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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
(iv) 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.

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

2.1. 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.

2.2. 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.

3.1. Purpose of the analysis of alternative sources of CDW.

The purpose of this document is the identification of additional or alternative CDWs with high technical and economic potential.

The main sources of CDW acquisition are construction and demolition works. They are the primary waste streams to be recycled, which will ultimately be the "source of raw material" for projects as Green Instruct that intend to use them.

For the raw CDW material to meet the quality parameters such as adequate purity, moisture content, size fraction and be used for further production, it is necessary to apply complicated technological processes. In many cases, the degree of contamination prevents its use for more demanding technologies.

Therefore, it is also advisable to seek additional alternative sources of CDW, which are characterised by high technical and economic potential.

International Synergies research for Alternative Raw Materials for Construction has identified a potential pool of more than 17 million tonnes of alternative raw materials generated each year and available for re-use by the construction industry.[2]

If the construction industry were to widen its approach to reusing surplus resource streams generated by other industries as well as its own it would result in a dramatic reduction in the industry's reliance on primary resources and significantly reduce its carbon emissions – reports International Synergies.

[2] Project *Alternative Raw Materials for Construction* – Partner International Synergies

4. CDW's market in Poland and EU

4.1. Current situation.

Waste is an issue that affects us all. We all produce waste: on average, each of the 500 million people living in the EU throws away around half a tonne of household rubbish every year. The household rubbish is on top of huge amounts of waste generated from activities such as manufacturing (360 million tonnes) and **construction (900 million tonnes),** while water supply and energy production generate another 95 million tonnes. Altogether, the EU produces up to 3 billion tonnes of waste every year.[3]

The 46% average recycling rate for EU-27 is a broad estimation with high uncertainty. However, it looks rather plausible, and within the range of estimates proposed by experts and literature: 30 to 60% [4]

At a national level, the current situation is as follows:

- 6 countries report recycling rates that already fulfil the Directive's target (Denmark, Estonia, Germany, Ireland, the UK and the Netherlands)
- 3 countries report recycling rates between 60% and 70% (Austria, Belgium, and Lithuania)
- 4 countries (France, Latvia, Luxembourg and Slovenia) report recycling rates between 40% and 60%
- 8 countries report recycling rates lower than 40% (Cyprus, Czech Republic, Finland, Greece, Hungary, Poland, Portugal and Spain)
- For 6 countries, no data was available to estimate the recycling rates (Bulgaria, Italy, Malta, Romania, Slovakia and Sweden)[5]

In Poland, approximately 5.7 million tonnes – the amount of generated waste from the construction, renovation and demolition of buildings and road infrastructure (2012)[6], - accounts for nearly 4% of industrial waste, while recycling is only 15-30%.

In Poland, for the year 2012:

Generated mineral CDW (tonnes)	**3 510 300**
Recycled CDW (tonnes)	2 044 263
Backfilled CDW (tonnes)	733 703[7]

In Austria, 8.3 million tonnes of CDW were produced in 2013 with a yearly increase[8]. Largest shares account for the categories of concrete demolition waste, building debris and bitumen/asphalt.

[3] European Commission, Being wise with waste: the EU's approach to waste management
[4] European Commission DG ENV Final Report Task 2 – Management of C&D waste 2011
[5] European Commission DG ENV Final Report Task 2 – Management of C&D waste 2011
[6] Central Statistical Office
[7] Central Statistical Office (2013) Study "Environment 2012"

Since the Directive of the European Parliament envisages extending the list of proper waste management practices and setting specific targets for recycling and reuse, this raises new obligations for the EU Member States.

In the case of construction waste, as much as 70% of their mass is to be recycled or reused by 2020. This target opens the door to the construction waste market in Poland and the other European Member States, new development prospects and the need to develop new strategies for the proper management and use of recycled materials.

Many EU countries have achieved a high level of recovery and recycling of construction waste, mainly through the use of aggregates produced and smaller fractions for low-value applications in civil engineering like the foundations of roads for example. Their key parameters implying physical and chemical properties, which result in high levels of uncertainty regarding strength parameters and the presence of unwanted dopants such as wood or plastics. As currently achieved levels of recovery of construction and demolition waste are much lower in Poland than the 2020 targets, large quantities of these wastes are still going to incinerators or landfills. Austria achieved a CDW recovery rate of 87 % in 2013[9], as a CDW management has been in place for several decades, and many initiatives exist on the national and local level, such as guidelines for CDW reduction. A revised Recycled Construction Materials Ordinance came into force in Austria in 2016 stating specific requirements that need to be met during the construction, demolition and dismantling of structures.[10] It further regulates the duty to separate resulting waste and specifies quality standards for CDW recycling manufacturers.

It is an imperative to develop and implement a number of technological solutions for innovative recovery strategies for high-value building and demolition waste materials, which allow them to increase their use or raw material use.

The re-use of useful demolition construction elements should be considered at the design stage. It would make it possible to reconcile the standards that modern building materials must meet within the requirements of the Waste Framework Directive.

Valuation of construction and demolition waste for the recovery of high-value raw materials for use in raw materials or utility should have an attractive business dimension for both, those producing waste and recyclate recipients or purchasers of used construction materials. The main obstacle is the lack of an integrated approach to the management of construction and demolition waste and the inclusion of all participants in such a chain.

At present, it is not profitable for companies to recover waste materials for high-value applications mainly due to high costs and potential problems with recyclate recipients. Little use is made of useful construction building elements, as the companies are lacking in willingness, and there are no appropriate organisational solutions supporting the circulation of these materials.

