

# Exchange of experiences on LCA for waste and material flows

## GOOD PRACTICES

During the 2<sup>nd</sup> day of the LCA4Regions online event, 21 October, will be presented one good practice for waste and material flows per region.

### LODZKIE REGION (POLAND)

#### **A PUBLIC PRACTICE REGARDING THE REDISTRIBUTION OF FUNDS FROM ENVIRONMENTAL POLLUTION CHARGES TO PRO-ENVIRONMENTAL INVESTMENTS.**

2001 – Ongoing

This good practice refers to public institutions. It concerns the regional redistribution of funds from environmental fees obtained from entities using the environment, and then investing them in pro-ecological projects. The mechanism for redistributing funds is as follows:

1. Collection of environmental fees - The Marshal's Office of the Lodzkie Region (regional authority) collects environmental fees from entities conducting activities that pollute the environment. This is possible on the basis of the national Environmental Protection Law
2. The next step is to transfer these funds to the National Fund for Environmental Protection (NF)
3. Redistribution - based on environmental analyses and current needs, the NF distributes funds to its regional funds. One of them is the Regional Fund for Environmental Protection in Lodz (RF)
4. Allocation of funds - on the basis of analyses of negative emissions and environmental risks RF allocates funds in the region performed using LCA/LCC or equivalent methodologies to invest in green technologies and pro-ecological installations.

Thanks to funds from environmental fees, RF grants subsidies and preferential loans for green investments in the areas of air protection (e.g. installation of heat pumps and PV panels, thermal modernization), protection of water resources (modernization of sewage treatment installations), waste management, waste disposal and reclamation, green education projects. Final beneficiaries of this practice are both public and private entities and individuals.

The Fund's data for 2019 indicate a significant environmental and material effect achieved by grants and loans granted to final beneficiaries. In 2019, 4,484 contracts for co-financing pro-ecological investments were concluded. Thanks to this, the following were performed:

- Thermomodernisation of 27,800 m<sup>2</sup>
- PV installations - 2829 kWe
- Reduction of waste stream for disposal by 32,500 tons
- The amount of waste subjected to the biological treatment process 52 tons

This practice supports transforming traditional technologies into pro-environmental investments and minimizes the negative impact of pollution on the ecosystems and the well-being of the region's inhabitants. The described mechanism allows dedicating funds year to year where the pro-environmental intervention is the most urgent and where it will bring the best results. The public profile of the institutions participating in the process allows for flexible planning and cooperation with experts and scientists. This result in the implementation of modern and effective technologies as well as the use of various analytical tools including the calculations based on LCA related tools as well as the carbon footprint.

## **PYHÄJÄRVI INSTITUTE (FINLAND)**

### **PROCESSING ALTERNATIVES OF BIODEGRADABLE WASTE – ANAEROBIC DIGESTION, ENERGY & BIOFUEL**

June 2014 – January 2016

Regional policies to utilise biowaste in environmentally sustainable manner need to follow guidelines depicted in EU waste directive. The priority hierarchy needs to be followed. Material circulation is prioritised to fuel production. Other utilisation options are possible, if LCA indicates such solutions as sustainable options.

Climate change, acidification and eutrophication were included in the analysis relating to the environmental impact. The study was able to utilise widely openly available datasets, such as Biomass Atlas, VAHTI and Ecoinvent databases and other information. SimaPro software was utilised. Degree of uncertainty was evaluated by Monte Carlo analysis. The use of three processing alternatives could outweigh the impact of the processing, excluding the effects of acidification. Burning generates the most significant eutrophication effects due to sulphur dioxide emissions. The carbon credits received for the replacement of the method of energy production significantly vary depending on what the energy to be replaced is presumed to be.

The outcome of this practise has been utilised in Finnish waste act preparation, and has aided in launching the preparation of Finnish national biogas programme, and in the regional level the promotion of bio and circular economy initiatives and policies. Main stakeholders include waste management companies, regional development organisations, policy makers and municipal actors.

The practice thoroughly analysed LCA of biowaste processing options. In terms of direct environmental impact, anaerobic digestion is the best alternative for processing biodegradable waste in analysed environmental categories. The second alternative is burning and the last alternative is the production of biofuel. Carefully conducted, reliable study is widely utilised. The government programme 2019 includes strong support for anaerobic digestion. New plants in region utilise biowaste.

