COST is supported by the
EU Framework Programme
Horizon 2020

Book of Abstracts

Workshop on
Recovery technologies for construction and demolition waste

16-17 November 2016
Technische Universität Wien
Vienna, Austria

Organized by
COST Action "Mining the European Anthroposphere"
www.minea-network.eu

Vienna, November 2016

Impressum

Workshop title

Recovery technologies for construction and demolition waste.

Workshop venue

Technische Universität Wien
Karlsplatz 13
1040 Vienna
Austria

Workshop Programme Committee

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Dr. Ulrich Kral	Technische Universität Wien, Austria *MINEA Chair*

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Printing advice

The document is optimized for 2-sided printing on A4-format.

Acknowledgement

The Book of Abstract is based on contributions to the COST Action "Mining the European Anthroposphere" CA15115, supported by COST (European Cooperation in Science and Technology).

Version history

n°	Date	Description	Edited by
1.0	2016/10/28	First release	U. Kral, I. Hengl
2.0	2016/11/16	Release for review by speakers	U. Kral
3.0	2016/12/02	Public release	U. Kral

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Workshop Program

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09:40	**COST Action CA15115: Mining the European Anthroposphere (MINEA)** Ulrich Kral (TU Wien, Austria)
10:00	**KEYNOTE PRESENTATIONS**
10:00	**ZenRobotics waste sorting technologies** Maciej Borkowski (ZenRobotics, Finland)
10:30	**Material Flow Analysis of stocks and flows to assess construction and demolition waste recovery potential** Clemens Deilmann (Leibniz Institute of Ecological Urban & Regional Development, Germany)
11:00	**Strategies for the recovery and recycling of raw materials from construction and demolition waste: IRCOW and HISER projects** Amaia Lisbona (Tecnalia, Spain)
11:30	**COFFEE BREAK**
11:45	**Construction and demolition waste recovery assessment and optimisation** Mohamed Osmani (Loughborough University, UK)
12:15	**Recycling and closing the loop for gypsum products: The European Gypsum Industry circular economy approach** Christine Marlet (Eurogypsum, Belgium)
12:45	**Recycling of construction finishing work wastes** Rym Mtibaa (Recylum, France)
13:15	**LUNCH**
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	Topic 1: Construction and demolition waste recovery challenges. **Topic 2: Construction and demolition waste recovery enablers.** Session facilitator: Mohamed Osmani (Loughborough University, UK).
15:30	**COFFEE BREAK**
15:45	**DEBATE** **The EC and Member States' actions and incentives to support the industry to achieve the Waste Framework Directive target to reuse, recycle and recover 70% (by weight) of construction and demolition waste by 2020.**
	Panel members: Maciej Borkowski (ZenRobotics, Finland); Clemens Deilmann (Leibniz Institute of Ecological Urban and Regional Development, Germany); Amaia Lisbona (Tecnalia, Spain); Christine Marlet (Eurogypsum, Belgium)); Rym Mtibaa (Recylum, France).
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11:30	**Dynamic Performance Assessment of the construction and demolition waste recovery policies.** Ibrahim Motawa (Heriot-Watt University, Scotland).
12:00	**Density based separation of heterogeneous construction and demolition waste mixtures** Erik Marklund (Luleå University of Technology, Sweden)
12:30	**WORKSHOP CLOSING REMARKS AND COST Action CA15115 (MINEA) NEXT STAGES**
	Mohamed Osmani (Loughborough University, UK) and Ulrich Kral (TU Wien, Austria)
13:00	**LUNCH**

Biographies

(in alphabetical order without titles)

Borkowsky, Maciej [ZenRobotics, Finland]

Received Ph.D. in electrical engineering 2008. With ZenRobotics since 2009. Initially in research & development, later in business development and sales. Entrepreneur who will not sit and wait until robotic technology revolutionises recycling.