The way to develop an integrated approach could be the creation of a new, specialised service along with the entire business model targeted at property owners as potential

[8] Deloitte. 2015. 'Construction and Demolition Waste Management in Austria - V2 September 2015'.
[9] Deloitte. 2015. 'Construction and Demolition Waste Management in Austria - V2 September 2015'.
[10] Federal Law Gazette for the Republic of Austria. *Recycled Construction Materials Ordinance*. *BGBl. II 181/2016*.

customers to demonstrate this integrated service. This approach would ensure that the materials and raw materials contained in construction and demolition waste are subjected to the maximum extent of recycling and reuse.

The Polish national waste management plan up to 2022, prepared in 2016 (Resolution No. 88 of the Council of Ministers of 01.07.2016), presents the following lines of work: waste from construction, renovation and dismantling of buildings and road infrastructure.

Information and education activities for building awareness among investors and entities producing waste from construction, repair works, disassembly of buildings and road infrastructure in the proper handling of the waste stream indicated above:

- Introduction of incentives for selective collection of CDW
- Introduction of incentives to promote the use of recycled CDW
- Continuation of control of the entities producing waste from the construction, repair and dismantling of buildings and road infrastructure in the scope of proper handling of the stream of the abovementioned waste
- Extension of technical infrastructure for the selective collection, processing and reuse of recovery including CDW's recycling.

The content of this resolution appeared in Monitor Polski pos. 784 of 11.08.2016r.

4.2. The main sources of CDW

The main sources of CDW are:

- construction works

- demolition works
- adaptation and repair works

From which is obtained (graphically represented in Fig.1):

• Concrete, ceramic and brick rubble

• Wood mainly in the form of MDF, OSB and particleboard

• Polymers i.e. PE, PU and PVC

• Metals

• Glass

• Textiles

• Paper

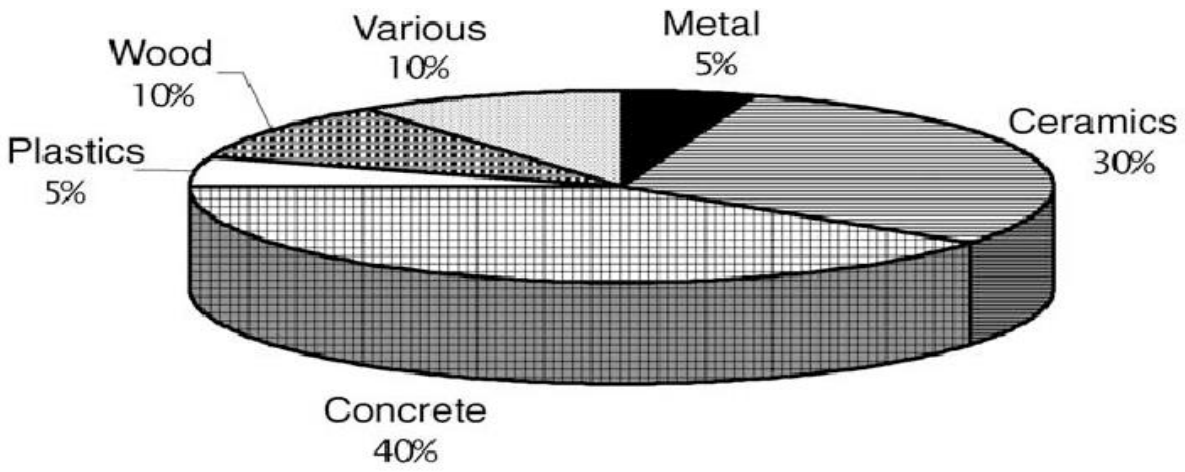


Figure 1 Basic composition of demolition wastes – (approx.)[11]

[11] Cement and Concrete Composites 27(2):315-318 · February 2005
https://www.researchgate.net/publication/222515274_Recycled_concrete_aggregates

Figure 2 (a) Demolition - steel construction (b) Demolition – traditional construction (c) Construction works – new (d) Construction works – traditional (e) Construction work – roads (f) Construction work - Reinforced concrete technology

4.3. Polish legislation

Polish legislation classifies waste within a so-called catalogue of waste containing 20 main groups, among which construction waste was assigned number 17 with the individual subgroups and descriptions of types of waste. Group 17 includes wastes from the construction, repair and dismantling of buildings and road infrastructure.

In Poland, according to statistics, most of the construction waste is produced in sub-group 1705, i.e. soil and stones - about 75-77% of all generated waste. These quantities are generated during the first phase of the life cycle of construction or road works.

Next, are classified:

➔ 1704 - metallic waste and scrap and metal alloys

➔ 1701 - wastes of materials and building elements and road infrastructure

➔ 1703 - waste of asphalt, tar and tar products

➔ 1702 - waste wood, glass and plastic

➔ 1706 - insulating and structural materials containing asbestos

➔ 1709 - other wastes from construction, repair and dismantling

➔ 1708 - construction materials containing gypsum

Mass of waste from construction, repair and dismantling of buildings and road infrastructure produced in 2011-2013 broken down into subgroups

Waste group	Waste name	Waste weight in thous. Mg,		
		2011	**2012**	**2013**
1701	Waste materials and building components and road infrastructure, such as concrete, bricks, tiles, ceramics	679,1	481,9	608,6
1702	waste wood, glass and plastic	15,7	16,0	23,1
1703	waste of asphalt, tar and tar products	24,5	14,7	67,0
1704	metallic waste and scrap and metal alloys	635,7	568,8	545,5
1705	Soil and stones, including soil and stones from contaminated land and dredged spoil	6.859,4	4.349,3	4.475,5
1706	insulating and structural materials containing asbestos	5,8	4,4	2,8
1708	construction materials containing gypsum	0,1	0,0	0,0
1709	other wastes from construction, repair and dismantling	16,6	321,1	19,1
	Total	**8.236,9**	**5.756,2**	**5.741,6**

Source: The data comes from the GUS survey and according to the reporting criterion include units generating over 1 thousand of aggregate per year. Mg waste, excluding municipal waste, or having 1 million Mg and more accumulated waste.