### **LIFE CYCLE ENVIRONMENTAL IMPACTS OF DIFFERENT CONSTRUCTION WOOD WASTE AND WOOD PACKAGING WASTE PROCESSING METHODS**

December 2014 – August 2015

The wood waste recycling targets are challenging in Finland, because forestry and forest industry generate plenty of high-quality by-products, which is why there has been low demand for less clean construction wood waste and wood packaging waste as recycling materials. Instead, wood waste has primarily been used in energy production. Since the life cycle environmental impacts of wood packaging waste and construction wood waste have not been previously examined, the purpose of this work is to produce more material on wood waste processing methods to support decision-making.

The life cycle environmental impacts of different wood waste processing methods were compared in three impact categories: climate change, acidification and eutrophication. The wood waste reutilization methods examined were the use of wood waste in terrace boards made out of wood composite, which replace impregnated terrace boards, incineration of wood waste in a multi-fuel boiler instead of peat, and the use of wood waste in the production of particleboard in either Finland or Central Europe. The calculation tool used was the SimaPro life cycle modelling program.

The outcome of this practice has been utilised in the negotiations on the amendment of the EU Waste Directives and in Finnish waste act preparation. Main stakeholders include forestry and forest industry companies, construction companies, regional development organisations, policy makers and municipal actors.

The practice thoroughly analysed life cycle environmental impacts of wood waste processing options. Based on this study, the energy recovery of wood waste is a justified option in Finland and results in an overall better environmental outcome in regard to life cycle impacts compared to the other recycling methods examined. The study is utilised in developing regional forestry programme in Satakunta, where the side streams of forestry and forest industry are under examination.

## KAUNAS UNIVERSITY OF TECHNOLOGY - KTU (LITHUANIA)

### APPLICATION OF LIFE-CYCLE ASSESSMENT IN OPTIMIZATION OF MUNICIPAL WASTE MANAGEMENT SYSTEMS AND PRESENTATION OF THE LITHUANIAN CASE STUDY

2008 – 2009.

In the EU, municipalities increasingly have the responsibility to organise solid waste management. It is not uncommon that smaller municipalities lack a clear understanding of environmental and economic implications of different elements of municipal solid waste (MSW) management, which sometimes leads to sub-optimal strategic decisions.

The good practice (GP) reveals use of the Life cycle assessment (LCA) methodology to build a model and test different waste management scenarios in order to see whether the waste management hierarchy is influenced by regional conditions. The study also tests to which variables in waste management systems the results of the LCA are most sensitive. The discussion is built around a case study in Lithuania where several waste management scenarios have been analysed and compared in the LCA framework. The GP educed several methodology related issues and discusses what implications waste related policy intervention would have on the environmental outcomes of different waste management scenarios.

The results indicated the importance of conducting LCA for decision-making and pointed out the problems and possibilities of sustainable waste management. The main stakeholders of this good practice were regional, including municipalities, as well as environmental authorities and waste management companies.

The GP was a result of the PhD dissertation “Integrated Municipal Waste Management System Decision Support Model”, author dr. Jūratė Miliūtė-Plepienė, Institute of Environmental Engineering, Kaunas University of technology.

The use of an LCA approach in modelling the waste management systems provided also a good opportunity to map the entire system in its entirety and makes it possible to assess the data quality requirements. This has been shown when testing the sensitivity of the results to transportation distances and the choice of marginal data for substituted thermal energy and electricity. The study results also showed the importance of conducting an LCA study, and the shortcomings of the existing waste management strategies.

### LITHUANIAN'S DEPOSIT SYSTEM

February 2016 – Ongoing.

The public institution Užstatymo Sistemos Administratorius (USAD) manages the entire deposit system, starting with collection of the packaging waste and ending with it being recycled.

The main goal is a system that operates efficiently and is convenient for all stakeholders (producers and importer, retailers, consumers).

The founding members of USDA (Lithuanian Association of Breweries, Association of Lithuanian Trade Enterprises and Lithuanian Natural Mineral Water Manufacturers' Association) release more than 80% of the packaging covered by the deposit system to the market.

