Volume 1, Issue 2, 2014 ISSN: 2392 - 9537

P - ESEM

Procedia Environmental Science, Engineering and Management

18th International Trade Fair of Material & Energy Recovery and Sustainable Development, ECOMONDO, 5th-8th November, 2014, Rimini, Italy

Selected papers (2)

www.procedia-esem.eu

SNSIM

P - ESEM

Procedia
Environmental Science, Engineering and Management

http://www.procedia-esem.eu

Volume 1, Issue 2, 2014

Procedia
Environmental Science, Engineering and Management

Editor-in-Chief: **Maria Gavrilescu**

Co-editor: **Alexandru Ozunu**

Guest Editors: **Fabio Fava & Grazia Totaro**

18th International Trade Fair of Material & Energy Recovery and Sustainable Development, ECOMONDO, 5th-8th November, 2014, Rimini, Italy

Selected papers (2)

In memory of

Professor Matei Macoveanu,
founder of the school of environmental engineering and management at the *Gheorghe Asachi* Technical University of Iasi, Romania

Professor Iustinian Petrescu
founder of the school of environmental science and engineering at the *Babes-Bolyai* University Cluj-Napoca, Romania

Procedia
Environmental Science, Engineering and Management
http://www.procedia-esem.eu

Aims and Scope

Procedia Environmental Science, Engineering and Management (P - ESEM) is a journal focusing on publishing papers selected from high quality conference proceedings, with emphasis on relevant topics associated to environmental science and engineering, as well as to specific management issues in the area of environmental protection and monitoring.

P - ESEM facilitates rapid dissemination of knowledge in the interdisciplinary area of environmental science, engineering and management, so conference delegates can publish their papers in a dedicated issue. This journal will cover a wide range of related topics, such as: environmental chemistry; environmental biology; ecology geoscience; environmental physics; treatment processes of drinking water and wastewater; contaminant transport and environmental modeling; remediation technologies and biotechnologies; environmental evaluations, law and management; human health and ecological risk assessment; environmental sampling; pollution prevention; pollution control and monitoring etc.

We aim to carry important efforts based on an integrated approach in publishing papers with strong messages addressed to a broad international audience that advance our understanding of environmental principles. For readers, the journal reports generic, topical and innovative experimental and theoretical research on all environmental problems. The papers accepted for publication in *P – ESEM* are grouped on thematic areas, according to conference topics, and are required to meet certain criteria, in terms of originality and adequacy with journal subject and scope.

Procedia
Environmental Science,
Engineering and Management
http://www.procedia-esem.eu

GUEST EDITORS

Fabio Fava, born in 1963, is Full Professor of "Industrial & Environmental Biotechnology" at the School of Engineering of University of Bologna since 2005.

Dr. Fava is the coordinator of the FP7 projects NAMASTE (on the integrated exploitation of citrus and cereal processing by-products with the production of ingredients and new food products) and BIOCLEAN (aiming at developing biotechnological processes and strategies for the bioremediation and the tailored depolymerization of major oil-deriving plastics). He also coordinates the Unit of the University of Bologna participating in the FP7 projects ECOBIOCAP and ROUTES (on the production of microbial polymers from different organic waste and food processing effluents).

Other projects are MINOTAURUS and WATER4CROPS (on the intensified bioremediation of contaminated waste- and ground-water and the integrated decontamination and valorization of wastewater of the food processing industry and of biorefineries), and ULIXES and KILL-SPILL (on the development of strategies for intensifying the in situ bioremediation of marine sediments polluted by (chlorinated)hydrocarbons and for the isolation and industrial exploitation of microbes from those matrices).He is the Past- and the current vice-chairman of the "Environmental Biotechnology" section of the European Federation of Biotechnology (EFB) . He is member of the "Task Force on Industrial Biotechnology" of the Working Party on Biotechnology of the Organisation for Economic Co-operation and Development (OECD, Paris). Further, he is joining the "High Level Group on Key Enabling Technologies" and the "Expert Group on biobased products" of the DG-Enterprise and Industry of European Commission (Brussels), as well as the "Expert Group on eco-industries" of the JRC Directorate at the European Commission. Finally, he is the Italian Representative for Bioeconomy in Horizon2020 Programme Committee.