Deilmann, Clemens
[Leibniz Institute of Ecological Urban and Regional Development, Germany]

Prof. Deilmann, Clemens; Dipl.-Ing., Architect
Head of Research Area Resource Efficiency of Settlement Structures

Academic Training
1979: RWTH Aachen: Diplom (Architect)
1980: A. A. School of Architecture London: Post-graduate Diplom 1980

Professional Experience
1981-1984: Architect (Medellin, Colombia, housing and urban development projects)
1984-1992: freelanced Architect ("eco-architecture")
1992-2009: Head of Department Housing and Sustainable Construction (IOER)
Since 2009: Head of Research Area “Resource Efficiency of Settlement Structures” (IOER)
Since 2010: Honorar-Professor at HTW Dresden “Ecological design and construction"

Research Interests
Material flow analyses of buildings and infrastructure, urban structural analyses
Building assessment (building passport), monitoring of urban development, development scenarios
Implementation of sustainable construction - barriers, obstacles, instruments

Kral, Ulrich [Technische Universität Wien, Austria]

Educated in Austria (doctoral degree in technical sciences, Vienna University of Technology), Dr. Kral holds a post-doc position at the Institute for Water Quality, Resources and Waste Management at Vienna University of Technology. His research focuses on the life cycle of materials in the anthroposphere, in particular on methodologies to analyse, evaluate and manage material stocks and flows. His PhD thesis focused on an indicator to assess material flows that leave the anthropogenic material cycle into regional sinks. The indicator provides guidance to manage material flows with respect to available sink capacities and allows benchmarks between different regions. Since PhD graduation, his focus is also on the assessment of anthropogenic material stocks in infrastructure assets.

He chairs the COST Action "Mining the European Anthroposphere".

Lisbona, Amaia [Tecnalia, Spain]

Ms. Amaia Lisbona is a civil Engineer (University of Cantabria. 2004). She was part of Sestra consultant team, developing road and housing design projects. Her work has been around valorisation of waste and industrial by-products for building and civil applications since she joined the Construction Unit of TECNALIA Research & Innovation (former Labein) in 2008. Her current research interest is concerning issues related to the optimisation of (de)construction practices to maximize material recovery, the development and testing of building materials manufactured with treated waste, the valorisation of waste materials in civil works or the development of methodologies to promote the use of recycled materials in construction. She is co-author of the paper "Pre-normative research on the use of mixed recycled aggregates in unbound road sections" (Vegas et al., Construction and Building Materials 25, 2011). She's been also working on projects around the use of recycled aggregates in bound road applications. She was part of the coordinating team in EU funded FP7 IRCOW project: "Innovative Strategies for High-Grade Material Recovery from Construction and Demolition Waste" (Grant Agreement nº 265212) and at present she is coordinator of the EU funded Horizon 2020 HISER project "Holistic innovative solutions for an efficient recycling and recovery of valuable raw materials from complex C&DW" (Grant Agreement nº 642085).

Marlet, Christine
[Eurogypsum - The European Plaster and Plasterboard Industry, Brussels]

Christine Marlet was born in 1960. She graduated with honours from the Faculty of political sciences at the University of Loouvain-La-Neuve (Belgium). she continued her studies with a Master Degree in Educational Sciences, Istituto Internazionale per l'Educazione, Rome, Italy.

After a work experience in Luxemburg, she joined in 1997, the European Associaition for print and digital communication as general advisor where she performed project management and public affairs tasks in R&D. In May 2001, she joined Eurocommerce where she managed a European project in the field of ecommerce and developed the environmental and logistics policies of the association. Finally, she joined the European Gypsum Industry in 2005 as secretary general of the association.

Marklund, Erik [Luleå University of Technology, Sweden]

Erik Marklund has been a PhD student at the Waste Science and Technology research group at Luleå University of Technology since April 2016. His present research looks at characterization and methods to treat waste with carbon content unfavorable for both landfilling and incineration. He has a master's degree from the Department of Industrial Ecology at Royal Institute of technology (KTH) in Stockholm.