Retailers apply deposit for one-way packaging when selling beverages. Consumers can redeem deposit when returning empty packages back to retailers. The approved value for the packaging deposit is 0,10 euro.

**The deposit is applicable to the following types of one-way packaging:** Glass; Plastic (PET); Metal.

**The deposit is applicable to one-way packaging for the following beverages:** beer, beer cocktails, cider, perry, fruit wine, fruit-wine cocktails, fruit-wine-based drinks, alcoholic and non-alcoholic beverages (soft drinks, table water, kvass), natural mineral water, spring water, bottled drinking water, juices and nectar.

By returning the beverage containers, consumers are contributing to the preservation of the environment and the protection against pollution. The deposit system ensures the maximum collection and recycling of one-way beverage packages – 92% collection and recycling rate is achieved annually in Lithuania’s deposit system.

USAD collects over 600 million beverage packages through the reverse vending machines and at the manual collection points (operated by retailers). Collected containers are delivered to USAD counting centre, where packages are counted, sorted and prepared for recycling.

The deposit system reduces the demand for raw materials and electricity, and thus mitigates our impact on the environment on an annual basis. The Lithuanian deposit system alone is preventing 55,000 tonnes of carbon dioxide (CO2) from being released every year.

## CIMBAL (PORTUGAL)

### (UN)BUILDING FOR THE CIRCULAR ECONOMY

2020- Ongoing

(Un)building for the Circular Economy project results from the work initiated by CCDR Alentejo with the participation of CIMBAL, the municipalities of Baixo Alentejo and a wide range of partners. Its main objective is to promote a regional strategy for the reuse of construction products and components, as well as the recycling of construction and demolition waste (CDW), thus reducing the environmental impact of construction and promoting its circularity.

The Project arose from the need to identify the main concerns and pressing needs in the management of CDW and develop an integrated and efficient solution at regional level.

It's implementation is divided in three stages:

1 - Common regulatory reference basis for all municipalities, for environmental and urban planning, including selective demolition/deconstruction processes, preventing reuse and recovery of waste;

2 - Regional Integrated Management System (RIMS): including the development of a materials passport and a registration system, providing information to promote the circularity of materials and for management for the reuse of materials from selective demolitions and the recovery of the inert fraction of RCD to incorporate recycled aggregates. It also includes the creation of a material bank, accessible to all, based on the passports and registration system, involving the local authorities and also the possibility of integrating social shops through Private Social Solidarity Institutions.

3 - Evaluation and adjustment of the integrated system: will be developed a mathematical model that use preliminary results as distances covered by CDW, competitive factors, environmental impacts, among other, to adjust when needed the RIMS.

The main stakeholders and beneficiaries are regional parishes, municipalities, waste management operators and systems, construction sector and other entities somehow linked to the problem of CDW management.

## GREENEDGE

2015-Ongoing

Promoting the valorisation of material from pruning vineyards and olive groves for the production of briquettes and biomass pellets, in Baixo Alentejo region. The Greenedge unit was the first in the Iberian Peninsula to work with woody material from pruning.

Alentejo region, including Baixo Alentejo, has a long tradition in vine and olive grove cultivation. The waste from these cultures comes from pruning activity and it is estimated that, in the Alentejo, there are 205,000 tonnes/year that have no use.

GreenEdge was established in 2015 with the opportunity and the aim to valorise this agricultural residue. Besides not having any use it, these wastes have negative effects on the environment and on the culture itself and cause increased costs in its removal and burning to the farmer.

It started developing its activity in the valorisation of dried olive pit, for use in central heating equipment in public and private buildings.

In 2017 GreenEdge launched a new project, the GreenEdge ECO PELETES, aiming at valorisation waste from pruning vineyards and olive groves. The construction of the new industrial unit occurred in parallel with the implementation of an organised waste collection network at the pruning sites (vineyards and olive groves). This network acts as a vehicle for obtaining raw material without costs for the farms owners and at the same time also serves as an aid to the progressive reduction of the spreading and burning of prunings by the farmers.

The inclusion of technologically advanced equipment studied/selected in a careful way enables GreenEdge to transform what is now waste without beneficial use, into a product with added value, which can be exported, creating wealth and employment in one of the most desertified regions of the national territory, Baixo Alentejo.

