

Project Title:

“Green Integrated Structural Elements for Retrofitting and New Construction of Buildings”



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Deliverable Title	CDW Recycling Process	
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1. Project Summary

The Green INSTRUCT project will develop a prefabricated modular structural building block that is superior to conventional precast reinforced concrete panels by virtue of its reduced weight, improved acoustic and thermal performance and multiple functionalities. The Green INSTRUCT block consists of over 70% of CDW in weight.

The Green INSTRUCT project will:

- (i) achieve sustainability and cost savings through CDW sourced materials and C2C,
- (ii) develop efficient, robust, eco-friendly and replicable processes,
- (iii) enable novel cost efficient products and new supply chains,
- (iv) develop a building block that renders refurbished or new buildings safe and energy efficient and safeguard a comfortable, healthy and productive environment.

It can be achieved by defining the structural, thermal and acoustic performance of our final product to be competitive to similar products in the market. The types and sources of CDW are carefully identified, selected and processed while the supply chain from the sources, processing, fabrication units to assembly site of the whole modular panel will be optimized.

The project is guided by a holistic view through building information modelling and optimal overall performance. This includes considering the life cycle analysis, weight, structural performance, thermal and acoustic insulation, connectivity among modular panels and other structural/non-structural components as well as the compatibility of different internal parts of the each modular panel. In order to homogenize the production process, all individual elements are fabricated by extrusion which is a proven cost effective, reliable, scalable and high yield manufacturing technique. The concept, viability and performance of developed modular panels will be verified and demonstrated in two field trials in test cells.

2. Glossary of Terms

Table 1 – Glossary of terms.

Acronym	Meaning
EC	European Commission
EU	European Union
CDW	Construction and Demolition Waste
WP	Work Package
PVC	Polyvinyl chloride
PP	Polypropylene
PE	Polyethylene
OSB	Oriented Strand Board
MDF	Medium-Density Fibreboard
MH	Mirror hazardous
MN	Mirror non-hazardous

3.1 Definitions

Words beginning with a capital letter shall have the meaning defined either herein or in the Rules or in the Grant Agreement related to the Project.

3.2 Additional Definitions

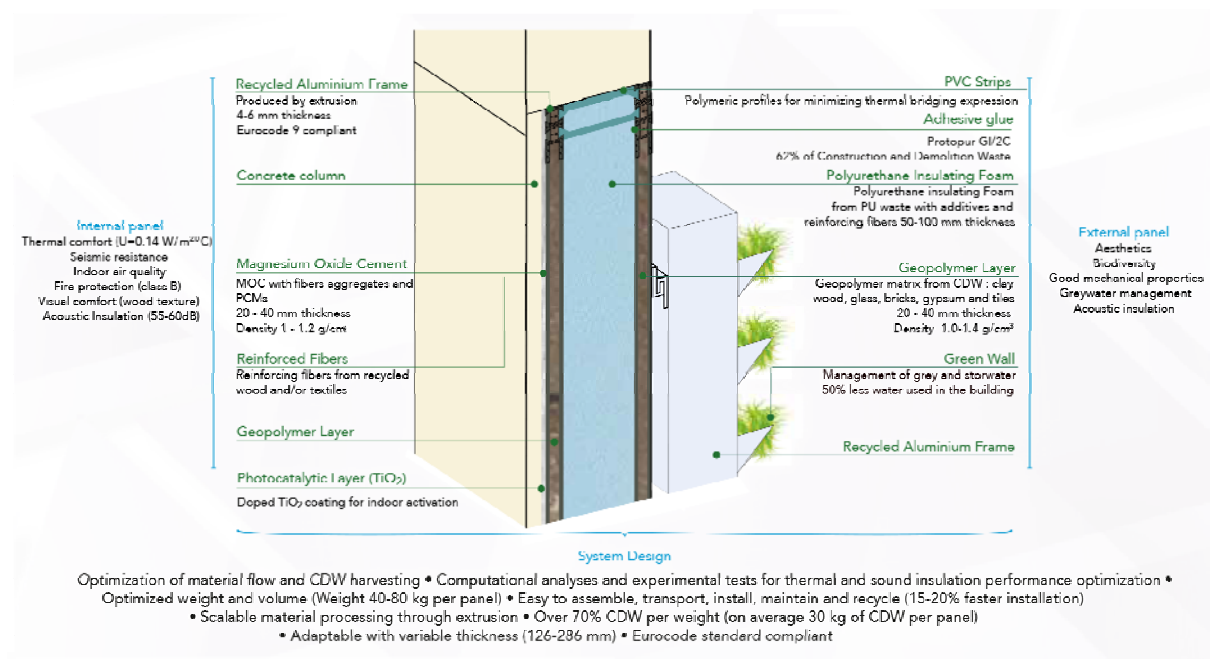
- **Project**: Project refers to the Green INSTRUCT project funded from the European Union's Horizon 2020 research and innovation programme under Grant Agreement 723825.
- **Construction Demolition Waste (CDW)**: means those materials resulting from the alteration, construction, destruction, rehabilitation, or repair of any manmade physical structure including houses, buildings, industrial or commercial facilities, and roadways.

3. Description of Work

The purpose of this document is to present the recycling processes of materials serving as raw material for the production of the innovative Green Instruct panel.

The assumption of the Green Instruct project is the use of recycled materials which content in the total weight of the product will be at least 70%. Each layer of the Green Instruct panel must contain the appropriate amount of "raw material" from recycling.

The final version of the Green Instruct panel project is as follows:



In order to achieve objectives of the Green Instruct project, it was necessary to identify CDW sources as well as their alternative sources.

The average statistical composition of the CDW stream was confronted with a single case of the demolition of a residential building carried out as part of the Green Instruct project.

As a result of the demolition, a CDW stream was created, which was subjected to recycling processes.

In this document, the complete demolition and recycling process resulting in CDW stream will be presented in detail, including logistic, economic and technological aspects.

Alternative sources of CDW have been defined and described in a separate document (D4.1.Report on additional CDW). Currently, we will focus on analyzing the process carried out by NRGIA for the purposes of the Green Instruct project.

4. CDW Recycling process

4.1. The first stage of work

First stage of work of Green Instruct project was focused on searching materials from CDW that could potentially be a good base to produce building materials from – a main goal of the project.

At this stage various samples of materials were collected and prepared to be recycled, and then, after obtaining the appropriate technical parameters (particle size, humidity, level of pollution, etc.), sent to Partners for further processing and testing.

During this first stage, over 50 different types of samples were prepared (various materials with different parameters) with a total weight of over 1,000 kg and sent to project partners in order to check their suitability for further production processes.

The general principle of obtaining and processing the above-described samples is shown in Figure 1 - CDW processing - Flow Chart.