Mlinar, Christian [Bernegger GmbH, Austria]

Academic Training:

- 1993 - 2004: University of Natural Resources and Life Sciences (BOKU), Vienna, Forest and ecology
- Engineer: Graduate engineer
- 1997 -1998: Sveriges Lantbruksuniversitet Umeä, Sweden, Sokrates Program

Professional experience:

- 2000- 2003: University of Natural Resources and Life Sciences, Department of Forest and Soil Sciences, Project Manager
- 2005-2008: lntergeo ZT GmbH, Technical Geology and Civil Engineering, Project manager
- 2008-2014: ASFINAG Bau Management GmbH (BMG), Austrian highway company, Team leader Environmental Department
- Since 2014: Bernegger GmbH, Team member Department Environment and Waste Management

Motawa, Ibrahim [Heriot-Watt University, United Kingdom]

Dr Ibrahim Motawa is an assistant Prof in Construction IT at Heriot-Watt University, UK. Before joining the University, he was working at the University of the West of England as a Lecturer in project management. His main research interest covers IT in construction, energy efficiency in construction, modelling construction processes and BIM. During 2005, he worked as a research associate at Heriot-Watt University (UK) on a project funded by the EPSRC. For the period 2001 –2004, he worked as a research associate on a project funded by the EPSRC at Loughborough University (UK). Dr Motawa gained his PhD in late 2001 from the department of Civil & Building Engineering, Loughborough University, UK. Dr Motawa got his undergraduate degree in Civil Engineering and his Master degree in Structural Engineering.

Mtibba, Rym [Recyclum, France]

Rym MTIBAA began her career in 2006 at AgroParisTech (*Paris Institute of technology for life, food and environmental sciences)* where she worked on land-use competition and conflicts in the outer-urban area of Paris. She then continued her career in IRSTEA (*National Research Institute of Science and Technology for Environment and Agriculture*) where, for four years, she made environmental, social and techno-economic studies about optimal size and location of waste management facilities. In 2011 she moved to Ile-de-France Regional Council where she was in charge of construction and demolition waste management policy for the Ile-de-France area. Since October 2016 she works for Recylum as project leader in charge of construction and demolition e-waste and she also coordinates the DEMOCLES project.

Osmani, Mohamed [Loughborough University, United Kingdom]

Dr Mohamed Osmani is an architect with a PhD in sustainable building design. He is the Director of the Architectural Engineering and Design Management Programme at the School of Civil and Building Engineering, Loughborough University, UK. He has developed a significant portfolio of research projects in the field of C&D waste prevention and recovery. He is currently supervising a range of research funded projects and doctoral studies covering material resource efficiency; circular economy; designing out waste; end of life material optimisation; and Building Information Modelling (BIM)-aided-waste minimisation. He has published over 150 papers and technical reports, most of which are material efficiency and C&D waste-related.

His international roles and duties include: Leader of the EU COST Action CA15115 (MINEA) Working Group on "Resource Potential of C&D Waste; C&D Group Leader of the International Waste Working Group (IWWG); Reviewer for Hong Kong Environment and Conservation Fund

(ECF); Reviewer for the Technology Foundation STW Dutch Funding Agency, the Belgian Research Foundation: Fonds Wetenschappelijk Onderzoek - Vlaanderen (FWO), the Canadian Funding Agency: Fonds de Recherche du Quebec (FRQ) and Qatar National Research Fund (QNRF); and over 20 international journals, including Cleaner Production and Waste Management.
His UK national roles and duties include: Committee Member of the UK Government Strategic Forum for Construction Waste Group (part of the UK Green Construction Board), which was entrusted the responsibility to monitor the UK Strategy for Sustainable Construction waste targets; Panel Chair of a new suite of British Standards -BS 8895 Part 1 to 4: Code of Practice for Designing for Material Resource Efficiency in Building Projects; the Chairman of the Construction Industry Research and Information Association (CIRIA) Sustainability Advisory Panel, which provides a focus on sustainability issues facing the UK construction industry; Panel Member of BS 8001 (Framework for implementing the principles of the circular economy in organizations); and Judging Panel Member of the Chartered Institution of Wastes Management (CIWM) for the annual C&D 'Environment Excellent Awards'.

Petrovszki, Krisztián [Clean-Way Ltd., Hungary]

Mr. Krisztián Petrovszki is an Environmental Management Agricultural Engineer (Faculty of Water and Environmental Management, Szarvas, Diploma in 2008), Environmental Engineer (University of Szent István, Szarvas, Diploma in 2015) and a Waste Management Engineer (Engineering Chamber membership SZKV1-0115760). During his college years, working for a family business of road construction (Leel-Őssy Kft.), he already had the chance to recognize his own enthusiasm towards working with soil and to realize his interest about reuse and recycle of construction and demolition waste (CDW). He was Development and Project Director of the biggest waste management public enterprise (Multi-Utility Company) and now he is the Executive Director and Owner of the Clean-Way Environment and Public Procurement Ltd. The company has reused 250-350.000 tons of CDW since it was founded in 2008. It has its own waste recovery site (2360 Gyál, out of the city 076/1, 078/13) and it recycles everywhere in Hungary based on its mobile permission. Besides investing in its own projects, the company helps other market leader construction enterprises in Hungary to reuse CDW.