## NATIONAL INSTITUTE OF CHEMISTRY - NIC (SLOVENIA)

### LIFE CYCLE ASSESSMENT OF DIFFERENT TYPES OF GRAVEYARD CANDLES

2010

This good practice aims to demonstrate examination from an environmental point of view the life cycle of different types of graveyard candles, traditional and electronic. The different candles are compared in the context of life cycle assessment methodology through specialized software. Each candle life cycle is first analysed to evaluate and assess its resources and materials needs and its associated environmental impact. As a second step, the results of emissions and environmental burdens: depletion of abiotic resources (ADP), acidification potential (AP), eutrophication potential (EP), global warming potential (GWP 100 years), depletion to ozone layer (ODP) and photochemical ozone creation potential (POCP) are analysed to the purpose of determining the category of graveyard candles that represents the best eco-friendly option. Gabi software databases were adopted for the simulation of the required operations. This practice demonstrates that electronic candles are the best option with lower environmental impact whereas PVC body traditional candles are the most damageable for the environment.

In this example of good practice, LCA has been applied for the analysis of the whole life cycle of different graveyard candles in order to assess its environmental impact. To carry out this study, it has been developed a model for the analysis of each one of the candles life cycle, from its production based on raw materials to its final disposal as solid waste.

The analysis of the model results indicates that the main group of emissions of graveyard candles life cycle are air emissions with almost 75 % of the total amount. The most significant compounds emitted to the atmosphere during candle's life are carbon dioxide, followed by sulphur compounds: sulphur hexafluoride and sulphur dioxide, and nitrogen oxides. The total amount of output emissions for 100 units of graveyard candles is similar for traditional and electronic candles, with the exception of paper and glass candles, with a lower emissions number.

Nevertheless, if the total emissions are calculated for burning hour it is possible to conclude that electronic candles have the most optimal ratio of emissions per hour.

The comparison of Life Cycle Impact parameters determined that the environmental burden associated with each candle life cycle is mainly due to the depletion of abiotic resources (ADP), followed by the emission of greenhouse gases (global warming potential GWP 100 years) and eutrophying emissions (eutrophication potential EP). Electronic candles are situated in the last place in number of emissions per burning hour in all categories.

## **COMPARATIVE LIFE CYCLE ASSESSMENT OF ALTERNATIVE PACKAGING MATERIALS FOR BEVERAGE**

2019

The goal of this practice is to present assessment of the potential environmental impact of the following packaging systems: polyethylene terephthalate (PET) bottles, glass bottle (GL) and aluminium can (ALU). The functional unit of the study was defined as the packaging, necessary for filling and distribution of 1000 L of filled beverage. The reference flow of a product system included the actual beverage packaging, labels and closures, transport packaging (reusable bottle boxes, corrugated trays, shrink-wrap for disposable containers, pallets).

The study has been carried out following the ISO 14040/44 life cycle assessment (LCA) methodology.

Under the assumptions made in this study, the drink packaged in PET bottle has the lowest environmental impacts followed by aluminium can. Extraction of raw materials for the processing of primary packaging has the highest environmental impact. Therefore, great attention must be paid to the eco-design of packaging, including the selection of packaging materials. Furthermore, it can be observed that the end-of-life and transport phases affect the final values of the indicators less than expected.

The purpose of this practice is to assess the potential environmental impact of disposable beverage packaging available on the Slovenian market. The study presents a practical example of evaluating the packaging system of polyethylene terephthalate (PET) bottles, bottles (GL), aluminium cans (ALU). The value of the contribution is not only in the obtained results of the analysis, but we want to contribute supporting information for easier and more intensive use of LCA analysis. This will provide companies with an instrument to support packaging policy decisions and make it easier to choose between different packaging options with comparable properties.

The OpenLCA software tool was used to model the life-cycle assessment. Environmental impacts were assessed using the 2001 CML method.