4.4. Austrian legislation.

In Austria, the revised *Recycled Construction Materials Ordinance* came into force in October 2016. It aims at promoting a closed-substance-cycle economy and material efficiency. The ordinance regulates the construction and demolition activities, treatment of material and the quality standards for recycled construction materials. Permitted raw materials for recycled construction products are:

1. Debris (no. 31409), mainly roof tiles & masonry, concrete & screed
2. Ceramics (no. 31407), only bricks from production (e.g. defective batches)
3. Fragments of concrete (no. 31427), also concrete from production (e.g. defective batches)
4. Road-sweeping grit (no. 91501), (May be assigned to U-A, provided that the fine fraction (below 2 mm) and the oversize particle (exceeding 12 mm) were verifiably separated; before and during treatment, no other waste was or is admixed; and there are no known or obvious impurities or pollutant contaminations of road-sweeping grit e.g. with mineral oil.)
5. Railroad ballast and technical backfill (no. 31467)

Other materials like soil excavation are authorised additives for material improvement.

Regarding contamination, following substances must be avoided:

1. Asbestos
2. Artificial mineral fibre
3. (H)CFC (e.g. in extruded polystyrene (XPS), polyurethane (PU))
4. PAH (e.g. tar)
5. PCBs
6. Phenols
7. Mineral oil
8. Gypsum
9. Magnesite- or cement-bounded wood-wool structural insulation panels
10. Cement-bounded wood-chip concrete
11. Fire protection panels
12. Artificial marble

4.5 UK Legislation.

Waste Classification: Guidance on the classification and assessment of waste (1st edition 2015)

CODE	DESCRIPTION	Entry Type	Example Provided
17	**construction and demolition wastes (including excavated soil from contaminated sites)**		
17 01	**concrete, bricks, tiles and ceramics**		
17 01 01	concrete	MN	
17 01 02	bricks	MN	
17 01 03	Tiles and ceramics	MN	
17 01 06*	mixtures of, or separate fractions of concrete, bricks, tiles and ceramics containing hazardous substances	MH	
17 01 07	mixtures of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06	MN	
17 02	**wood, glass and plastic**		
17 02 01	wood	MN	
17 02 02	Glass	MN	
17 02 03	Plastic	MN	
17 02 04*	glass, plastic and wood containing or contaminated with hazardous substances	MN	
17 03	**bituminous mixtures, coal tar and tarred products**		
17 03 01*	bituminous mixtures containing coal tar	MH	
17 03 02	bituminous mixtures other than those mentioned in 17 03 01	MN	
17 03 03*	coal tar and tarred products	AH	
17 04	**metals (including their alloys)**		
17 04 01	copper, bronze, brass	MN	

17 04 02	aluminium	MN	
17 04 03	Lead	MN	
17 04 04	zinc	MN	
17 04 05	Iron and steel	MN	
17 04 06	Tin	MN	
17 04 07	mixed metals	MN	
17 04 09*	metal waste contaminated with hazardous substances	MH	'q'
17 04 10*	cables containing oil, coal tar and other hazardous substances	MH	
17 04 11	cables other than those mentioned in 17 04 10	MN	
Note 'q': The term 'metal waste contaminated with' indicates that the metal waste itself is not considered in the assessment. Hazardous substances in paints, coatings or other contamination are considered. Metal elements in alloys in massive form are generally excluded from assessment by the List of Wastes.			
17 05	**soil (including excavated soil from contaminated sites), stones and dredging spoil**		
17 05 03*	soil and stones containing hazardous substances	MH	
17 05 04	soil and stones other than those mentioned in 17 05 03	MH	
17 05 05*	dredging spoil containing hazardous substances	MH	
17 05 06	dredging spoil other than those mentioned in 17 05 05	MN	
17 05 07*	track ballast containing hazardous substances	MH	
17 05 08	track ballast other than those mentioned in 17 05 07	MH	
17 06	**insulation materials and asbestos-containing construction materials**		
17 06 01*	insulation materials containing asbestos	MH	
17 06 03*	other insulation materials consisting of or containing hazardous substances	MH	
17 06 04	insulation materials other than those mentioned in 17 06 01 and	MN	

	17 06 03		
17 06 05*	construction materials containing asbestos	MH	
17 08	**Gypsum-based construction material**		
17 08 01*	gypsum-based construction materials contaminated with hazardous substances	MH	
17 08 02	gypsum-based construction materials other than those mentioned in 17 08 01	MN	
17 09	**other construction and demolition wastes**		
17 09 01*	construction and demolition wastes containing mercury	MH	
17 09 02*	construction and demolition wastes containing PCB (for example PCB-containing sealants, PCB-containing resin-based floorings, PCB-containing sealed glazing units, PCB-containing capacitors)	MH	'r'
17 09 03*	other construction and demolition wastes (including mixed wastes) containing hazardous substances	MH	
17 09 04	mixed construction and demolition wastes other than those mentioned in 17 09 01, 17 09 02 and 17 09 03	MN	
Note 'r': 17 09 02* is used when PCBs are present in an item of construction and demolition waste at a concentration of equal to or greater than 50 mg/kg (0.005%).			

5. Alternative sources of CDW.

Construction and 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.