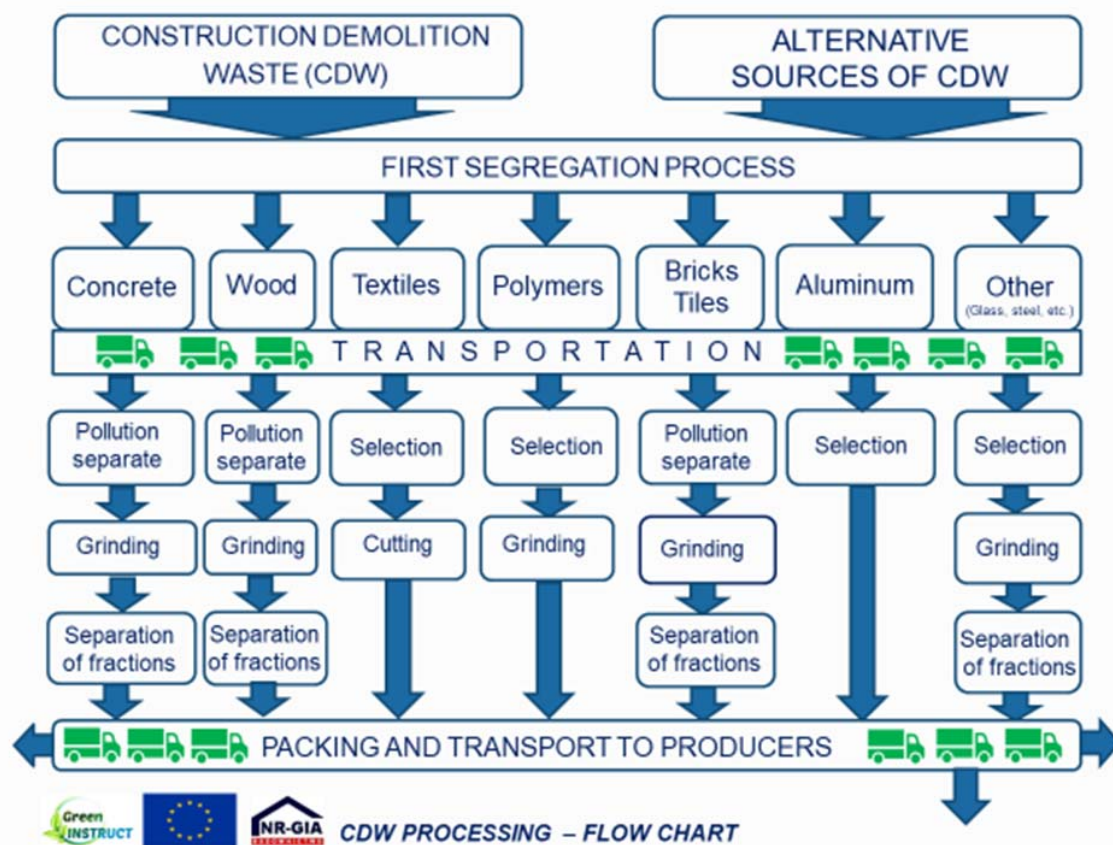


Figure 1 - Flow chart of CDWs processing.

All prepared and sent samples of materials have been cataloged in the summary table, which is included in the Table 2 below.

Table 2. CDW samples sent to partners.

No	Sample No (CODE)	Date of shipment	Recipient	Sample description	Weight of sample (kg)	Source		Partical size (mm)
						CDW	ALT	
1	#01/22/02/2017/NTUA/BRICKS/IND#	22.02.2017	NTUA - GREECE	brick powder	25		X	0,15-2
2	#01.01/01/03/2017/CIDETEC/FOAM/CDW#	01.03.2017	CIDETEC - SPAIN	PU foam	0,5	X		0-1
3	#01.02/15/03/2017/CIDETEC/FOAM/CDW	15.03.2017	CIDETEC - SPAIN	PU foam	2	X		pieces
4	#02/01/03/2017/LEITAT/WOOD/IND#	01.03.2017	LEITAT - SPAIN	wood chips	5	X		2-30
5	#03/01/03/2017/LEITAT/WOOD/IND#	01.03.2017	LEITAT - SPAIN	wood chips	5	X		0,5-2
6	#04/01/03/2017/LEITAT/MDF/IND#	01.03.2017	LEITAT - SPAIN	MDF dust	5		X	0,1-1
7	#05/22/03/2017/LEITAT/MDF/CDW#	22.03.2017	LEITAT - SPAIN	MDF chips	4	X		20-70
8	#06/22/03/2017/LEITAT/CHIPB/CDW#	22.03.2017	LEITAT - SPAIN	chipboard chips	6	X		20-70
9	#07/22/03/2017/LEITAT/OSB/CDW#	22.03.2017	LEITAT - SPAIN	OSB chips	5	X		20-70
10	#08/22/03/2017/LEITAT/TEXT/RECY#	22.03.2017	LEITAT - SPAIN	cotton	3		X	20-80
11	#09/03/04/2017/LEITAT/PCV/RECY#	03.04.2017	LEITAT - SPAIN	PVC	27	X		1-5
12	#10/06/04/2017/LEITAT/SOFTPVC/RECY#	06.04.2017	LEITAT - SPAIN	SOFTPVC	12	X		1-5
13	#11/06/04/2017/LEITAT/PET/RECY#	06.04.2017	LEITAT - SPAIN	PET	12		X	1-5
14	#12/06/04/2017/LEITAT/CLAPVC/RECY#	06.04.2017	LEITAT - SPAIN	PVC cladding	12	X		1-5
15	#13/06/04/2017/LEITAT/PE/RECY#	06.04.2017	LEITAT - SPAIN	PET	10	X		1-5
16	#14/30/06/2017/LEITAT/PET#	30.06.2017	LEITAT - SPAIN	PET	12		X	1-5
17	#15/30/06/2017/LEITAT/PET#	30.06.2017	LEITAT - SPAIN	PET	12		X	1-5
18	#16/30/06/2017/LEITAT/HDPE#	30.06.2017	LEITAT - SPAIN	HDPE	19	X		1-5
19	#17/30/06/2017/LEITAT/LDPE/GRAN#	30.06.2017	LEITAT - SPAIN	LDPE	21		X	1-5
20	#18/03/07/2017/UBRUN/WOOD#	03.07.2017	UBRUN - UK	wood chips	5	X		1-3
21	#19/03/07/2017/UBRUN/WOOD#	03.07.2017	UBRUN - UK	wood chips	5	X		1-5
22	#20/11/07/2017/NTUA/XPS#	11.07.2017	NTUA - GREECE	XPS	4	X		1-2
23	#21/11/07/2017/NTUA/EPS#	11.07.2017	NTUA - GREECE	EPS	5	X		1-2
24	#22/13/07/2017/CIDETEC/PUFOAM#	13.07.2017	CIDETEC - SPAIN	PU foam	8	X		0,2-1
25	#23/27/07/2017/COLL/BRICPOW#	27.07.2017	COLL - ITALY	brick powder	21	X		0-5
26	#24/27/07/2017/COLL/CEM#	27.07.2017	COLL - ITALY	cement	24		X	0,1-2
27	#25/22/08/2017/UBRUN/CELLCON#	22.08.2017	UBRUN - UK	cellular concrete	21	X		1-5
28	#26/03/10/2017/NTUA/GLASS/RECY#	03.10.2017	NTUA - GREECE	glass	15	X		1-3
29	#27/31/10/2017/UBRUN/BRICKPOW#	31.10.2017	UBRUN - UK	brick powder	116	X		1-3
30	#28/02/11/2017/UBRUN/XPS/RECY#	02.11.2017	UBRUN - UK	XPS	3	X		1-3
31	#29/28/11/2017/LEITAT/TEXT/RECY#	28.11.2017	LEITAT - SPAIN	cotton	4			pieces
32	#30/28/11/2017/LEITAT/MDF/CDW#	28.11.2017	LEITAT - SPAIN	MDF	5	X		pieces
33	#31/28/11/2017/NTUA/BRICKPOW/SAMESOURCE#	28.11.2017	NTUA - GREECE	brick powder	57	X		1-3
34	#32/11/12/2017/NTUA/BRICKPOW/RECY/CONT#	11.12.2017	NTUA - GREECE	brick powder	27	X		1-3
35	#33/12/12/2017/ALCN/BRICKCHIPS/RECY/CONT#	12.12.2017	ALCN - AUSTRIA	brick chips	29	X		3-8
36	#34/03/01/2018/LEITAT/PET/RECY#	03.01.2018	LEITAT - SPAIN	PET	17		X	1-3
37	#35/22/01/2018/ALCN/BRICHIPS/RECY/CONT#	22.01.2018	ALCN - AUSTRIA	brick chips	28	X		3-8
38	#36/22/01/2018/ALCN/BRICHIPS/RECY/CONT#	22.01.2018	ALCN - AUSTRIA	brick chips	21	X		3-12
39	#37/20/02/2018/NTUA/BRICKPOW/RECY/CDW#	20.02.2018	NTUA - GREECE	brick powder	60	X		1-3
40	#38/12/03/2018/COLL/PUFOAM/RECY#	12.03.2018	COLL - ITALY	PU foam	3	X		0,1-2
41	#39/05/04/2018/UBRUN/WOODDUST/RECY/#	05.04.2018	UBRUN - UK	wood dust	16	X		0-0,1
42	#40/09/04/2018/NTUA/BRICKPOW/RECY/CDW#	09.04.2018	NTUA - GREECE	brick powder	23	X		0-0,1
43	#41/09/04/2018/UBRUN/BRICKPOW/RECY/CDW/#	09.04.2018	UBRUN - UK	brick powder	23	X		0-0,1
44	#42/17/05/2018/NTUA/CERBRICKPOW/RECY/CDW#	17.05.2018	NTUA - GREECE	cer brick powder	26	X		0-1,5
45	#43/08/06/2018/LEITAT/BRICHIP/RECY#	08.06.2018	LEITAT - SPAIN	brick chips	59	X		4-8
46	#44/04/07/2018/NTUA/BRICPOW/RECY/CDW#	04.07.2018	NTUA - GREECE	brick powder	60	X		0-0,1
47	#45/10/08/2018/UBRUN/BRICKPOW/RECY/CDW	10.08.2018	UBRUN - UK	brick powder	50	X		0-0,1
48	#46/10/08/2018/UBRUN/SAWDUST/RECY/CDW#	10.08.2018	UBRUN - UK	saw dust	12	X		0-1
49	#47/05/10/2018/NTUA/BRICKPOW/RECY/CDW#	05.10.2018	NTUA - GREECE	brick powder	55	X		0-0,1
50	#48/22/10/2018/LEITAT/HDPE/RECY/#16	22.10.2018	LEITAT - SPAIN	HDPE	20	X		1-5
51	#49/30/10/2018/LEITAT/HPDE/RECY/#16	30.10.2018	LEITAT - SPAIN	HDPE	27	X		1-5
52	#50/21/11/2018/UBRUN/CELLCON/RECY/CDW#	21.11.2018	UBRUN - UK	cellular concrete	10	X		0-5
53	#51/28/11/2018/UBRUN/CELLCON/RECY/GREY/	28.11.2018	UBRUN - UK	cellular concrete	13	X		0-5
54	#52/28/11/2018/UBRUN/CELLCON/WHITE	28.11.2018	UBRUN - UK	cellular concrete	10	X		0-5
				Total weight (kg)	1079,5			