In this example of good practice, the effects of three packaging systems for the distribution of 1000 L filled beverages (used cans, bottles and bottles with a single 0.5 L filled unit) were evaluated. The study shows that the production phase is the one that contributes the most to the overall environmental impacts of the global warming potential (around 90 %), so it is necessary to pay the most attention to this phase and plan packaging in accordance with eco-design guidelines. The main factors of this result are the type and amount of material used. There is a likely link between bottle weight and environmental impact. However, this connection is also not true for aluminium cans, which are the lightest in terms of weight, but still show a greater environmental impact than PET bottles. It should be noted that the single-use system has been assessed as one of the most common practices in the world. If the returnable bottle system were taken into account, the bottles would probably show lower environmental impacts, but the returnable bottle system should take into account additional bottle cleaning processes, return transport, etc.

The performed analysis shows that PET bottles are the least stressful among the evaluated systems, followed by aluminium cans and finally non-returnable bottles.

**GOVERNMENT OF NAVARRE & AIN (SPAIN)**

## THE CARBON FOOTPRINT OF THE ACTIVITIES OF THE FOOD BANK OF NAVARRA

December 2019 - September 2020

Currently, roughly one-third of food produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion tons per year. This increases the release of greenhouse gases (GHG) and affects climate change due to the inefficient use of resources. Global food loss and waste generate annually 4.4 Gt CO<sub>2</sub>e or about 8% of total anthropogenic GHG emissions.

The Food Bank of Navarra (BAN) is a Foundation, with 25 years of experience, that plays a key role in the rescue of food that would otherwise be wasted, as well as in its intermediation so that it reaches the most disadvantaged people in the community free of charge.

Around 70% of the food managed by the BAN, 2,434 tons in 2019, is poorly packaged food or close to the expiration date, which would otherwise be wasted and disposed in landfills, composted, incinerated or treated for reuse or recycling, processes that would generate GHG emissions.

The BAN has estimated its annual carbon balance in order to quantify the environmental benefits, in terms of GHG emissions, of food waste reduction. The balance is the result of the consideration of two elements: the emissions generated by the BAN activities, and the emissions that are avoided by the use of food that would otherwise be wasted.

Annual carbon balance of the BAN = + Emissions generated by the BAN - Emissions avoided by the use of food that could potentially become waste.

The Institute for Innovation & Sustainable Development in the Food Chain (ISFOOD) of the Public University of Navarra (UPNA) carried out the calculation of the BAN carbon footprint.

The GHG emissions generated by the BAN activities were notably lower than those in a potential scenario without the existence of the BAN; 147 versus 4,715 t CO<sub>2</sub>e in 2018, and 148 versus 4,304 t CO<sub>2</sub>e in 2019.

The activity of the BAN prevented the emission of 4,568 tons of CO<sub>2</sub>e in 2018 and 4,157 tons of CO<sub>2</sub>e in 2019.

These results highlight not only the social but also environmental relevance of the BAN, since it prevents a large amount of GHGs from being emitted into the atmosphere.

## **AGROPAPER®, A NEW SUSTAINABLE AND BIODEGRADABLE SOLUTION FOR THE AGRICULTURAL MULCHING TECHNIQUE. DESIGNING AS FIRST STEP TO AVOID WASTE.**

January 2018 - ongoing

There is a problem in the management of agricultural plastic mulching after its use. It is difficult to remove the complete plastic, therefore small pieces end up in the soil and the surrounding areas. In addition, there is an issue when valorisation the agricultural plastic mulching due it is “dirty” with high percentage of soil in it and usually it end up in landfills.

Smurfit Kappa has develop a new product called AgroPaper® that solves this problem from the origin. It has the same advantages of the plastic mulching, but improves its disadvantages.

It was used a Life Cycle Cost from the farmer purchase of the product to its final management and the economic price of the AgroPaper® is slightly superior than the plastic mulching, but all the environmental impacts of the waste management are avoided.

It was carried out a first test of the product with the support of a public organisation, Navarre Institute of Transfer and Innovation in the Agri-food sector in different experimental farms and with different crops in Navarre.

Although the product it is already in the market, currently, a wider test is going to be performed to validate the product with several crops and different climatic regions with the aid of three new stakeholders: AN, Florette and CSIC and a life cycle assessment (LCA) of the product will be developed.