CDW includes structural and functional materials comprising the structure and surrounding site improvements, including:

- Brick, concrete, and other masonry materials
- Stone
- Glass
- Wall coverings (paper, vinyl, textile)
- Drywall
- Framing and finishing lumber (wood)
- Roofing materials (foils)
- Plumbing fixtures (toilets, sinks, water heaters, pipes – PE, PEX, PVC)
- Heating equipment (furnaces, duct work, heaters)
- Electrical wiring and components containing no hazardous fluids or refrigerants
- Insulation (PU foam, Styrofoam, XPS, mineral wool, foils)
- Wall-to-wall carpeting (textile)
- Asphaltic substances
- Metal incidental to any of the above
- Windows and doors (wood, PVC, AL)

5.1. Industry

An extremely attractive source of raw materials for the Green INSTRUCT project seems to be the waste from the industry - both the building materials industry as well as other industries.

5.1.1. Brickworks

Apart from their basic product i.e. bricks, producers offer brick powder (shown in Fig.3) which is a result from the milling of production waste. The advantage of this product is the lack of a large amount of contamination, which occurs in bricks from demolition (cement-lime mortar, adhesives for facade systems, plaster, etc.)

The cost of obtaining these materials is as follows:

Description	**Fraction**	**Price PLN/1kg**	**Price €/1kg**
Brick powder	0 – 2 mm	0,27 – 0,32	0,06 – 0,07
Brick powder	0 – 5 mm	0,25	0,06

Figure 3 Brick powder

5.1.2. Concrete plants.

Apart from the production of concrete, concrete plants usually produce concrete elements (blocks, floor elements, curbs, etc.). Waste components from such production are crushed (Fig.4) and reused to produce non-contour elements as aggregate.

The cost of obtaining these materials is as follows:

Description	**Fraction**	**Price PLN/1kg**	**Price €/1kg**
Crushed blocks	0 – 31 mm	0,04	0,01
Crushed blocks	0 – 63 mm	0,02	0,005

Figure 4 Crushed concrete product

5.1.3. PVC window and door producers/wall cladding (cladding, siding) manufacturers.

PVC windows waste is produced during the production of windows and doors (shown in Fig.5). These wastes are clean, with no signs of mounting foams, plaster, etc. They may be useful for recycling and further production.

The cost of obtaining these materials is as follows:

Description	**Fraction**	**Price PLN/1kg**	**Price €/1kg**
PVC	pieces	Free for Recipient of the waste	Free for Recipient of the waste
PVC recycled	2 – 5 mm	3,00	0,70

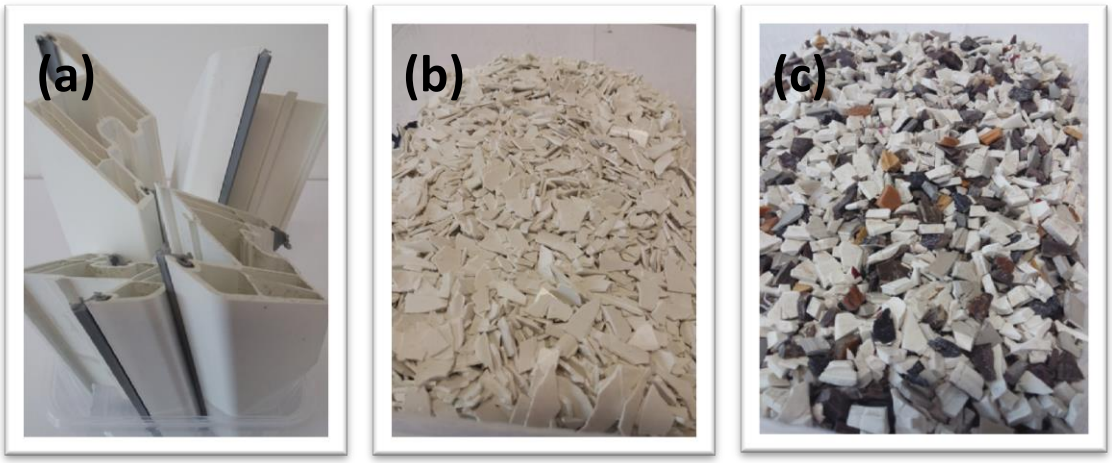


Figure 5 (a) PVC profiles (b) hard recycled PVC (c) Milling PVC colour profiles

5.1.4 Furniture production

The production of furniture produces waste of chipboard, MDF, fibreboard and solid wood (shown in Fig.6). These wastes are clean, dry, free from foreign matter and can be found in the form of chips, dust, and larger pieces.

The cost of obtaining these materials is as follows:

Description	**Fraction**	**Price PLN/1kg**	**Price €/1kg**
MDF, fibreboard, solid wood.	Chips, dust, larger pieces	Free for Recipient of the waste	Free for Recipient of the waste
MDF, fibreboard	Chips and dust	0,01	0,002