Rammer, Hubert [Bernegger GmbH, Austria]

Academic Training:

- 2003 - 2007: Technical University Graz, Industrial engineering and management: Graduate engineer
- 2007 - 2008: Technical University Glasgow, Industrial engineering and management: Graduate engineer
- 2014- 2015: Montane University Leoben, Mineral Resources Engineering

Professional experience:

- 2008- 2013: Bernegger GmbH/GROUND UNIT, Operation Manager of a C/P plant for recycling contaminated soil and demolition waste.
- Since 2013: Bernegger GmbH/GROUND UNIT, Director of a C/P plant for recycling contaminated soil and demolition waste.
- Since 2013: Bernegger GmbH, Manager Maintenance for recycling, gravel, quarry and concrete plants

Rigamonti, Lucia [Politecnico di Milano, Italy]

Lucia Rigamonti is an environmental engineer graduated at Politecnico di Milano (Italy) in 2003 cum laude. In 2007 she completed her PhD in Sanitary and Environmental Engineering with a thesis on the topic of Life Cycle Assessment (LCA) applied to different integrated municipal solid waste management systems. She is a senior researcher at the Department of Civil and Environmental Engineering (DICA) of Politecnico di Milano. She is professor for the university courses 'Phenomena of pollution' and 'Sanitary - environmental engineering'. In 2013 she spent three months at the Scion Research Center (Rotorua, New Zealand) and in 2015 two months at the University of Queensland (Brisbane, Australia). She has authored over 140 publications, including more than 25 on ISI/SCOPUS journals. She coordinates the working groups 'DIRE (Development and Improvement of LCA methodology: Research and Exchange of experiences)' and 'Waste management and treatment' of the LCA Italian network. Her research interests include: waste management and treatment, waste prevention, life cycle thinking approach, industrial symbiosis, sustainable use of resources and sustainable consumption.

Vrijders, Jeroen [Belgian Building Research Institute, Belgium]

Jeroen Vrijders (°1982)

- Deputy Head of the Laboratory for Sustainable Construction of the Belgian Building Research Institute (www.bbbri.be). BBRI is a private research organisation, working mainly for the Belgian contractors as research centre, information point & stimulator of innovation & development.
- Graduated in 2005 as a Civil Engineer in Construction, option Environmental Technologies. –
- Since 2005 active as researcher in the broad field of waste management and recycling of construction and demolition waste, in several regional, national & European projects on:
    - Waste management on construction sites: development of economic and practical models, organising the logistic chain, creating added value …
    - Pre-demolition audits, solution development for hard to recycle waste streams, optimisation of demolition & on-site recycling,
    - Use of recycled aggregates in concrete and other domains: research on durability, support in applications on site, policy preparation, standardisation development, innovative solutions…

  The research is always translated into concrete support for the Belgian construction sector, by transferring knowledge on innovation, technical solutions, standardisation, …
- Active in national & international commissions & work groups
    - CEN TC 104 Concrete - Belgian Expert in TG19 – Use of aggregates
    - Secretary of the Belgian Working Group on Certification of concrete with recycled aggregates
    - CEN TC 350 Sustainability of construction works – Belgian Expert in WG4

Abstracts

(in chronological workshop program order)

ZenRobotics waste sorting technologies

Maciej Borkowski (ZenRobotics, Finland)

ZenRobotics Ltd is the leading supplier of robotic waste sorting technology. ZenRobotics was the first company to successfully bring robots to work in the demanding waste management environment - an environment far too complicated and chaotic for standard robot control systems.
The company's robotic waste sorting system, ZenRobotics Recycler (ZRR), aims to transform the waste processing industry just like industrial robots changed the automobile industry. Designed to lower costs and increase the efficiency of waste sorting, ZRR defines Next Generation Recycling.