AgroPaper® has the same advantages of the plastic mulching (prevent from weeds, no use of weed-killers, water efficiency, temperature control or higher performance), but improves its disadvantages. There is no need to manage the waste due to the product is incorporated to the soil, helping to enrich and improve the quality of the land for future crops. Therefore, no cost for management is needed and environmental impacts are avoided. It has the peculiarity to withstand the sedge, a weed that plastic mulching do not control. Also, it avoids the carbon footprint of the plastic production, 1kg of plastic emit 3.5 kg CO<sub>2</sub>, due to the paper has a negative one thanks it comes from sustainable forest. Finally, as is made of long pine fibre, is a perfect compost to improve the soil quality.

## **WASTE SEPARATION THROUGH REWARDING CITIZENS**

April 2019 - ongoing

Experience of circular local economy on organic waste and plastic not package or container through a local currency for rewarding citizenships best separation at source.

The percentage of recycling material from wastes was under 20%, far away from 50% demanded. Therefore, Irati RSU local council s association wants to recirculate in a more local and sustainable manner. It started two new initiatives:

- Domestic organic waste: Separate organic waste and compost it in local farms, not at large scale in centralized facilities. One organic farm received 100 t/year, and other four vegetable gardens and cereal farms are waiting to join.
- Plastic no package or container is gathered, shredded and store before transport to a regional industry where is melted and extrudes, and return in the form of street furniture demanded from local administrations. The same amount of plastic shredded come back in furniture, as a concrete circular engagement.

The rewarding to citizens permits to have a really well separated organic wastes. Citizens can obtain banknotes that are circulating between neighborhood and 50 local retailers. This initiative stimulate the activity of these sparsely populated areas.



A preliminary carbon footprint has been made to compare the previous organic waste collecting system and the new one. A more complete LCA is foreseen for both organic and plastic new systems.

Along the first year, 2020, have been issued and supported 3500 € for recover near 100 t of well separated organic waste, and 3'5 t of plastic not packages. Participation of 150 homesteads and 50 commerce retailers in September 2020, and expected to achieve to 250 in January 2021, and further until at least 80% en 2023.

## LOMBARDY REGION (ITALY)

### **PROGETTO SCARTO 0: USE OF BY-PRODUCTS OF CUTTING MATERIALS FROM THE ORNAMENTAL MARBLE QUARRIES IN CARRARA FOR THE CONSTRUCTION OF THE MULTIFUNCTIONAL PLATFORM IN VADO LIGURE**

September 2018 - June 2019.

The excavation of ornamental marble has a yield of 25%; the remaining debris, due to the construction crisis, has difficulty in finding markets in which it can be located and this has led to an accumulation over the years.

The challenge was to find, to create, a market in which to place large quantities of this debris.

San Colombano contributed to the construction of the Vado Ligure (SV) platform of approximately 211,000 square meters (one of the largest container terminals in the Mediterranean), with the supply of approximately 800,000 tons of this debris, deriving from its own quarry and from 17 other quarries located in the Apuan-Versilian stone district.

The project was possible thanks to several factors:

- multimodal transfer, as only 17 km were covered by road, while the remaining approx. 160 by sea from the port of Marina Carrara in Vado Ligure.

- high IT content, necessary to guarantee traceability of the material so that only the quarries and authorized transporters could carry out the operations. The software / hardware created specifically for the project made it possible to halve the delivery times, as each trip was saved approx. 3 minutes for each vehicle that accessed the port of Marina Carrara: taking into account that 200 daily passages were made, this saved 600 minutes a day.

The elimination of the phase of stopping, and restarting of the trucks at the port weigh station reduced the environmental impact in terms of CO<sub>2</sub> and particulate emissions into the atmosphere, and eliminates possible inconveniences to traffic and the community.

The supply took 10 months, with a rhythm of about 12 monthly loading operations for the ship at the port of Marina di Carrara.

The subjects who have benefited from this project and organizational model are: other stone companies, the municipality of Carrara (which receives a contribution per ton), the port authority, suppliers, the community, the contracting authority.

The project was appreciated by both the institutions and the various stakeholders as it made it possible to develop a new market in which to place the debris deriving from the excavation of the ornamental marble quarries of Carrara.

The degree of circularity of this project was measured in accordance with the BS 8001 standard, obtaining an exceptional result of 85%.

This result, combined with those relating to the reduction of CO<sub>2</sub> emissions, has made it possible to obtain the Afnor XP X30 901 (Circular Economy) certification, first issued in Europe by Bureau Veritas.