4.2. Selection of the site to be demolished

One of the goals of the Green Instruct project is to track the entire process of recycling CDW from the moment of selecting the site for demolition, initial inventory of the quantity and composition created after the depollution of waste, preparation of places for loading, carrying out all formal actions related to the demolition, etc.

For the purposes of the Green Instruct project, the following object for demolition was selected – Figure 3 and Figure 4.

It is a residential building, with a traditional structure: walls made of bricks, wooden ceilings, wooden roof construction covered with bituminous roofing paper. The building is located in the city center of Radom 26-600, ul. 25th of June, Poland.

A valid demolition permit has been issued for demolition work.

The works were secured in accordance with the plan of work safety and employee protection. All recommended measures to protect the place and health and life of employees were applied. The work area was secured against accidental entry by third parties.

Demolition was carried out in accordance with the adopted plan and dates.

GREEN Integrated STRUCTural Elements for Retrofitting and New Construction of Buildings



Specification of the building to be demolished:

1. Freestanding, three-storey building, without basements, brick construction.
2. Year of construction 1935.
3. Construction wall thickness - 38-64 cm.
4. Wooden ceilings.
5. Wooden roof construction, covered with bituminous roofing paper, full boarding.
6. Gutters, downpipes, galvanized steel flashing.
7. Electrical installations, lighting, void and sewage, heating.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723825

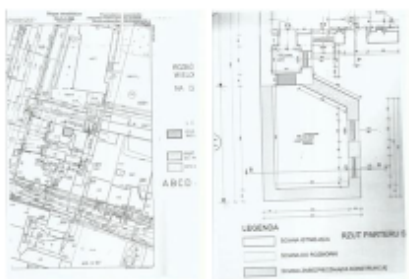
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Figure 2 - Specifications of the building to be demolished.

GREEN INtegrated STRUCTural Elements for Retrofitting and New Construction of Buildings



8. Plot No. 56, Śródmieście District 2.



9. Building area - 32.79 m²

10. Cubature - 366.92 m³

11. Permission for demolition -191/2018

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Figure 3 - Location of the building to be demolished.

4.3. Demolition process

The demolition process was carried out within 7 working days by 6 people.

A very important factor during demolition is the maintenance of procedures to separate the various types of construction debris. It is a kind of "selective demolition/deconstruction" similar in principle to "separate collection of municipal waste".

The process of demolition can be divided into two basic stages:

4.3.1. Deconstruction

After the inventory of the facility to demolish, all technical devices, water installations, sewage systems, electrical and tele-tech installations, roof coverings and constructions, windows, doors, floors, etc. are disassembled sorted and stored separately – Figure 5.



Figure 5 - Deconstruction of the building.

