COMMENTS
Open time (in min)	> 1 minute (60-80 sec)	Value: to set by DELAX
Viscosity at 120°C	60 Pa.s	Measured at 1rad/s
Tg	-20°C < Tg < 50°C	Measured at t=0s Temperature ramp = 10°C/min
Hardness – Shore A	16 Shore A	Measured after 7 days at 23°C/50%HR
Lap shear strength (in MPa)	0,4 MPa +/-0,1 Cohesive failure	Samples geometry: 100x25x1,2mm Substrate nature: Aluminum 2024 T3
"Velcro sound" effect	No sound	When someone is laid on the mattress To be checked on samples

*Set from Hot Melt properties supplied by DELAX

NEEDLE-FELT

PROCOTEX defined the following characteristics to produce needle-felt long fibres (>20 mm) obtained by cutting and unravelling textile waste from mattresses and other textile waste.

Minimum specifications raw material:

- Big textile fabrics that are knitted or woven in order to cut them and unravel them into fibres with a size >20 mm. The bigger the size of the textile fabrics the more valuable they are to produce needle-felts.
- These textile fractions should not be laminated or contain glue or any kind of fixed plastics on the textile.
- No hard pieces contaminants (plastic, metal, wood, zip…). Especially pieces with one direction exceeding 5 mm (Length or width or height).
- No PU foam contamination.
- Moisture acceptable: 10% on synthetic fibre and 22% on Natural fibre maximum. The fibre resulting must of be odourless.
- No cotton. Except if it is mixed with other synthetic fibre (less than 50% cotton).
- Is convenient to obtain needle-felts from the waste of fibres and fabrics of DELAX.
- Each type of fibre should be separated as much as possible. Or we would need to find a technology able to do it or to find a specific application with the blend we will receive (more difficult).

In the URBANREC project, needle-felts were applied for the backside face in cushion textiles, e.g. in de topping in mattresses.

Minimum specifications of the end product:

- Needle-felts will have to be produced in fabrics on rolls with a width of 2,20m.
- Thickness and softness of the needle-felt depend on the end application.
- The weight of the needle-felt must be 100 gr/m^2. The degree of compression of the needle-felt resulting in rolls should of be equal to the standard fibres in rolls.
- In the case of the topping in matrasses this will have to be further discussed with DELAX.

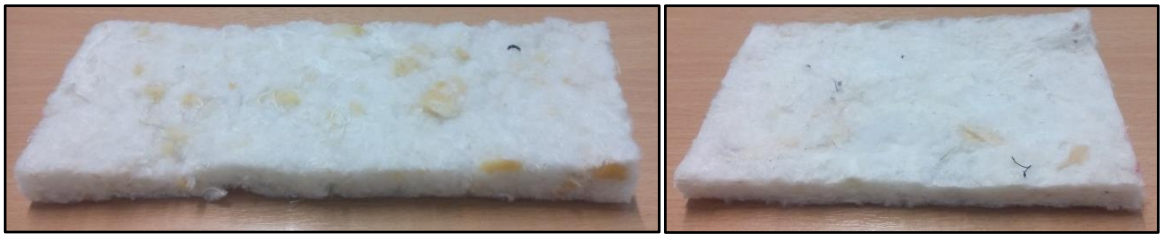

Fig. 2. Two types of needle-felts produced from recycled fibres obtained by Procotex. On the left side is a soft needle-felt made out of textile fibres contaminated with small particles of PU foam (yellow particles). On the right side there can be observed a hard needle-felt composed out of textile fibres and non-woven particles.

SHORT FIBRE REINFORCED COMPOSITES

For the production of short fibre reinforced composites, long fibres (5-1 mm) were required, mainly composed out of cellulose or high melting polymers that were implemented in a PP matrix manufactured with virgin and recycled PP.

Minimum specifications raw material:

- Big textile fabrics that are knitted or woven in order to cut them and unravel them into fibres with a size between 5-1 mm.
- No laminated or glued textiles or PP plastics.
- No hard pieces contaminants (plastic, metal, wood, zip…). Especially pieces with one direction exceeding 5 mm (Length or width or height).
- No PU foam contamination.
- Moisture acceptable for high melting synthetic fibres 0 – 10% and for natural fibres 0 – 22%.
- Each type of fibre should be separated as much as possible. Recycled PP should be more than 99% pure.