Grazia Totaro, born in 1976, has a degree in Chemistry (University of Ferrara), a Master's Degree in Science, Technology & Management with a specialization in Environmental Chemistry (University of Ferrara) and a PhD in Materials Engineering, about modification, characterization and applications of technopolymers (University of Bologna). She worked at the R&D Centre of Basell Polyolefins in Ferrara for 2 years in the frame of a project addressed to the development of a novel methodology for qualitative and quantitative analysis of additives in polymers. She also worked at ARPA, Regional Agency for Environment in Ferrara, division Water Analysis. Then she started working at the school of Engineering of the University of Bologna for a Ph.D. in Materials Engineering (2007-2010).
After that she had a scholarship "Spinner 2013" in cooperation with Reagens spa (San Giorgio di Piano) on novel PVC nanocomposites. Now she is post doc fellow at the same school on new polymer-based nanocomposites from renewable sources and inorganic fillers. She also worked at the laboratoire de Chimie et Biochimie Pharmacologique et Toxicologique (Université Réné Descartes) in Paris in 2001 and was visiting professor at the Ecole Nationale Superieure de Chimie (Université Blaise Pascal, Clermont Ferrand, FR) in 2012. Dr. Totaro has about 13 scientific papers and several participations at conferences and scientific schools.

(http://en.ecomondo.com/Meetings_and_events/layout_eventi.asp)

SNSIM

Procedia
Environmental Science, Engineering and Management
http://www.procedia-esem.eu

Procedia Environmental Science, Engineering and Management **1** (2014) (2) 99-192

18th International Trade Fair of Material & Energy Recovery and Sustainable Development, ECOMONDO, 5th-8th November, 2014, Rimini, Italy

CONTENTS

Procedia
Environmental Science, Engineering and Management
http://www.procedia-esem.eu

Procedia Environmental Science, Engineering and Management **1** (2014) (2) 99-102

18th International Trade Fair of Material & Energy Recovery and Sustainable Development, ECOMONDO, 5th-8th November, 2014, Rimini, Italy

RECLAIM EXPO - Reclaim expo 2014

ENVIRONMENTAL AND SAFETY BENEFITS DERIVING BY A SPECIFIC PHYSICS-BIOLOGICAL REMEDIATION METHOD*

Alessandra Bonoli[1], Alice Dall'Ara[2], Nora Rappoli[3], Andrea Tarabusi[1]**

[1]University of Bologna, Civil, Chemical, Environmental, and Materials Engineering Department (DICAM), Via Terracini 28, 40131, Bologna, Italy
[2]ENEA, Faenza Technical Unit for Materials Technologies (UTTMATF) Research Laboratory Faenza, Via Ravegnana 186, 48018 Faenza (RA, Italy
[3]AMEK scrl, via de Romei 32, 44100 Ferrara, Italy

Abstract

This paper analyzes, through its technological framework, an innovative patented physics-biological remediation method for of environmental restoration sites or old uncontrolled landfill in relation with methane emissions risk. The shown technology is site-specific and based on tailored compost and vegetable enzymatic cocktail, which would afford to recover the area for planned agronomic use in a short time, thanks to sustainable execution and low management cost. It incorporates several technologies deriving from bioremediation and it can be applied also in other contexts or conditions as in mitigation of landfill impact.

Keywords: biogas, biopile paper sludge, quarry restoration, tailored compost

1. Introduction

In an ex quarry area of clay materials, restored by paper sludge 10 years ago, anaerobic degradation of buried organic substance occurred production of a large amount of biogas and its subsequent uncontrolled migration to neighboring areas, in absence of biogas drainage and piping.

---

[*] Selection and peer-review under responsibility of the ECOMONDO
[**] Corresponding author: alessandra.bonoli@unibo.it

In 2005, one year later the end of restoration efforts, biogas (methane) production and migration caused two explosions in a joint inside a building set in an adjacent area of the restoration site. The case study description and buried paper sludge characterization were reported in (Bonoli and Dall'Ara, 2012).

Local Authorities (Municipality, Regional Agency for Environment Protection and Health Prevention, Sanitary Agency) had to face a new environmental emergency, without specific references for technical and administrative aspects (Ferri et al., 2013). Similar cases were not known (or were not reported) in literature: all explosions that have been described over the world are generally connected with a production and subsequent uncontrolled migration of landfill gas (LFG).