4.3.2. Demolition

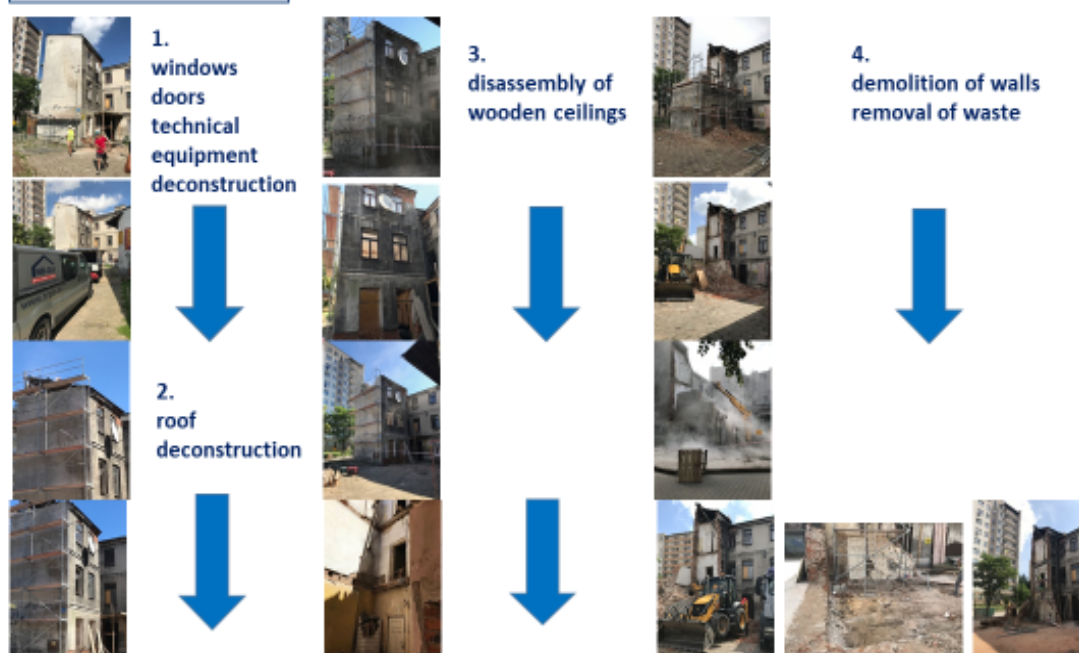
The structure of the building (in this case a brick construction made of red brick) was demolished using a bulldozer / backhoe loader.

The process of demolishing the object is presented in the following Figure 6.

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Demolition process.



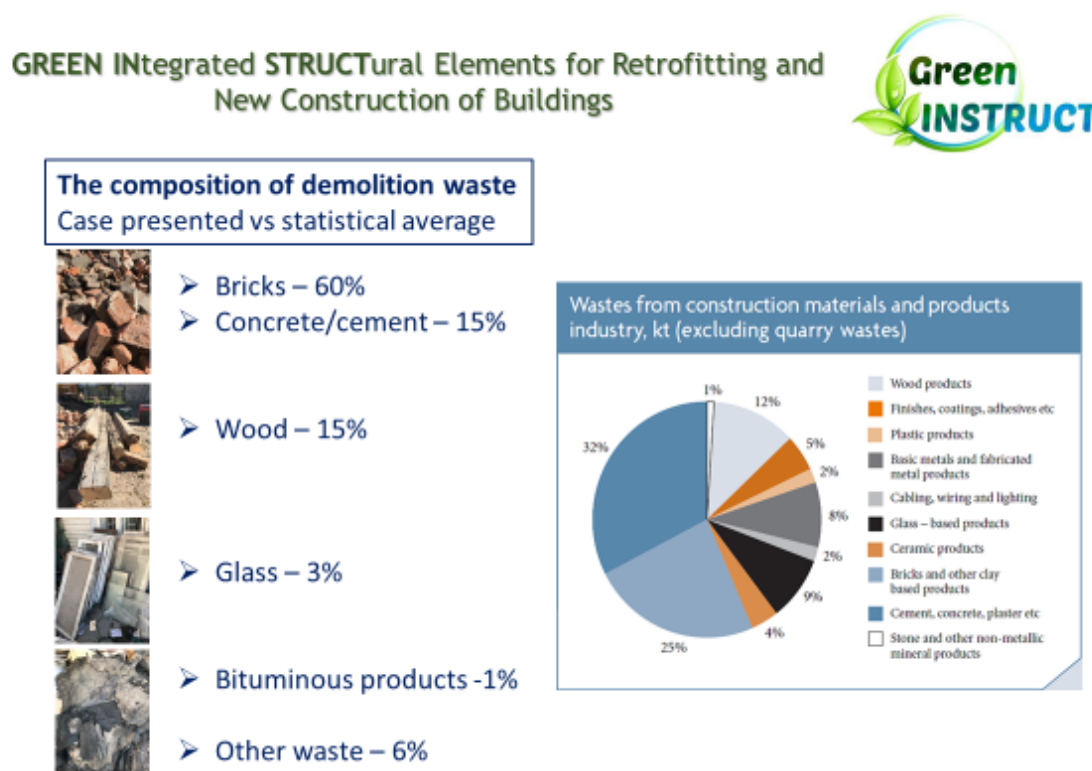
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Figure 6. - Demolition processing.

4.4. CDW stream

As a result of the demolition of the housing facility, the following CDW groups were inventoried, and the resulting CDW stream has the following morphological composition - Figure 7.



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Figure 7- Composition of demolition waste.

To implement the objectives of the Green Instruct project, the following groups of waste were designated for recycling, which will serve as raw materials for the production of Green Instruct panel layers:

1. Aggregates, brick rubble.
2. Concrete debris.
3. Aluminum.
4. Polymers.
5. EPS/XPS, polyurethane foam.
6. Wood.
7. Textile.
8. Glass.

5. Aggregates recycling process

5.1 Sources of aggregates

- Construction and modernization of roads, bridges, infrastructural objects – big amount of concrete, bricks and soil.



- Demolition work.



5.2 Aggregates recycling process.

- I. Clean debris obtained as a result of demolition work - as far as possible separated concrete debris from brick debris.



- II. Transport to the place where grinding equipment is located. If there are surface possibilities at the demolition point and the possibility of carrying out loud works, you can use mobile crushers with sieves to separate various aggregate fractions.



- III. Crushing of debris in jaws/ hammer crushers - stationary or mobile.



- IV. Separation of various aggregate fractions on rotary sieves.



- V. In order to obtain the smallest fraction - grinding of aggregates in ball mills additionally with the possibility of drying buried aggregate to the mill.



- VI. The smallest fractions of aggregates - volatile fractions, to collect in the filters dedusting the conducted crushing processes.



- VII. Transport to the place where the "raw material" is processed to the final product.

The bricks recycling process is shown in Figure 8.