Intelligent robotic waste sorting systems are autonomous, multitasking, learning and scalable systems that can operate tirelessly 24/7. They provide forward-thinking waste management companies numerous economic, social and process-related incentives. For example, robotic waste sorting can create significant cost savings generated by process efficiency while allowing new revenue streams from high-purity recyclables.

Intelligent robotic systems can process various waste streams as sorting capabilities can be redefined for every new market situation – even on a daily basis. Increased flexibility in recognition and sorting capability gives plant operators the possibility to explore new use cases. This kind of flexibility has not been available in waste sorting earlier.

Material Flow Analysis of stocks & flows to assess construction & demolition waste recovery potential

Clemens Deilmann (Leibniz Institute of Ecological Urban and Regional Development)

Material flow analysis (MFA) is a suitable tool to understand and to promote circular economy. In quantitative terms, in particular the built environment is important to consider, i.e. it is decisive to describe the large mass relevant material flows. There are MFA approaches that depict inflows and outflows using different methods and different levels of detail but usually without connecting the two ends of inflow and outflow. Doing this, qualitative aspects of in- and outflows are to be observed, because not only the quantity but also the quality of material determine the possibilities of recycling from the technical point of view. Achievable qualities with regard to the outflow and required material qualities with regard to the inflow are thereby decisive. The former requires the integration of process engineering knowledge and treatment technology of waste management, the latter civil engineering knowledge about technical aspects which form the boundary conditions for the use of secondary material in new infrastructures or buildings.

This contribution introduces the integration of both aspects within the MFA approach. Therewith the entire material cycle can be represented completely and emphasized with quantities. Flows are evaluated and merged in compliance with waste management technologies and civil engineering requirements. The concept of a Closed Loop MFA is presented and applied to German building dynamic, considering potentials of a high quality recycling (from buildings to buildings).
There are two results: first the extended MFA-Approach that enables to quantify closed loops and second empirical results showing profiles of resource saving potentials for regions with specific building stock dynamic. Huge regional and temporal disparities in the available amount of and the need for mineral recycled aggregates in the building sector are indicated. Hereupon policies aiming on fostering high grade recycling in the construction industry can be developed.

Strategies for the recovery and recycling of raw materials from construction and demolition Waste: IRCOW and HISER projects

Amaia Lisbona (Tecnalia, Spain)

IRCOW (2011-2014) and HISER (2015-2019) projects aim to develop solutions for maximizing the material recovery from construction and demolition Waste (C&DW). Cost efficient recovery requires both enhanced segregation of materials at demolition/refurbishment works and integral recycling approaches. Providing solutions for increased levels of quality assurance of recycled materials, higher certainty of their influence in current manufacture processes and (performance/durability) of the subsequent building products is also aimed, as can lead to increased demand. Also standards/policy recommendations are expected, to drive higher market acceptance.

Amongst others, IRCOW adapted advanced sorting technologies for improving the quality of recycled aggregates. This approach is being fine-tuned in HISER. Other HISER technological solutions for C&DW recycling refer to electro-fragmentation techniques (for the selective release of materials adhered in the stony fraction) or the mobile treatment plant for stony fraction, including ADR classification/refining process and a LIBS-based quality assurance system. Innovative recycling equipment of gypsum-based waste and the optimization of recovery concepts for C&D wood and mineral wool are in the pipeline. Moreover, closing the material loop, a range of recycled products was designed in IRCOW. Likewise, HISER is optimizing products such as cements, concretes, bricks, gypsum-based products or extruded composites.

In the chapter of solutions for increased segregation of materials at works, HISER is developing a software tool to support the pre-demolition study. Also a tracking system that can lead to higher quality of the to-be recycled waste and increased trust in its quality. Reuse option was also explored by IRCOW. All solutions are/will be tested in case studies and (economically/environmentally) assessed from a life cycled perspective.

IRCOW and HISER projects received funding from the European Union's Seventh Framework Programme and Horizon 2020 Research and Innovation Programme respectively, under grant agreement numbers 265212 and 642085.