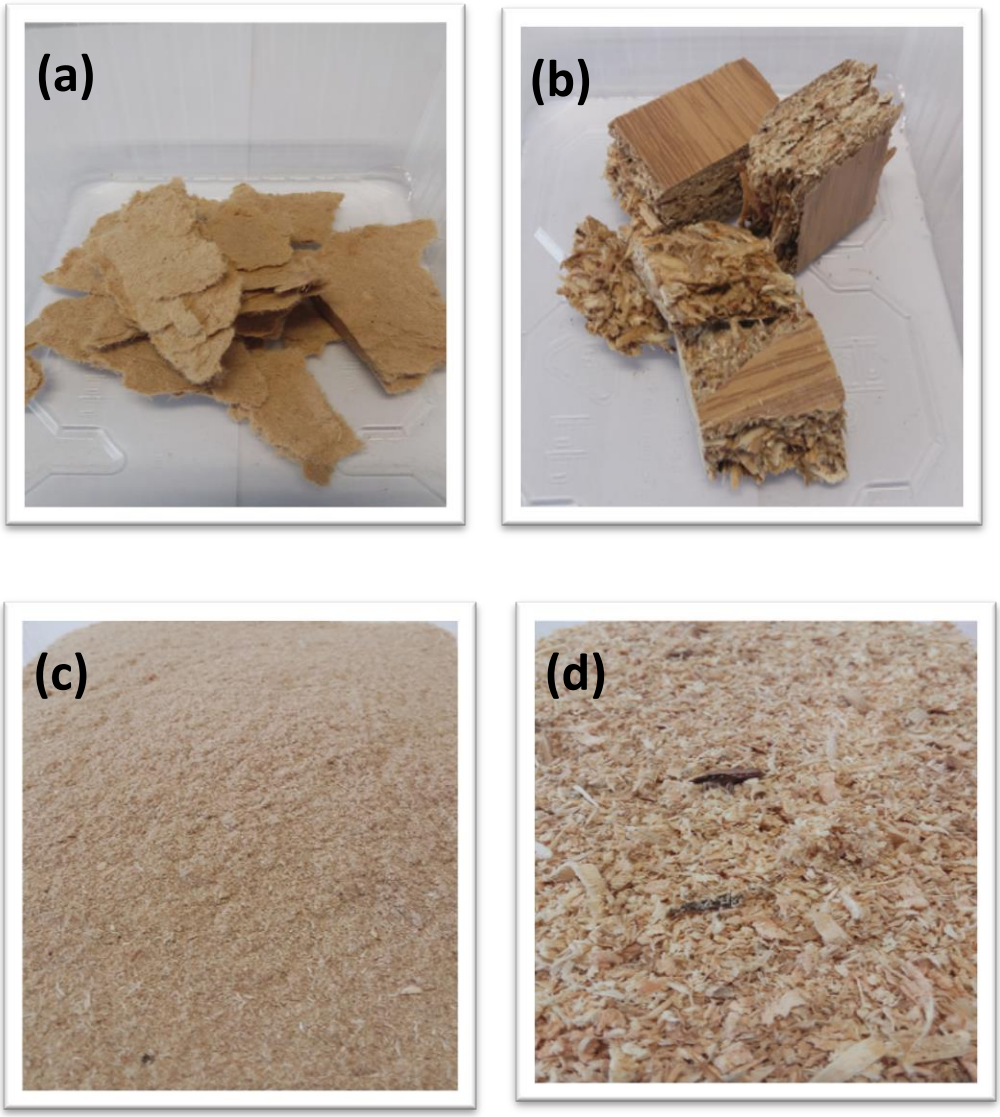


Figure 6 (a) MDF (b) Fibreboard (c) MDF dust (d) Wood and fibreboard shavings

5.1.4. Aluminium window and door producers/wall cladding manufacturers

As with the production of window and door joinery from PVC, the production of window and door joinery (as well as blinds, wall coverings) of aluminium results in valuable aluminium waste (shown in Fig.7), which is a highly valued secondary raw material to produce new aluminium products. Reusing such waste is simple, and the recovery technology is simple and relatively cheap. Consequently, the price of such waste is relatively lower than other wastes mentioned in this study.

The cost of obtaining these materials is as follows:

Description	Fraction	Price PLN/1kg	Price €/1kg
AL	pieces	4,00 – 5,70	0,95 – 1,33

Figure 7 Aluminium profiles

5.1.5. Clothes producers.

Many wastes of various types of textile materials are produced in the process of clothing manufacture. The cuttings are clean, can be well separated from other materials, prepared for further processing without additional separation, sorting or purification processes (shown in Fig.8)

The cost of obtaining these materials is as follows:

Description	Fraction	Price PLN/1kg	Price €/1kg
Colour cotton	pieces	2,00 – 4,00	0,47 – 0,93
White cotton	pieces	4,50	1,05

Figure 8 Cotton material

5.1.6. Sandwich panel producers.

Panel manufacturers use polystyrene core or PU foam as the core. In the production of boards, which are produced on orders, waste is generated in the form of polystyrene foam and PU foam (shown in Fig.9). The foam is paletted and blended with different recipients for further processing. The material is clean and there are no traces of other substances.

The cost of obtaining these materials is as follows:

Description	**Fraction**	**Price PLN/1kg**	**Price €/1kg**
PU foam	pieces	No data	No data