In addition, local conditions were different from "conventional" conditions of reclamation: methane is not included in the contaminants list and treatment's efficiency cannot be expressed as a percentage of methane concentration reduction compared to the initial conditions. In fact, during the time, methane is continuously produced by anaerobic decomposition and the instantaneous concentration results by the difference between generated and removed methane amounts.

At first, about 8 years ago, the aim of the intervention was to assure safety condition for inhabitants and buildings in the site adjacent area: an emergency safety plan was set up by means of a perimetric trench and a soil vapour extraction system around the site. In the meanwhile, preliminary tests were performed in order to select a proper technology for inside site reclamation (Ferri et al., 2013).

2. Objectives

The main objective of the present study is to analyze this innovative physics-biological remediation method in comparison with other conventional methods, both through technological framework and by environmental and safety benefits.

3. Materials and methods

First step consisted of a state of art analysis related to landfill gas production and bioremediation technologies for site contamination by hydrocarbons. Consequently, the choice of the most appropriate technology for permanent safety was restricted to the following: removal of sludge mixed with soil and their subsequent treatment / disposal at an authorized facility; bioventing; biopile on site.

The second step carried out an analysis and an evaluation of the chosen technologies both by an environmental and an economic point of view to verify their efficiency in function of four objectives: reduction of methane formation, minimizing the potential of methane production by paper sludge; reduction of the presence of methane, by removal of gas already produced; recovery of the site for agricultural use; to avoid inconveniences for residents in the surrounding areas.

The achievement of these objectives could be done through the reduction of biogas production by degradation of the solid phase, by means of biofiltration and bioconversion of the produced methane and by the recovery of the same area for agricultural purposes.

The site specific assessment is reported in Table 1. After emergency intervention, Local Authorities decided to overcome the technologies mentioned above, and allowed use of an innovative technique of passive in situ bioremediation for permanent safety.

The chosen remediation method is an innovative patented (Amek, 2008) physics-biological and site-specific method, based on tailored compost and vegetable enzymatic cocktail, which would afford to recover the area for planned agronomic use in a short time, thanks to sustainable costs and low management expenditure. That choice was motivated by the objectives of minimizing inconvenience to local residents and management costs, also in order to avoid bankruptcy of the responsible company and a consequent remediation cost transition to the community (Ferri et al., 2013).

Table 1. Site specific assessment

Technology	*Environmental impact*	*Visual impact*	*Times*	*Costs*	*Other aspects*	*Agronomic recovery*
Removed paper sludge mixed with soil and treatment/disposal	Very high (impact noise, odours and emissions during excavation)	High during excavation	Short	Very high	Transport and soil cost	Only at end of removal
Bioventing	Low (acoustic impact and atmospheric emissions due to the fan)	Average (because of the pipes and equipment)	Long	Low	Regular monitoring operations	Only at end of treatment
Biopile on site	Very high (impact noise, odours and emissions during excavation)	High during excavation, average for biopile presence	Average	High	Regular monitoring Operations Compost cost	Only at end of treatment

4. Results and discussion

The proposed technology can be defined as a Passive Bioremediation because doesn't require electricity, water or other resources, but only human intervention during the preparation phase. These features make it a sustainable technology in compliance with national legislation. The main environmental and economic advantages are (Dall'Ara et al., 2009): minimization of noise, minimization of emissions into the atmosphere, reduction of visual impact upon the completion of the site, mitigation of the greenhouse effect, reduction of the costs for technology realization and management, minimization of inconvenience for inhabitants and acceleration recovery of the site for agriculture.

The bioremediation has only a disadvantage represented by o a difficulty for the prediction of the time needed for the completion of restoration, which however is known to be among the medium and long term. This technology belongs to biological treatment class, so-called Bioremediation in-situ, providing only use of "tailored" Compost, site specific, combining properties of high quality compost with high maturation degree and high metabolic activity for cellulose degradation; vegetable enzymatic cocktail, produced according to a method patented in Italy (AMEK, 2008).

Particularly, this technology covers following bioremediation techniques:

- composting for biopile realization, inside soil, in order to improve sludge degradation;
- bioaugmentation, because tailored compost and vegetable enzymatic cocktail provide active biomass with high metabolic degradation activity, especially high content of methanotrophs bacteria;
- biostimulation, because compost have high nutrients content, especially Nitrogen, so C/N ratio has became optimal for aerobic degradation and also soil is enriched;
- natural attenuation because there isn't a direct action on organic substance, but only an incentive for starting natural process of aerobic degradation.