The project compared the production of short fibre reinforced composites for a commodity materials with standard PP products or alternatives for glass fibre, wood and flax fibre reinforced composites.

Fig 3. One the left side: ISO527 tensile bares that will be produced to investigate the effect on the tensile strength and impact strength on short fibre reinforced composites. On the right side: A possible example of a produced commodity product that could be made with short fibre reinforced composites: in this case an ice bucket.

Minimum specifications end product:

- Product tensile and impact strength should be at least similar as standard PP.
- Homogeneous dispersion of the fibres into the PP matrix.

Table 1. Mechanical property examples of different reinforcements of polypropylene.[1]

	Reinforcement	Average tensile strength		Average impact strength	
		(MPa)	Variation (%)*	(J/m)	Variation (%)*
PP Ho	None	30	-	40	-
PP 10-40% Mineral	Spherical particles	21	-30	74	+85
PP 10-20% glass fibres	Fibres	45	+50	97	+142
PP 30-40% glass fibres	Fibres	56	+87	102	+155
PP 10-40% Talc	Platelets	24	-20	115	+187
PP Copolymer	Copolymer	32	+7	280	+600
PP High impact	Dispersed polymer	30	0	554	+1285

Variation (%) relative to the value measured for neat homopolymer polypropylene.

The standard PP that Centexbel applyed for injection moulding were a nucleated heterophasic copolymer and had a tensile strength of 28 MPa and impact strength of 8 kJ/m² at 23°C. With the addition of fibres, it strived to obtain similar tensile strength and impact strength as for glass fibre reinforced PP.

WPC PRODUCT:

Wood plastic composites (WPC) in the URBANREC project was defined as hybrid materials containing recycled thermoplastic and hard plastic with fine wood particles, both obtained from bulky wastes. WPC materials developed in this project were used as products in the same WPC market, such as decking, wall panel, siding, fencing, garden furniture, toys, etc.

WPCs was made from a PE, PP or PVC matrix in which wood is added as cheap filler. During the project, recycled polymers were studied to replace the virgin polymer matrix and wood filler fraction was studied to assure if it could be replaced, whether partially, by recycled short textile fibres. Additionally, the insertion of recycled materials was studied to see if it can result in an improvement of the overall properties of WPC materials for an increase in the economic margin. In addition; additives, compatibilizers, or processing aids can also be added for property improvement as well as cost reduction. Due to the good arrangement and control of aspect ratio (L/D) of fibres in polymer matrix, properties of WPC material could be improved, especially flexural (bending strength) and impact properties.

Minimum specifications raw material:

- Textile fabrics that are knitted or woven in order to cut them and unravel them into fibres with a size between 20-1 mm.
- Textiles or PP, PE based plastics may have very small contamination of laminate of glue. No PVC coating or contamination.
- Moisture acceptance 0-5%.

[1] Thermoplastics and thermoplastic composites: Technical information for plastics users, Michel Biron, Elsevier, 2007

- Recycled PP, PE should be more then ≥95% pure and sized in particles between 12 – 5 mm.
- No metal contaminants. It is allowed to have small contamination of other plastics.
- Wood should be sized into particles with 100 – 500 µm diameter range.

Within the URBANREC project, research will be conducted to produce WPC materials for mostly outdoor applications. It can also be applicable as product in Decking, fencing, garden furniture, siding, steps, solid panels,…