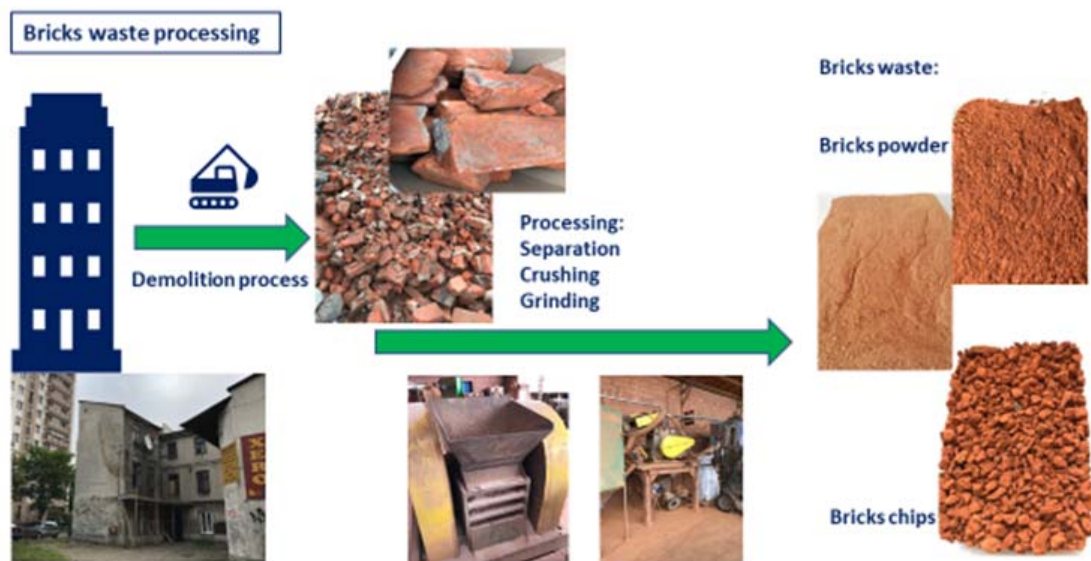


Figure 8 - Recycling process of bricks.

6. Concrete debris recycling process

Recycling of concrete waste is processed in order to re-use it:

- in the form of aggregates as a road foundation, hardening of squares, pedestrian paths, parking lots, etc., or
- as an addition to non-structural concrete products.

In the recycling process (Figure 9), after preliminary cleaning of impurities (steel, polymers, wood) concrete debris is crushed in stationary or mobile crushers. Standard fractions of obtained aggregate of concrete debris: 0-17mm; 17-32mm; 32-63mm; over 63mm

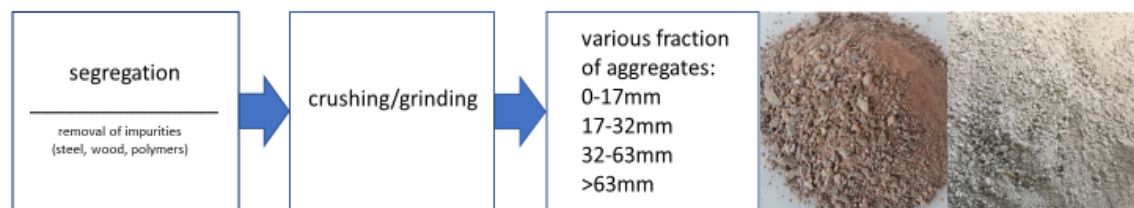


Figure 9 - Recycling process of concrete.

7. Aluminum recycling process

Aluminum recycling process is a process commonly used in the production of aluminum alloys. Recycling aluminum uses about 5% of the energy required to create aluminum from bauxite².

Depending on its source, aluminum scrap may contain a range of impurities.

These impurities are removed in technological processes during aluminum processing in metallurgical furnaces.

The resources of aluminum scrap allow production of aluminum alloys, in which the content of aluminum from re-cycles reaches 40% of weight. From the technological point of view, there are no limitations in the aluminum content from recycling in aluminum alloys - with proper availability of scrap, alloys may contain 100% of the aluminum from re-cycling without changing the properties. Limiting the content of recycled aluminum is therefore commercial not a technological reason.

The diagram of the aluminum circulation is shown in Figure 10.

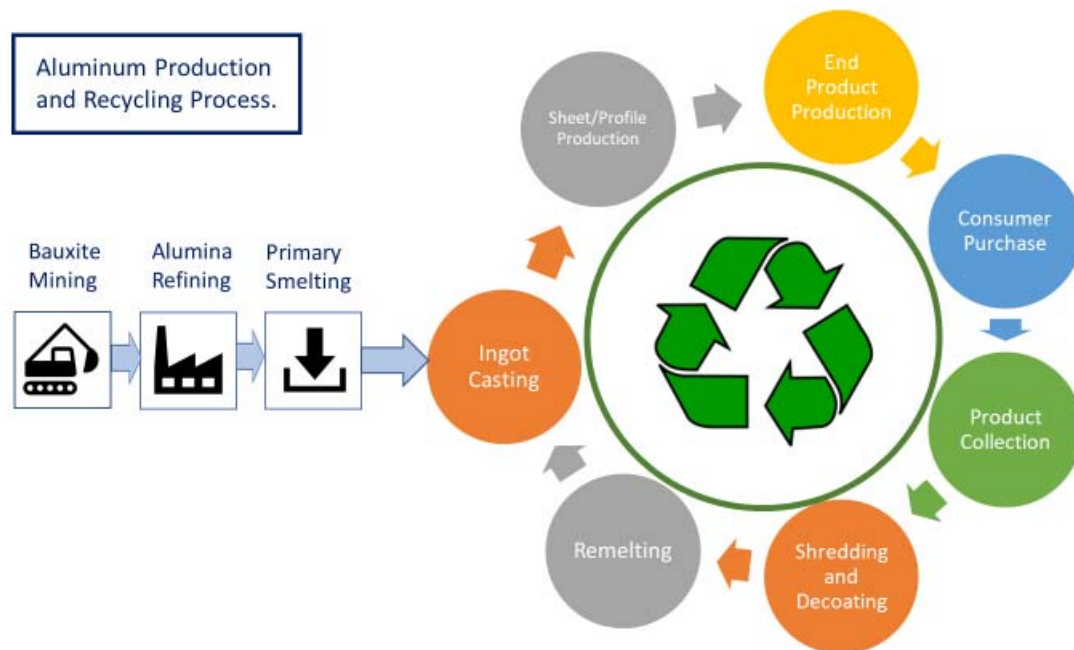


Figure 10 - Diagram of the aluminum circulation.

² Aluminum: The Element of Sustainability A North American Aluminum Industry Sustainability Report (PDF) (Report). The Aluminum Association. September 2011.

Aluminum recycling processes carried out for the purposes of the construction profile for the Green Instruct panel frame, including technological details, are shown in Figure 11.