In this case, the hazard is not in relation with a real environmental contamination but with dangerousness connected with uncontrolled migration of the methane as in landfill. For gas drainage and methane oxidation, a passive oxidation system was used, as described in Dall'Ara and Bonoli (2012). This specific system can be included in the category cover systems (biocover, biowindows, biofilters) that are commonly used in landfill for fugitive emissions. This applied technic can be considered as a merging of a remediation and a specific landfill cover system technology (Fig. 1).

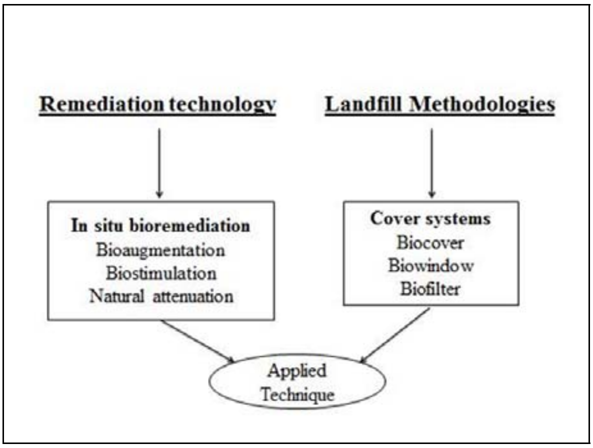


Fig. 1. Applied Technique scheme

5. Concluding remarks

Seven years after the beginning of the described remediation intervention, thanks to a meticulous and intensive monitoring activity, it can be said that the results are absolutely favourable and can guarantee the quality of the restored area also in compliance with legal expected limits.

This experience could be considered as a first interesting application in environmental restoration intervention in a site characterized by an incorrect filling, using untreated paper sludge, for a quarry remediation activity. The method that has been tested during seven years of activity seems to be applicable to other restored zones destined to agricultural uses, also in sites placed near houses, or in sensible and critical areas.

References

AMEK, (2008), Process for Reduction of methane Production and Emissions from Landfills and Waste Recovery Sites, IT Patent.

Bonoli A., Dall'Ara A., (2012), A bioremediation case of an ex-quarry area restored by paper sludge. *Journal of biotechnology*, **157**, 499-504.

Dall'Ara A., Bonoli A., (2012), Biofilter behaviour in contaminated soils by untreated paper sludge: Critical issues and durability, *Environmental Engineering and Management Journal*, **11**, 1769-1773.

Dall'Ara A., Ferri F., Marroni V., Billi L., Bonoli A., (2009), *Low Impact Bioremediation Technology: application in a Restoration Site*, 12th International Waste Management and Landfill Symposium, S. Margeherita di Pula, Cagliari, Italy

Ferri F., Marroni V., Billi L., Bonoli A., Dall'Ara A. (2013), *Application of a Low Impact Bioremediation Technology: procedures and results(in Italian)*, 7th Remediation Technologies and Requalification of Territory Exhibition, REMTECH, Ferrara, Italy

Procedia
Environmental Science, Engineering and Management
http://www.procedia-esem.eu

Procedia Environmental Science, Engineering and Management **1** (2014) (2) 103-107

18th International Trade Fair of Material & Energy Recovery and Sustainable Development, ECOMONDO, 5th-8th November, 2014, Rimini, Italy

AN INNOVATIVE PROCESS FOR GROUNDWATER GREEN REMEDIATION BY A CIRCULAR AIR FLOW: ON SITE APPLICATIONS, SETUP AT BENCH SCALE AND SOFTWARE SIMULATION*

Irene Jubany[1], Montse Calderer[1], Xavier Gómez[1], Maria Dolors Riera[1,2], Vicenç Martí[1,2], Claudia B. Mosangini[3], Roberto Verri[3], Francesco Caridei[3], Fulvio Borrino[4]**