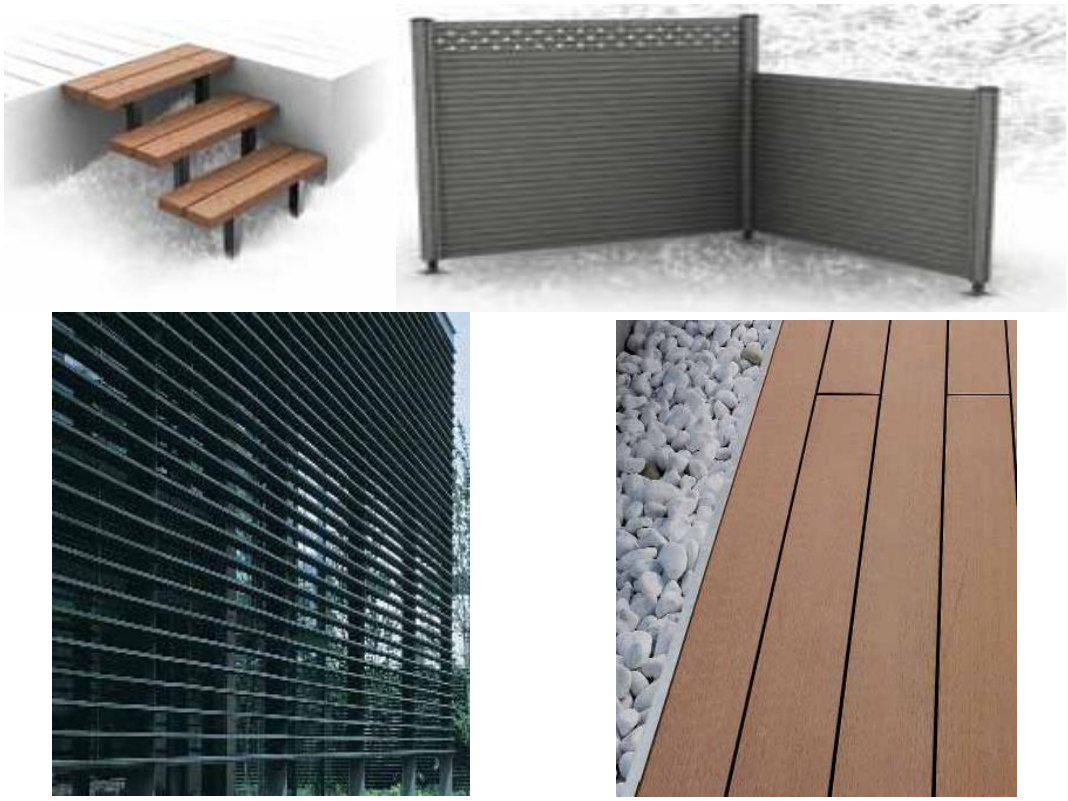

Fig 4. Samples of products developed with WPC materials.

Minimum specifications of end product:

- Mechanical properties (tensile, impact and flexural strength) and environmental resistance properties (%water absorption, dimensional stability, UV resistance (colour change)) of the developed product should be comparable with standard WPC product in the market.

- Produced WPC from recycled materials should be more economic or at least same price compared to virgin WPC or recycled WPC in the market.

Specifications of WPC products in the market (Wall solid panel and decking products)	
MECHANICAL PROPERTIES	
Tensile Strenght (MPa)	10-36
Tensile Modulus (MPa)	2000-2750
Flexural Strenght (MPa)	20-36
Flexural Modulus (MPa)	1800-2400
Impact Resistance (J/m)	12-36
ENVIRONMENTAL RESISTANCE PROPERTIES	
Water Absorption (%)	=<1
Size change (swelling) (%)	<0.5
Price range: ($) /m2	12-45

METHYLAL

BPP described below the parameters of the new plant to be constructed and methylal products to be developed:

	PROTOTYPE
Yield	0,5 Liter/kg
Electric Energy Required	2,70 Kwh/Liter
Thermal Energy Required	1,70 Kwh/Liter
Production Cost	1,26 €/liter
Technical Grade	90%
End product chemical composition	Methylal: 10% Polymethylal (n=2): 30% Polymethylal (n=3): 35% Polymethylal (n=4): 25%
Mineral Residues	5% of raw material
Mineral Residues	considered as building waste
Noise Emission	Within EU Regulation
Gas Emission	Within EU Regulation

Insulation panels made of textile fibres

An additional demonstrator was defined by Procotex:

Insulation panels from textile fibres which can be composed of whether or not thermopressed and laminated needlefelts or be produced via alternative fibre processing techniques. The same raw materials requirements apply as for the textile for needlefelts. Nevertheless, the fibre length could vary depending on the fibre processing technique. The panels should have similar λ-value (thermal conductivity) and fire resistance as PUR/PIR insulation panels. The λ-value of PUR roof panels for example, varies between 0.17 and 0.41 W/m².K depending on the panel thickness. The testing and classification of the reaction to fire of construction products was performed in accordance with a European standard, EN 13501-1 (see Table 1).