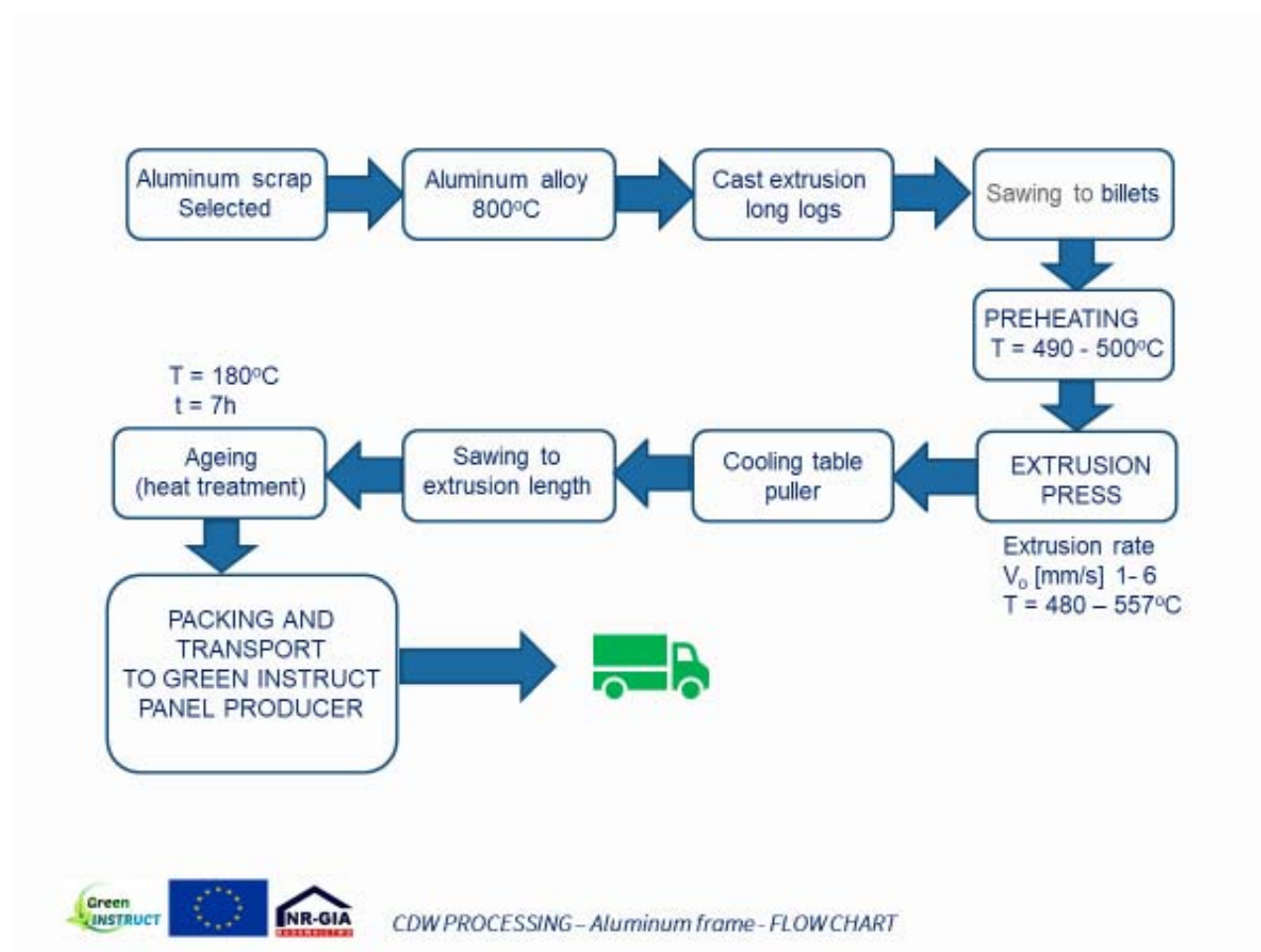


Figure 11 - Aluminum recycling processes.

8. Polymers recycling process

It is estimated that 26 million tons of plastic waste are produced in Europe every year. About 30 percent of them is recycled. The industry voluntarily undertook to increase re-use and recycling, prevent materials from entering the environment and improve resource efficiency. By 2030, the level of re-use and recycling of plastic packaging is expected to reach 60 percent. In terms of the demand for plastics, number 1 in Europe is Germany, followed by Italy, France, Spain, the United Kingdom and Poland. Main areas of their application are packaging industry (32.5%), construction (nearly 26%), automotive (about 10%) and production of electrical and electronic equipment (6.4%). All packaging will have to be reusable or recyclable.

The number of plastics produced and introduced to the market obliges the European Community to take all actions aimed at the development of recycling technologies in order to minimize the negative environmental effects associated with the production, recycling and utilization of plastics.

Types of plastic recycling:

- Material (mechanical)
- Chemical
- Thermal
- Composting (Biodegradation)

The optimal cycle of plastic circulation is shown in Figure 12.

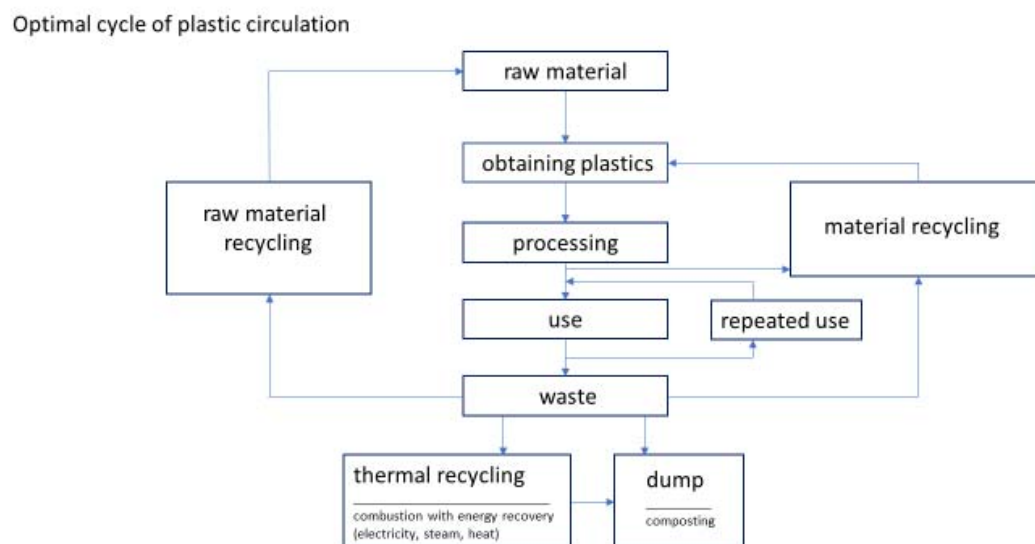


Figure 12 - Optimal cycle of plastic circulation.

Due to the needs of the Green Instruct project, a scheme for the recycling of plastics belonging to the first group – material (mechanical) was developed.

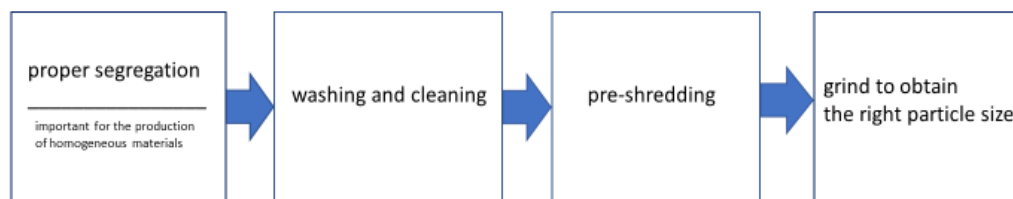


Figure 13. Developed recycling process of plastics for the needs of Green Instruct project.

According to this scheme, recycling of plastics was prepared. Then the appropriate materials with the appropriate granulation were sent to LEITAT to carry out further processes and to obtain a fiber to reinforce the layers in the Green Instruct panel - as shown in Figure 14.