## **LIFE CYCLE COSTING ON CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT SYSTEM**

November 2019 - Ongoing

During a Ph.D. project inside the AWARE Research Group, an economic analysis of the construction and demolition waste management system implemented in Lombardy will be carried out to give recommendations to the regional government to implement the widespread use of recycled aggregates.

Construction and demolition (C&D) activities generate every year a great volume of waste. Although most of this (especially in Italy) is already sent for recovery, some obstacles prevent the usage of the recovered materials. Among them, the mistrusting of the sector operators is the most impactful. Preferring natural cave-generated aggregates in place of the recovered ones means large amounts of recycled materials that remain unsold, other than the reduction of natural goods, of which availability can be more and more limited by time. An E-LCC (Environmental life cycle costing) will be carried on to investigate the costs of the entire chain. As a strategic decision tool, the economic evaluation of the advantages of using recycled aggregates compared to natural ones can be crucial to push the construction industry in using these. The project is on-going, and the inventory phase is almost completed. The data collected concerned with the first phase of demolition. The costs considered to build up the inventory can be divided into three main categories, and these are:

- preliminary costs and acquisition of machinery;
- maintenance and operation costs;
- gate-fee costs.

After this phase, the costs incurred by the recycling plant will also be examined.

## **WASTE TO RESOURCE VALUE CHAIN OPTIMIZATION THROUGH THE APPLICATION OF THE LIFE CYCLE ASSESSMENT METHODOLOGY TO THE REGIONAL MANAGEMENT SYSTEM OF CONSTRUCTION AND DEMOLITION WASTE (CDW).**

April 2016 – September 2017

The AWARE Research Group has applied the LCA methodology to evaluate the environmental performance of the construction and demolition waste (CDW) management system implemented in Lombardy to give recommendations to the regional government to maximize its resource-efficiency.

Construction and demolition waste accounts for 30-35% of the total waste yearly generated in Europe. Owing to its amount and its high recycling potential CDW has been identified as a priority waste stream. Indeed, CDW is mainly composed of valuable mineral materials that can be easily recovered and re-introduced in the construction sector as secondary materials (i.e. recycled aggregates, RAs). Currently, the 70% recycling target set by the directive 98/2008/EC and more recent programs/initiatives aiming at fostering the transition towards circular systems [e.g. Communication “Resource efficiency opportunities in the building sector” (2014), Circular Economy Action Plan (2015)] have pushed local authorities to identify solutions for enhancing the CDW management and recycling. In this context, the government of Regione Lombardia chose the Life Cycle Assessment as a tool to assess and optimize its own CDW management system. To provide a reliable decision/making support, AWARE Research Group collected updated primary data from all the stakeholders involved in the CDW value chain (builders, demolition workers, waste management/logistics managers, recyclers) through a deep investigation. Also, considerations about the quality of RAs, their actual end-uses and local markets were included in the environmental analysis to ensure a proper modelling of the geographical, temporal and technical context. The analysis allows to highlight current bottlenecks of the system that are still preventing closing materials loop [e.g. limited use of RAs in high-grade application] and to investigate possible solutions to foster the whole CDW value chain. This may give indirect benefits to all the stakeholders involved as constructors, recyclers, citizens and public administrations.

The applied LCA-based approach proved to be very useful in disclosing the hotspots in the current CDW management system of Regione Lombardia, as updated information and site-specific data have been used to build-up the life cycle inventory. The analysis highlighted where there is room for improvement, allowing to identify the most effective solutions for enhancing the sustainability of the CDW management through the quantification of their effects on the environmental and energetic performance of the entire system. Some recommendations/suggestions were provided to the regional government based on the LCAs outcome, that may help them in upgrading the regional waste management plan.

## ADMIXTURES FOR BITUMINOUS CONGLOMERATES

June 2019 - ongoing

Mapei developed new admixtures for creating bituminous conglomerates (MAPEI ACF-L1, ACF-L2 and ACF-L3) that allow substantial amounts of road asphalt to be recycled.

Mapei has recently developed a line of products for bituminous pavements: this is a new line developed by its R&D laboratories in Milan and is beginning to grow in other subsidiaries of the Group.