Construction and demolition waste recovery assessment and optimisation

Mohamed Osmani (Loughborough University, UK)

A Performance, Economic and Environmental Recycling Assessment (PEERA) Methodology was developed part of a project funded by the UK government and the construction industry, entitled "Built Environment Action on Waste Awareness and Resource Efficiency" (BEAWARE). The project addressed issues associated with: supply chain resource efficiency; and cross sector construction and demolition (C&D) waste recycling opportunities.

The PEERA methodology is a waste mapping and decision support tool to explore C&D waste recycling potential opportunities. It addresses several issues such as: gathering lifecycle data on waste types and quantities; examining disposal and current recycling costs; identifying and addressing reuse and recycling limiting factors (e.g. economic, technical and environmental blockers); ranking C&D waste materials in terms of their recycling potential; and assessing the feasibility of reprocessing routes. The PEERA methodology comprises ten stages: waste targeting; waste composition; waste prioritising; waste causes, quantities and value; waste costs and current recycling status; recycling limiting factors; addressing the limiting factors; re-use/recycling opportunities; re-use/recycling requirements; and re-use/recycling costs and markets.

The PEERA methodology was validated through a series of workshops and surveys, during which information was collected directly from key supply chain stakeholders. More than 45 C&D waste materials were identified during the initial waste targeting data collection. Through a thorough selecting and prioritising process across the PEERA methodology stages, 10 C&D waste materials with high recycling potential were selected for the final two stages: recycling requirements (Stage 9) and recycling costs and market value (Stage 10). Within the timeframe of the project, the focus has been directed towards waste materials that: occur in sufficient abundance; are chemically stable; are sorted at source; do not incur excessive collection, transportation and processing costs; and can be easily be linked with markets for recycled products. As a result, Glass Reinforced Plastic (GRP) waste was selected for recycling experimental optimisation programmes leading to new applications. Hence, laboratory testing tests were directed towards assessing the potential of recycling GRP waste in rubber composites and concrete composites. Although the validation of the PEERA methodology led to products within the construction sector, it could be customised and used for a wide range of potential applications in other industries.

Recycling and closing the loop for gypsum products: European Gypsum Industry circular economy approach

Christine Marlet (Eurogypsum, Belgium)

The European Gypsum Industry vision is to move away from today's linear "take-produce-dispose" resource consumption patterns towards a circular economy aiming at the reuse, recovery and recycling of waste and the minimization of landfilling.
For this to happen in real life, we need

- Deconstruction as a common practice all over Europe;
- Separation of the waste on site (including off-cuts from construction waste);
- Constant volumes and constant quality of the recycled gypsum.

Therefore, Eurogypsum, the European plaster and plasterboard manufacturer's federation led a consortium of 17 partners within a collaborative project between the gypsum industry and the actors of the value chain (demolishers, recyclers and manufacturers). The project was co-financed by the Life Programme and was realised between 1st January 2013 and 31st December 2016.
The GtoG project has put in place an integrated approach to C&D waste by holistic management, starting from the major refurbishment/demolition sites to the reincorporation of the recycled gypsum in the manufacturing process via the processing of gypsum waste as a secondary raw material.

Project outcomes

- showed that closed loop recycling involves a close collaboration among all the stakeholders throughout the entire value chain;
- Proved that re-incorporation (up to 30%) of recycled gypsum in Type A plasterboard manufacturing is feasible in practice;
- Proved that the reincorporation of recycled gypsum up to 30% does not noticeably affect the basic performance characteristics of Type A plasterboards;
- Highlighted potential production bottlenecks in terms of recipe modifications (e.g. in additives) and production process equipment;
- Showed that the end-of-waste status is appealing but in practice is today challenging to achieve at EU level for the recycled gypsum;
- Showed that the GHG emissions between natural and recycled gypsum are minor

Demonstrated in practice the full engagement of plasterboard manufacturers to develop recycling practices that will permit higher re-incorporation percentages in the future.