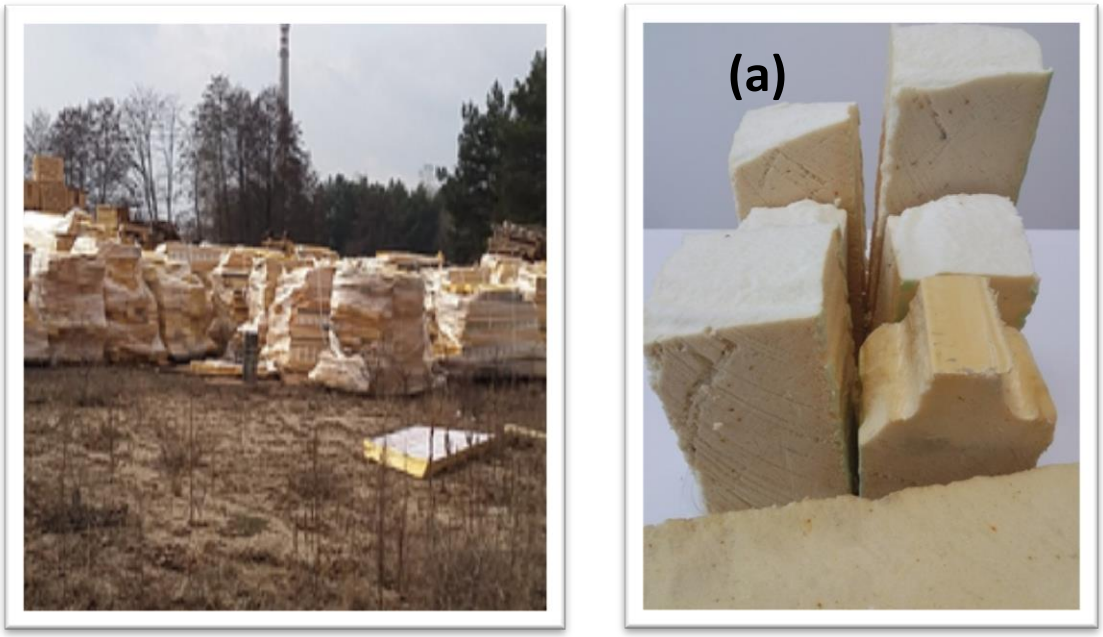


Figure 9 (a) PU foam pieces (b) PU foam pieces

5.1.7. Tiles producer

During the production of clinker or ceramic tiles, production waste is generated (shown in Fig.10). They are then crushed, milled and granulated. At the time of granulation, ingredients are added to improve the properties of the finished products. Manufacturers add up to 2% of the recycled material to the production mass.

The cost of obtaining these materials is as follows:

Description	Fraction	Price PLN/1kg	Price €/1kg
Powder	0 – 2 mm	No data	No data

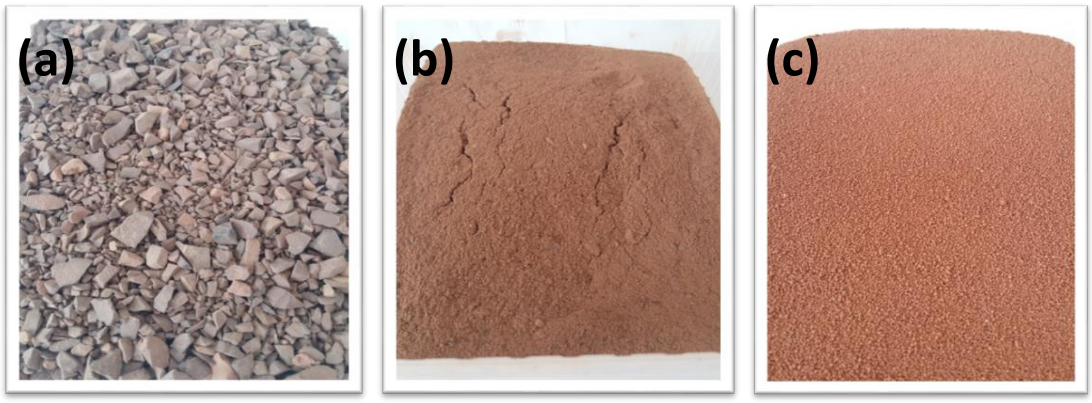


Figure 10 (a) crushed tiles (b) milled tiles (c) granulated tile powder

5.1.8 Trade

Trade also provides interesting materials that can serve as a raw material for innovative building materials technology. The trade produces enormous quantities of packaging (some of which is shown in Fig.11): metal, polymeric, aluminium, paper, glass and wood. Of course, packaging manufacturers are concentrated mainly around the manufacturing industry: food, marching, electronics, etc. However, the packaging ends up in the hands of consumers, and in most cases, they come back through recycling companies for reuse.

The cost of obtaining these materials is as follows:

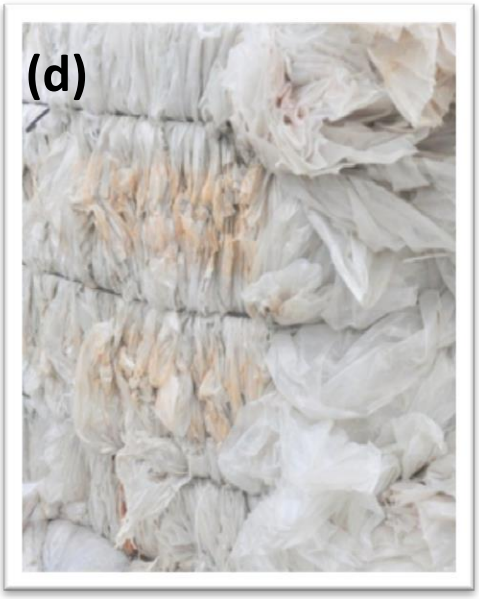
Description	**Fraction**	**Price PLN/1kg**	**Price €/1kg**
PET (bottles)	0-5 mm	3,00	0,7
AL cans	pieces	4,00	0.93
PE, PP	0-5 mm	0,05 - 2	0,01 – 0,50

Packaging marketed and achieved recycling levels in 2014 - source Ministry of the Environment (Poland) [12]

Package	Weight of the packaged packaging (tonnes)			Total waste recycled (tonnes)	Achieved level of recycling (%)
	Total	Subject to obligation			
		salvage	recycling		
Plastics	896 321	4 838 101	894 347	256 014	28,6
Aluminum	87 692		87 681	42 188	48,1
Steel incl. steel sheet	156 782		156 743	87 024	55,5
Paper, cardboard	1 567 973		1 566 751	1 141 764	72,9
Glass – ampoules excl.	1 027 963		1 027 644	618 432	60,2
Natural materials (wood, textiles)	1 108 601		1 108 583	538 286	48,6

[12] Monitor Polski, Poz.784, 11.08.2016.