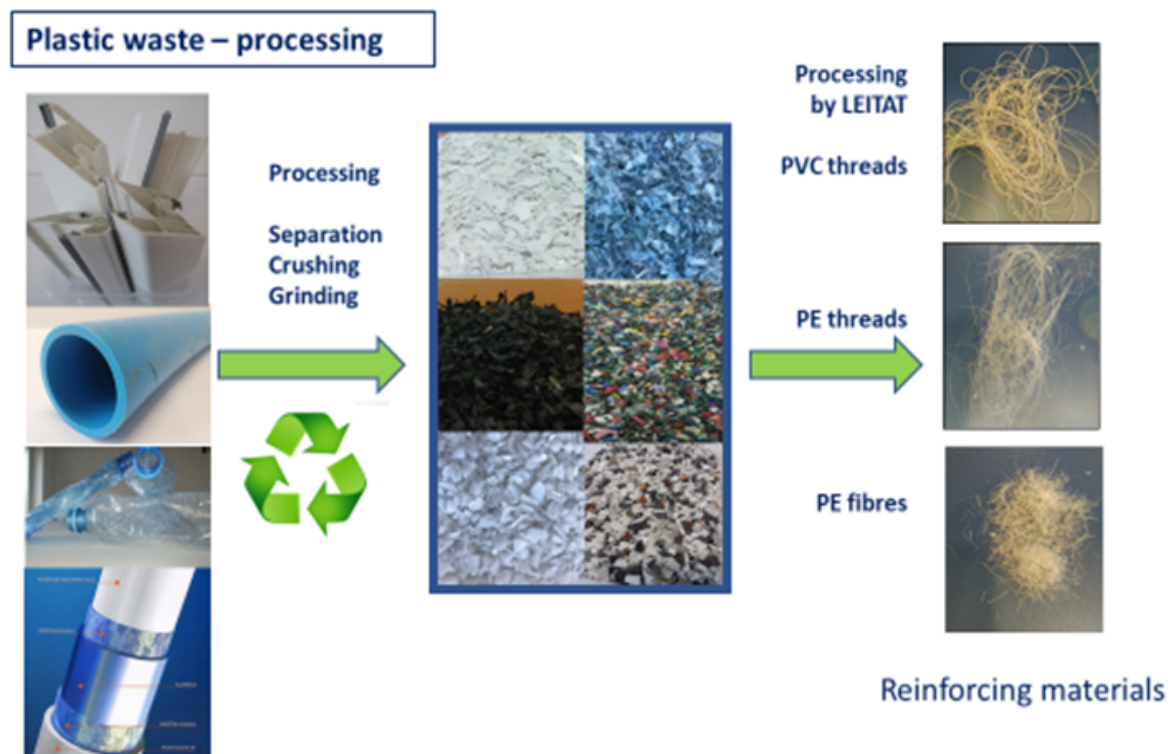


Figure 14 - Processes for the development of reinforcing fibres.

9. XPS, EPS, polyurethane foam recycling process

EPS / XPS recycling mainly involves cleaning and grinding waste. Initial operation of proper separation from other wastes and getting rid of any dirt guarantees good quality of the granulate obtained as a result of grinding.

This granulate is used as an insulating additive for concrete, soil conditioner, for the production of new insulation boards, etc.

These granules are also added as an additive to lower the weight of the geopolymer panels (lightweight agents) - one of the layers of the Green Instruct panel - Figure 15.

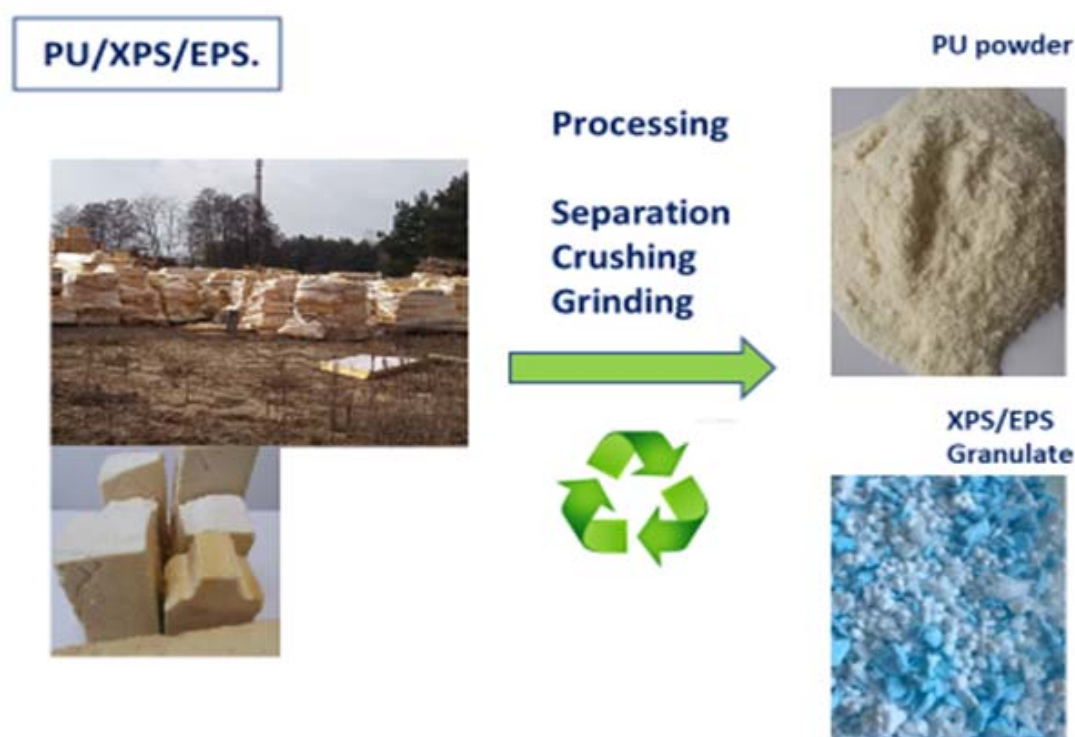
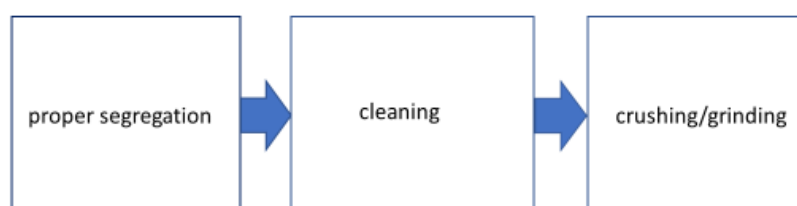


Figure 15 - Recycling process of XPS, EPS and polyurethane foam.



10. Wood recycling process

Wood waste is a valuable raw material that, depending on the quality, can be used both in the material recycling process and in energy production. Increasing disposal costs and increasing environmental awareness make recycling of wood waste increasingly important.

During the recycling process, wood waste is crushed and deprived of foreign materials, e.g. metal elements. The chips produced, depending on the quality, are recycled or incinerated to produce energy. Wooden waste suitable for recycling is most often used as raw material for the production of particle boards or other wood-based materials. In the case of thermal utilization, wood chips are valuable fuel used in biomass power plants or combined heat and power plants.

Wood waste produced in technological/production processes - dust generated when cutting wood or wood-based materials, chips, sawdust - can be used in the same way.

The Green Instruct project used processed wood waste in the form of chips and sawdust (Figure 16) as additions to the production of MOC panel.