Improving the recovery of construction and demolition waste

Rym Mtibaa and Hervé Grimaud (Recylum, France)

Construction and demolition waste (CDW) is one of the heaviest and most voluminous waste generated in the EU. In France it represents 245 million tons/year, about 70% of all waste production and most of them are inert waste (concrete, excavated material…).
Since 2015, the French law set the target of 70% of valorization for the non-hazardous construction and demolition waste which is an EU target. If this target seems reachable for inert waste like concrete, it is more difficult to reach for the 10 million tons of finishing materials waste.
DEMOCLES is a collaborative and operational project led by RECYLUM, integrating the whole chain of actors (from building owner to waste management companies) which aims to:

- Identify operational and economic difficulties in selective deconstruction;
- Define a common and reliable framework for selective deconstruction;
- Develop operational recommendations for the building project management.

The main results of the study:

- Mixing construction and demolition waste in one skip reduce valorization rate;
- It Is possible to increase significantly waste valorization without extra cost;
- A better construction and demolition waste management needs a formal involvement of all actors starting from building owner.

On-site Wet-Screening of Construction and demolition waste

Christian Mlinar (Bernegger GmbH, Austria)

To fulfil highest quality standards for aggregates derived from construction and demolition waste (CDW) it is necessary to treat the input material in a high-quality manner. These materials therefore had to be transported to the relatively few stationary treatment plants with a big transport effort.

The company Bernegger developed a container-portable CDW treatment plant, which is ready for use within one week. The goal of this multi-stage wet screening process plant is to gain the largest possible proportion of reusable materials and the smallest possible proportion of material to be deposited. The output products reach a very high quality while the pollutants are enriched in the fine fraction. The process water is circulated and continuously processed in the plant itself.

This plant is thus an innovative and effective overall solution for the on-site treatment of non-hazardous and hazardous mineral waste from the construction sector and thus primarily supports the efforts to keep a considerable proportion of the CDW in circulation, even if these are contaminated.

New initiatives in Belgium to improve the current C&DW management practice and to develop innovative solutions

Jeroen Vrijders (Belgian Building Research Institute, Belgium)

Belgium is a front runner in Europe when it comes to recycling of construction and demolition waste (C&DW) with a recycling rate over 90%. However, some challenges still remain. Different actions are ongoing to improve the current situation, varying from legislation and quality control mechanisms over practical approaches to research and development for new solutions.

On the one hand focus lies on improving the quality of recycled aggregate coming from demolition works. Sometimes, unwanted materials like wood, plastics, gypsum, … and - even worse - asbestos & other contaminants are present in the aggregates. Even though a pre-demolition audit is required for certain demolition works, the works are not executed accordingly. The Flemish government therefore imposes a new chain management system for demolition debris, making a distinction between selectively demolished and other waste. A new control body, Tracimat, is created to control and regulate the demolition works. In the long term better pre-demolition audits and quality controls will allow to identify key waste fractions and estimate their volumes more correctly.

On the other hand, several pilot projects are ongoing to investigate the possibilities for recycling of other, smaller fractions like insulation materials, several plastics, wood, … that are currently 'hard to recycle', because there is no market, or there is insufficient volume to make a viable investment. Attention goes out to innovative C&D waste management methods like sorting on site, using separate containers or big bags, innovative business approaches, …. The pilot projects currently in progress allow to quantify the smaller C&DW fluxes, and to extrapolate the results to get an idea of future waste streams, as well in construction as in renovation and demolition.

Construction and demolition waste management and recovery in Lombardy Region, Italy

Lucia Rigamonti and Sara Pantini (Politecnico di Milano / MatER Research Center, Italy)

Roughly 49 Mt of construction and demolition waste (CDW) were generated in Italy in 2013. Among Italian regions, Lombardy was the largest producer of CDW likely due to the high economic activity of this region.
This study aims at evaluating the environmental performance of the CDW recovery chain in Lombardy Region by applying the Life Cycle Assessment (LCA) methodology. The research is supported by the local regional government which is interested in identifying possible improving actions to support the CDW recycling as well as the market of the recycled aggregates.
To these ends, the following aspects have been evaluated:

i) Amount of CDW managed and treated in Lombardy Region in 2014.
ii) Local distribution, types and features of the CDW treatment facilities paying attention on how different types of CDW are handled and processed and on the level of treatment technology applied. Technical visits at 9 larger-size recycling plants have been carried out to address these issues and to collect primary data in terms of recovery efficiency, energy and fuels consumption, water supply, requirement of auxiliary materials, and waste scraps.
iii) Size classes, quality and actual use of recycled aggregated. Depending on the level of adopted technology, recycled aggregates of diverse grade may be produced: low quality aggregates are usually employed for environmental filling and rehabilitation of depleted quarries or landfill sites; medium quality aggregates are used for road constructions and paving; high quality aggregates are suitable for the production of new concrete or for road sub grade.
iv) Type and amount of “avoided” natural aggregates based on the quality of recycled products and on market demand. The local availability and capacity of quarries will be investigated and primary data will be collected from major plants processing natural aggregates, in order to adequately represent the environmental impacts from quarrying activities for the specific geographical context.