Table 1 The European fire classification of construction materials (Euroclass).

Euroclass	Contribution to fire/aspired safety level
F	Products for which no reaction to fire performances are determined or which cannot be classified in one of the classes A1, A2 , B , C , D , E .
E	Products capable of resisting, for a short period, a small flame attack without substantial flame spread.
D	Products satisfying criteria for class E and capable of resisting, for a longer period, a small flame attack without substantial flame spread. In addition, they are also capable of undergoing thermal attack by a single burning item with sufficiently delayed and limited heat release.
C	As class D but satisfying more stringent requirements. Additionally under the thermal attack by a single burning item they have limited lateral spread of flame.
B	As class C but satisfying more stringent requirements.
A2	Satisfying the same criteria as class B for the SBI-test according to EN 13823. In addition, under conditions of a fully developed fire these products will not significantly contribute to the fire load and fire growth.
A1	Class A1 products will not contribute in any stage of the fire including the fully developed fire. For that reason they are assumed to be capable of satisfying automatically all requirements of all lower classes.
Additional classifications for smoke production	s3: No limitation of smoke production required s2: The total smoke production as well as the ratio of increase in smoke production are limited s1: More stringent criteria than s2 are satisfied
Additional classifications for flaming droplets/particles	d2: No limitation d1: No flaming droplets/particles persisting longer than a given time allowed d0: No flaming droplets/particles are allowed

In Figure 1 some examples are shown, including a nonwoven produced for Urbanrec which could be applied for insulation applications (A), an insulation floor underlay produced for the Urbanrec project, and (C) an example of a commercially available PUR-based insulating wall panel.

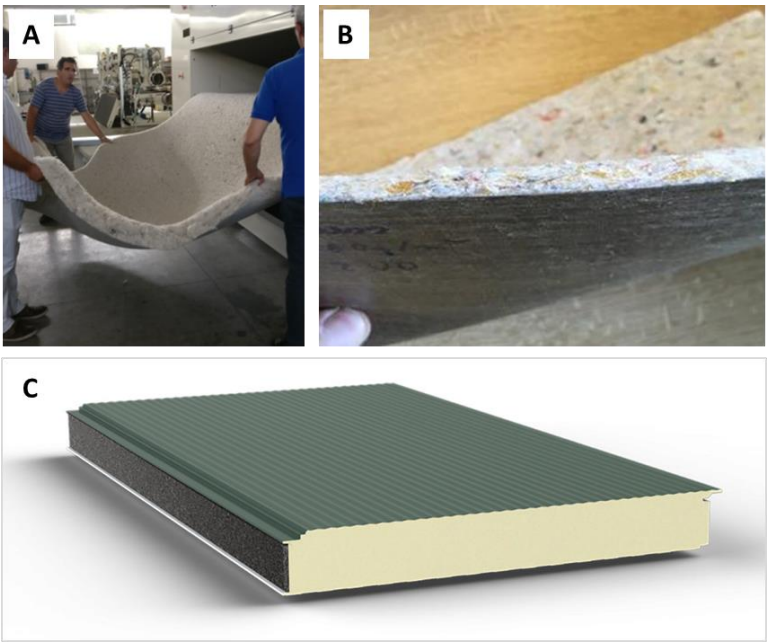

Figure 1 (A) Example of a nonwoven produced for Urbanrec which could serve for insulation purposes. (B) Example of an insulating floor underlay produced for Urbanrec. (C) Example of a commercially available insulating wall panel based on PU

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Insulation panels made of PUR foam

An additional demonstrator was defined by RAMPF:

PROPERTIES	PARAMETERS
Thermal conductivity:	22,6-22,2 mW/(mxK); DIN 12667
Compressive strength:	300-370 kPa; DIN EN 826
Tensile strength/adhesion: (adhesion to metal sheet)	350-550 kPa; DIN EN 1607