Figure 16 - Recycling process of wood waste.

11. Textile recycling process

Recycling of textile waste is carried out in three ways:

- mechanical,
- chemical
- thermal.

The most commonly used method for this type of materials is mechanical recycling, which consists of combing, stratifying or crushing waste.

Textile waste is a very wide group of waste: from floor coverings, tapestries of furniture, seats and other automotive elements, clothes, shoes, bags, curtains, small clothes, scouring etc. These products may contain various materials - plastics and natural materials.

For the purposes of the Green Instruct project, materials from cotton waste were processed - they were separated from fibres in further technological processes carried out by LEITAT.

12. Glass recycling process

Glass is ideal for re-processing as it is a material that can be recycled infinite amount of times. Subjected to re-melting, it does not lose its properties and the quality after all activities related to the re-use of this raw material.

Different types of glass (packaging, float glass) require different recycling processes (Figure 17). This is due to different levels of pollution and chemical composition.

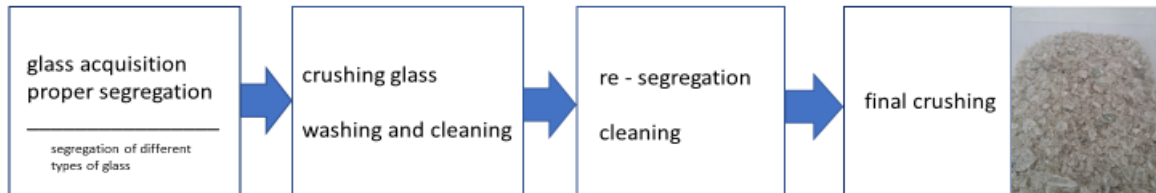


Figure 17 - Recycling process of glass waste.

13. Economics of processes

The costs associated with the recycling of different groups of materials depend on several determining factors:

13.1. Source availability

That characterizes what work must be done to take waste for further processing? How far it is from the source of waste to the recycling plant? What are the transport costs?

The cost of transport is the largest cost factor in the processing of some of the refuse - heavy waste (concrete rubble, brick rubble, rock waste, asphalt waste, land to be replaced). We can use mobile recycling installations that crush the material at the place of waste generation. Of course, other environmental conditions must also be met to perform such work, due to noise and dust.

The average transport costs (20t) are assumed at the level of 1.20 €/ km, but this does not apply to short distances. Short distances for heavy transport are calculated on an individual basis. Dumpers that take about 9t of waste for transport within a given city accept a rate of around 50 € per course.

13.2. Way of collecting waste.

The way waste is collected also has a large impact on the price of "raw materials" obtained as a result of recycling. In case of construction debris as described above, the most important thing is transportation and operating costs. Large amounts of weight give low cost per 1kg.

In case of other wastes - including light wastes (polyurethane foam, various polymers, aluminum) which require more procedures to obtain costs are supposed to be higher when measured per 1kg of "raw material".

Some of these wastes from alternative sources for CDW such as aluminum cans, glass, packaging, etc. - require specialized collection systems.

13.3. Costs of technologies used.

In case of using simple methods of waste processing, such as obtaining aggregates, crushing wood, milling polymers (PVC, PE), global costs of technologies used (depreciation of equipment, logistics, work) for 1kg of "raw material" are low.

In the case of complicated processing processes (regranulates - PVC, PE, PET, recycled aluminium alloys, glass melting, chipboard production, MDF, chemical textile recycling, etc.), costs of processes grow significantly, but the "raw materials" obtained in this way are ready to be used for production of new products.

When collecting and processing waste for the Green Instruct project, NRGIA used simple methods of waste recycling: collection, segregation, crushing and grinding to the required particle sizes. Transport of waste/materials was carried out by own means of transport, belonging to NRGIA - in accordance with the assumptions of the Green Instruct project.

Below we present unit costs obtained from CDW recycling. Costs contain transport (NRGIA own costs / commercial rates), amortization of machine and equipment, storage. In this

calculation we used average distance from waste sources. When calculating costs, the level of market prices of waste in Poland was also taken into account.

Material prices (Table 3) vary depending on the region of the country - in more industrialized areas prices are slightly higher, in areas with lower saturation with the industry, prices are lower. This is related to the demand for "raw material", transport costs (transport of "raw materials" to regions with higher industrialisation), production of waste in more densely populated areas.

Table 3 - Materials price list.

Description	Fraction	Cost €/1kg
Brick powder	0 – 2 mm	0,06 – 0,1
Brick powder	0 – 5 mm	0,05
Crushed blocks	0 – 31 mm	0,01
Crushed blocks	0 – 63 mm	0,005
PVC	pieces	0,02
PVC recycled	2 – 5 mm	0,70
MDF, fibreboard, solid wood.	Chips, dust, larger pieces	0,02
MDF, fibreboard	Chips and dust	0,01
AL	pieces	0,75 – 1,33
Colour cotton	pieces	0,47 – 0,93
White cotton	pieces	1,05
PET (bottles)	0-5 mm	0,7
AL cans	pieces	0.93
PE, PP	0-5 mm	0,01 – 0,50
Glass	0-5 mm	0,02 – 0,04
Concrete aggregates	0-63 mm	0,004 – 0,006

14. Conclusions

Project Green Instruct assumes use of processed CDW for producing an innovative construction panel with very high functional parameters. The basis for the process of developing the idea was to identify proper sources of CDW and alternative sources containing necessary types of waste.

The next step was to select those wastes which processing would bring the expected "raw material" effect to produce individual layers of the Green Instruct panel.

Large number of samples of various pre-testing materials was prepared, which determined the suitability of these materials for further processing.

As a result of tests carried out by the Green Instruct project Partners, a group of materials for further processing was selected.

After defining material requirements, an object for demolition was selected. NRGIA prepared the demolition process, obtained the necessary permits to carry out the work and carried out the demolition of the facility. The demolition site was secured and all safety rules were respected. All work has been documented.

The demolition was carried out in stages: starting with dismantling of all installations, equipment, constructions, equipment, etc. and then demolishing brick and concrete walls.

During the disassembly and demolition works, the waste was selected and placed in separate places. Then individual types of CDW were transported to a storage location where particular waste groups were recycled. Recycling processes of materials have been designed and carried out. Various groups of "raw materials" were obtained. All processes have been described and documented. "Raw materials" were sent to the Green Instruct project partners.

In case of material groups requiring specialized processing technologies (e.g. aluminium), work at the request of NRGIA has been carried out by specialist plants.

(NRGIA is responsible for the implementation of the aluminium frame constituting the structure of the panel. Performing this task requires several specialized operations: metallurgical - the process of creating an aluminum alloy ready for extrusion of the profile, preparation of a specialized tool for the extruder - matrix, performing the extrusion process. NRGIA commissioned these activities to a specialist production company).

While carrying out all the works, NRGIA's own costs were registered - labour, transport, machine depreciation costs, etc. This provided the possibility of calculating the prices of individual materials.

Task 4.2. has been done. NRGIA is constantly at the disposal of the Partners, and responds to all requests regarding "raw materials" (processed CDW) necessary for the further course of the Green Instruct project.

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