(c)


(d)


(e)


(f)

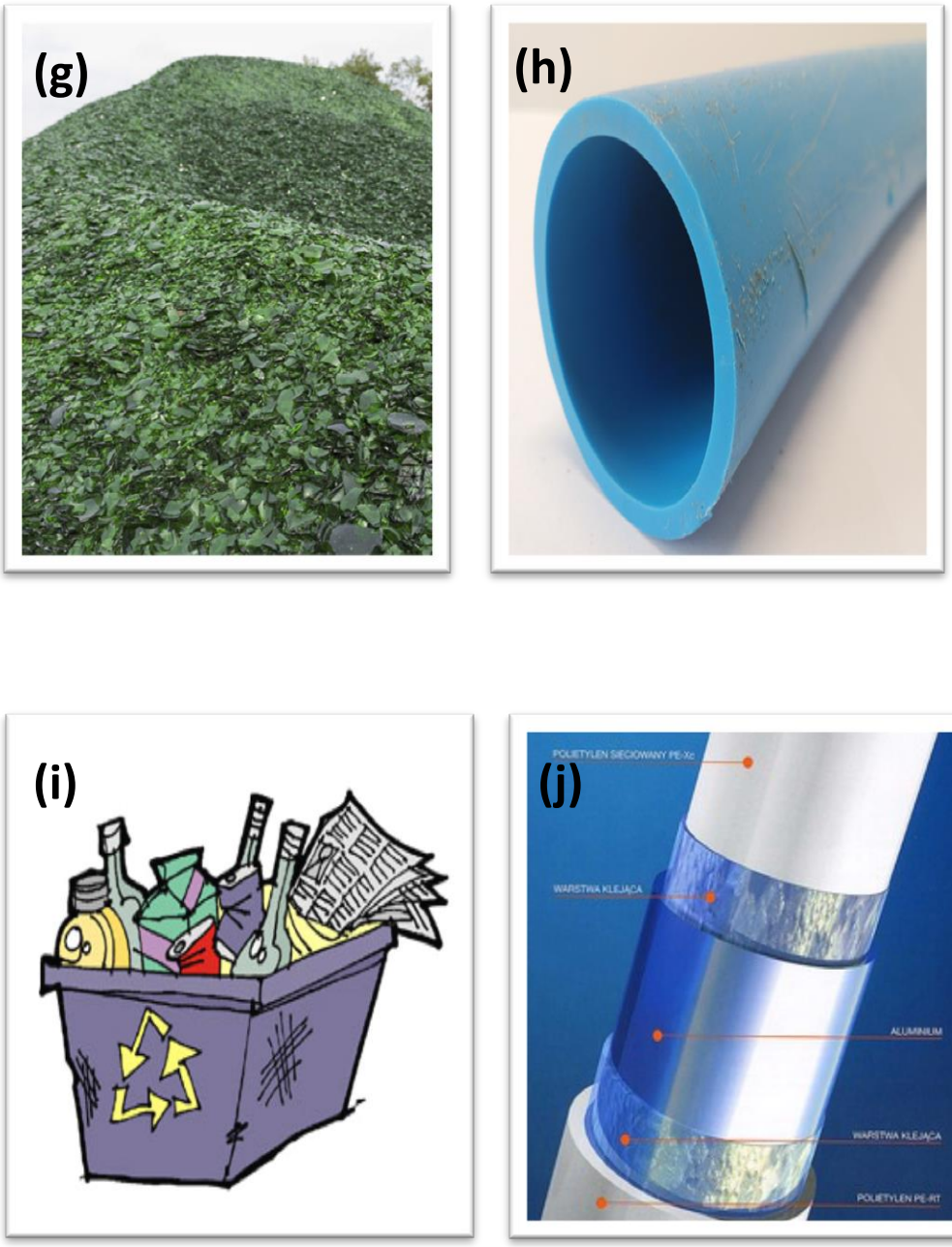


Figure 11 (a) PET chips (b) PET bottles (c) PET bottles (d) foil (e) AL Cans (f) white glass (g) colour glass (h) PE pipe (i) packaging of fast-moving goods (j) PEX pipe

5.2. Services

5.2.1. Prefabrication.

There are CDW with high technical potential: pure steel, structural block rubble in the prefabrication of structural materials such as reinforcement elements and wall elements.

5.2.2. Removals and cleaning services

Within these services, large amounts of textiles, wood in various forms, waste plastics and paper are produced.

6. Alternative CDW – management status.

CDW management options:

A range of techniques is used in the management of CDW throughout Europe. Some of the materials, such as bricks, are recovered from demolition sites and re-used directly in construction. Other materials can undergo some physical and thermal processes, including:

Screening – for the grading of soils and stones for re-use;

Crushing – for processing concrete and rubble for use as sub-base;

Shredding – for processing wood/boards etc;

Segregation and recycling – of waste component materials such as metal, plastic, glass and plasterboard;

Incineration (with or without energy recovery) – of wood, plastics and for the thermal destruction of hazardous components;

Landfill (inert, non-hazardous, and hazardous) – of various materials, ranging from simple sites for the disposal of inert materials to specific sites specialising in the handling of hazardous materials, such as asbestos and low-level nuclear waste.

Alternative CDW “raw materials” are produced at different stages of work, technological processes, sales and other processes, etc.

Depending on the place of origin, morphological composition, branches of industry, trade or services, the management of these materials is different.