Referring specifically to ACFs (Functional Chemical Admixtures), Mapei initially focused its efforts on creating high-performance chemical formulations designed to restore the fraction lost in the old oxidised bitumen in RAP (Recycled Asphalt Pavement), so more of it can be used in various layers of bituminous conglomerate.

Its attention then shifted to studying solutions guaranteeing the same performances as the previously developed ACFs but with a careful eye for aspects related to environmental sustainability and higher user safety, making these products much less hazardous.

The obvious environmental benefits deriving from the use of ACFs were evaluated by the LCA (Life Cycle Assessment) methodology, comparing the environmental impacts from a conventional bituminous conglomerate with those of a bitumen designed using ACFs and, hence, a greater amount of recycled material.

LCA methodology allowed to compare the environmental impacts caused by manufacturing asphalt containing only pure material, with an asphalt containing 15% RAP (recycled asphalt pavement) and another one with a 40% RAP: ACF admixtures promote the use of high percentages of RAP.

## ENVIRONMENTAL PASSPORT FOR THE AGRICULTURAL AND FOOD PRODUCTS OF THE MONTAGNA VICENTINA

September 2018-August 2020

Eco-design for seven agri-food production systems (cheeses, wine, fruit juices, oil and cereals) in the Montagna Vicentina.

The growing interest in safeguarding the environment requires the business world to adopt tools to reduce the environmental impact of the products they make. The "Eco- Passport for the food products of the Montagna Vicentina" project was conceived to respond to this need and to support 7 representative companies of the Montagna Vicentina (agricultural and processing companies) in the development of more environmentally friendly products. The principles of eco-design for managerial and technological innovation have been applied to the production systems, certifying the improved environmental performance through the use of the Life Cycle Assessment, according to the guidelines of the Product Environmental Footprint (PEF), as defined by the European commission.

The main steps were:

- Analysis of the external context: definition of the eco-design parameters according to the requests of customers and reference markets.
- Analysis of the internal context: definition of the reference production system (benchmark).
- Design and development of production systems with reduced environmental impact;
- Quantification of the reduction of environmental impacts.
- Review of studies according to ISO 14040 and ISO 14044.
- Definition of generalized procedures for the dissemination of the quantification methodology and of the technological-management choices adopted.

The seven companies involved have obtained the critical review of their LCA studies in which the reduction of the impacts associated with the improvement of the production system is demonstrated. Some of these products are already on the market. The companies have also entered into a voluntary agreement with the Ministry of the Environment. The generalized procedures are available online.

## CANTIERE GREEN

The Cantiere green protocol is a Save the Planet Onlus project which aims to reduce greenhouse gases (GHG) deriving from the use of electrical equipment on site. How can I check and calculate the CO<sub>2</sub>eq production on the site deriving from electrical machines?

According to an estimate by the Save the Planet research center, the emissions deriving from the use of electrical equipment on site are about 40% of the total GHG emissions produced.

To keep the energy consumed on site under control, lot measuring instruments (certified Smart Meter) are used, obtaining two advantages:

- Better accuracy in measuring the electricity absorbed;
- Measurement of consumption in real time.

The accuracy of the on-site measurement is indicative of real-time CO<sub>2</sub> production and savings. The CO<sub>2</sub>eq saved is calculated, knowing the emission factor of the kW of absorbed energy, belonging to the national energy mix.

Save the Planet uses green electricity companies for the project, which can certify the origin of the energy supplied, which must come from 100% renewable sources.

Through this protocol, carbon credits can be generated, which can be resold on the voluntary carbon credit market, creating a virtuous circuit. Each carbon credit is in fact equivalent to one ton of CO<sub>2</sub>eq saved. This mechanism for saving CO<sub>2</sub> emissions can be perfectly integrated with the current protocols used in construction to build (Leed, GBC, etc.).

The success that emerges from the "Cantiere green" protocol is highlighted in various aspects and results achieved. As a first goal, having reached about 50 construction sites in 11 months of the project with the first Italian protocol for the reduction of CO<sub>2</sub> on site; consequently, after 11 months from the start of the project, with the application of the protocol, being able to obtain a significant saving of CO<sub>2</sub> in the atmosphere equal to 308 Ton CO<sub>2</sub>eq.



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