Clean-Way software facilitating construction and demolition waste recycling - real-time data to reach Zero waste goal

Krisztián Petrovszki (Clean-Way Ltd., Hungary)

Clean-Way Ltd. is an innovative waste management company aiming to maximize the collection and recycling of construction and demolition waste in Hungary.

Being one of the leading companies with expertise in C&D waste management, the management launched an R&D project in order to maximise the reuse and recycling of C&D generated in Hungary. The final outcome of this project is an ICT tool: the Clean-Way software, which can help every stakeholder of the construction industry: municipalities, constructors, waste recyclers.

The software collects and shows real-time data to all users about the following:
- Site information is listed: all construction sites where C&D waste is being generated
- Location is shown: the sites are located on a map, using different
- Data of producer: C&D waste generating company and contact details
- C&D waste: Amount and EWC code of the C&D waste
- Data on material wanted: not only generated waste, but also “wanted” material can be registered, to help the match between producers and users of the material
- Stakeholders access: usage can be different according to the stakeholder (constructor generating waste, constructor looking for by-product or recycled material, authority)

The software can help in creating a link between the demolition site and the new construction site. It reduces transport cost, environmental emissions related to a low cost material.
We would like to highlight the benefits and the potential uses of the software, and start a regional or national discussion about the introduction of innovative (ICT) tools in waste management.

Our aim is to maximise waste reuse, save cost and reduce environmental emissions!

Dynamic Performance Assessment of construction and demolition waste recovery policies

Ibrahim Motawa (Heriot-Watt University, UK)

Different policies of the UK Government have been initiated to improve the recovery of the Construction and Demolition Waste (CDW). Various models have been developed to analyse the impact of these policies which are classified as disciplinary or multidisciplinary models comprising variables related to technology, economic, and climate. While being multidisciplinary, these models have limitations in simulating the complexity of the CDW recovery. As a socio-technical problem, this research aims to develop a System Dynamics (SD) model to analyse profiles of CDW recovery considering the interrelationships among these influential variables. The SD model is proposed to utilise the hard and soft data incorporated in the CDW processes with due cognisance to the inter-dependencies of variables that are involved in addition to mental judgement of the experts and industry practitioners. The proposed model can be used to test the effectiveness of each initiative based on the most recent statistics released and provide policy makers with a decision making tool upon which different scenarios regarding CDW recovery policies can be tested before implementation.

Density based separation of heterogeneous construction and demolition waste mixtures

Erik Marklund (Luleå University of Technology, Sweden)

When recycling construction and demolition wastes (CDW), there will always be a fraction that cannot be recycled. One example of this is a 40 mm under sieve fraction of mixed CDW, comprising of a highly heterogeneous mixture of concrete, wood, gypsum, plastics, mineral wool and glass, among other materials.

In our ongoing work we study different types of materials with an organic content too low for incineration and yet too high for landfilling, as for example the CDW mentioned above. The properties of these types of wastes are characterized with the aim to develop new methods for managing or recycling them.

Based on a density gradient observed in the studied CDW material, we are now evaluating a density based separation using water and the feasibility of this method to reduce and separate the organic materials of the waste. The resulting sink and float fractions are characterized, including biological, chemical and physical assays.

Primary studies of this simple sink-float separation show that 40% of the organic carbon can be separated from the material, and that the resulting sink fraction can be accepted at class II landfills. Leaching and biodegradation data also underpins this conclusion. Heating value measurements of the float fraction suggests it could be suitable for fuel purposes.
To conclude, these results indicate that using density based separation would enable this type of waste to be treated using current methods and handled within the main waste management systems of Sweden.