6.1. Recycling on the production lane

Examples of recycling on the production line are the processes used by the manufacturers of clinker tiles or ceramic tiles. Part of the production which does not pass quality control, shows technological defects, blemishes, etc. returns to the mills, is granulated, and then re-added to the mixtures used to produce the final product.

Typically, recycled granules for clinker tiles produce up to 2% of the weight of the new product.

A similar situation occurs in the production of bricks, concrete blocks, glass, aluminium, etc.

6.2. Reuse

Increasingly, the idea of reusing multiple materials in various areas of industry, commerce and services is being realised.

In many European countries, the reliance on reusable packaging materials goes from PET bottles, foil bags, etc. to reusable and easily recyclable glass bags, paper or textile bags, etc.

Also, the construction services sector uses dismantled wooden constructions for reuse, re-using brick from the demolition of old homes. Bricks from very old buildings reach higher market prices than new bricks and are highly sought after.

Probably, this situation also is related more to the social processes, fashion and design trends, but it can be used to handle large quantities of old furniture, clothes and various textiles, dishes and various industrial products.

6.3. Utilisation

In our understanding, the utilisation is mainly related to the management of hazardous waste arising either in production or demolition processes (asbestos, asphalt) or assembly (building chemicals, insulating materials, solvents)

Such disposal is handled by process technology manufacturers or by specialised waste management companies. The purpose of such activities is to secure the materials being processed so as not to jeopardise the life and health of humans, animals and the environment.

6.4. Disposal.

Commercial marketing involves much waste arising from different stages of the business.

Some manufacturers do not have recycling facilities that are involved in the manufacture of waste products, and these are collected by specialised recycling companies - either as a paid service or free of charge.

For example:

PVC - Manufacturers of windows made of PVC profiles make waste from their production to companies that specialise in milling window profiles. As a result, the so-called PVC milling is used in the manufacture of other plastic products: cables, pipes, cladding, windows border, PVC finishing products, bottles, cans.

Both in Poland and throughout Europe there are many companies that can use the waste to create good technological and economic systems for their use, processing and preparation for re-use by the market. Moreover, these processes are carried out in a positive economic account. The problem remains to increase the scale of such activity so that the thinking and action of individual industries are ecologically sound.

There are also waste management spheres where waste is becoming more and more difficult, as in the context of the discussions here raw material such as paper is in decline.

Cellulose - Today's paper is an extremely "short-lived" raw material. Manufacturers who produce cellulose-based products or provide services using this raw material (hydrosulphate) report high demand for waste paper, which is becoming increasingly difficult to access. The impact is on the disappearance of reading newspapers, books and transferring the entire information sphere to electronic media.

6.5. Other

Waste management assumptions in the EU are aimed to reduce the amount of waste drastically, maximising the potential of recycling all sorts of waste, finding new technologies that would benefit from the potential of industrial, construction and municipal waste.

Ways of using these wastes will always be different, depending on the progress of learning, technological possibilities, social processes and the level of education.

It does not matter whether waste management takes place at the level of the manufacturing capacity of their manufacturer or we reuse existing resources or create business models for processing waste produced in different ways; the main goal we must pursue is to improve waste management policy. CDW management system should be organised in the way to ensure preparation for re-use, recycling and other material recovery including backfilling operations using waste to substitute other materials and non-hazardous construction and demolition waste excluding naturally occurring material will have been increased to a minimum of 70 % of weight by 2020.

7. Conclusion

The CDW's structure depends on the technology of the work or object that is to be their "source".

For construction work, the structure of the CDW stream depends on the technology of construction of buildings. Concrete technologies limit the amount of construction rubbish to a minimum: usually, the size of reinforcing steel is optimised, prefabricated, and the amount of concrete poured strictly programmed. Steel technologies are also based on prefabricated components that are usually prefabricated.

Traditional technologies provide a wider range of CDWs. Brick rubble, rubble from all kinds of construction blocks, steel scrap, wood, paper, foil, PVC pipes and PE are very likely to be found.

Finishing works further expand the CDW range: ceramic tile waste, gypsum board, OSB boards, plastic pipes, electrical wires, etc.

The structure of the CDW stream generated during demolition works also depends on the type of demolished site - its construction technology, destination, etc. For residential buildings built before 1950, waste is limited to brick, steel, wood, cast iron, waste PE, PU or PVC pipes.

So, it seems reasonable to seek alternative CDW sources, that will provide the "full assortment of waste" needed to create innovative solutions for the construction industry, considering the needs of today's world. The needs of the environment, the protection of natural resources, the recycling of waste that today's world produces more and more.

Of course, alternative sources of CDW also increase specific problems during further technological processes. It should be noted that the use of generic names for certain CDW groups does not reflect the specific material from which they are made, and after testing the material does not appear to contain the expected components or other materials.

For example, PE Pipes: there are PEX pipes or a mix of different PE types. Still, PE is used everywhere as a generic name for all these types of pipes. Another example is cotton clothes:

some are pure cotton, and others have mix fibres (even without testing, just by stretching the clothes you can realise some of them contain non-natural fibres).

It is also worth noting that the separation of complex materials can be achieved only to a certain point and there is a limitation to the exact separation of certain fractions. It may seem simple, but if a specific recycling technique is required, technical limitations may arise due to the variety of materials in each fraction.

The goal of the Green INSTRUCT project is to develop and implement an innovative solution for the building industry: a multi-layer wall panel, of which 70% by weight will be made from processed CDW.

The purpose of this report is to indicate where it is possible to obtain waste as a "source of raw materials" for the Green INSTRUCT panel in addition to the "natural" sites of CDW formation.

Sources of such raw materials occur in some industries, trade and services. They have a lot of technical and economic potential, and their ease of access is a good alternative for some types of CDW.

8. Acknowledgment

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