[1]Fundació CTM Centre Tecnològic, Enviornmental Technology Area, Plaça de la Ciència 2, 08243 Manresa, Spain
[2]Universitat Politècnica de Catalunya, Chemical Engineering Department, ETSEIB, Av. Diagonal, 647, 08028 Barcelona, Spain
[3]Ecosurvey® LA152, Via Don Minzoni 11, 40121 Bologna, Italy
[4]Felsilab, Via Correnti 3 D-E, 40132 Bologna, Italy

Abstract

SmartStripping is an innovative on-site process for green remediation that reduces concentrations of volatile and semi-volatile organic compounds (VOC, sVOC) from unsaturated soils and groundwater. It differs from other technologies as it generates a "closed circular air flow" in the underground that reduces contaminants concentrations, cutting out environmental impacts, as it doesn't need groundwater extraction, water discharge, gas emissions or introduction of chemicals.

Keywords: EcoInnovation, green remediation, VOC – sVOC extraction, groundwater,

1. Introduction

This paper intends to underline the key role of Green Remediation technologies for the underground decontamination also in respect to the recent European Commission Communication: "Towards a circular economy: a zero waste programme for Europe" (EC, 2014). According to Green remediation purposes, Directive 2010/75/EU and Italian

*Selection and peer-review under responsibility of the ECOMONDO
**Corresponding author: cm@ecosurvey.it

Legislative Decree 152/2006 (EC Directive, 2010; Law 152, 2006), an innovative on-site process, called SmartStripping® (Caridei, 2007) has been developed to reduce concentrations, at industrial and civil sites, of organic compounds (VOC and sVOC) from unsaturated soils and groundwater with no water extraction and no substances (air or water) release into the environment. The technology is under a process of standardization and simulation through on-site applications, setup at bench scale and software simulation.

2. Technology description

The process can be defined as an innovative combination of Air Sparging (AS) (Suthersan, 1999a; Wilson, 1996), and Soil Vapor Extraction (SVE) (Suthersan, 1999b): groundwater remediation occurs by enabling a transfer of contaminants from a saturated zone (groundwater) to an unsaturated zone (vadose) trough a closed circular air flow. Heated air is blown in the aquifer from wells and, through groundwater stripping, separates VOC from groundwater.

The VOC are vented up to the unsaturated zone and captured trough activated carbon filters before air is re-inject in the aquifer to start the stripping process again, in a closed air circuit as shown in Fig. 1. During the process water is preserved in the underground.

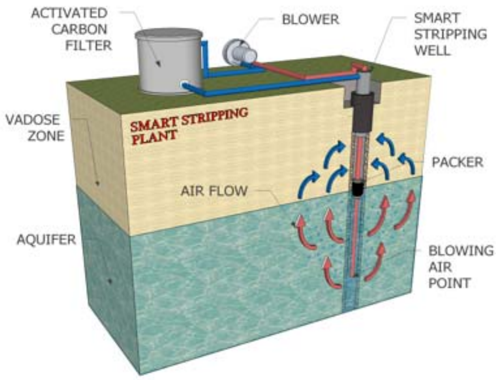


Fig. 1. Scheme of the technology

2.1. On-site application

The high efficiency of the technology was observed during its application for the groundwater remediation of about ten sites in Italy, among those:

- an industrial deposit of hydrocarbons in province of Parma with homogeneous medium-high permeability soils in which, after three months of the technology application, in groundwater the following reductions of concentrations occurred: total hydrocarbons from 10,000 to <10 μg/L, MTBE from 3,000 to <0.5 μg/L and Total Aromatic Hydrocarbons from 1,200 to <1 μg/L.
- a gas station in province of Grosseto with homogeneous medium-high permeability soils in which, after eighteen months of the technology application, in groundwater the following reductions of concentrations occurred: total hydrocarbons from 2,000 to <50 μg/L, MTBE from 6,000 to <75 μg/L and Total Aromatic Hydrocarbons from 100 to <1 μg/L.

Three case studies are currently applied in sites with low to medium permeability soils with shallow groundwater contaminated by chlorinated compounds with concentrations up to 18,000 µg/L for trichlorethylene, 7,000 µg/L for tetrachlorethylene and 27,000 µg/L for 1,2 dichloroethylene.

The remediation technology monitoring of the three case study plants includes the verification of the quality parameters of groundwater, of the air flow and of the active carbons filters that purify the contaminated air before re-injection in groundwater. For the major contaminant (1,2-dichloroethylene) the capture cycle shown in Fig. 2 was observed.

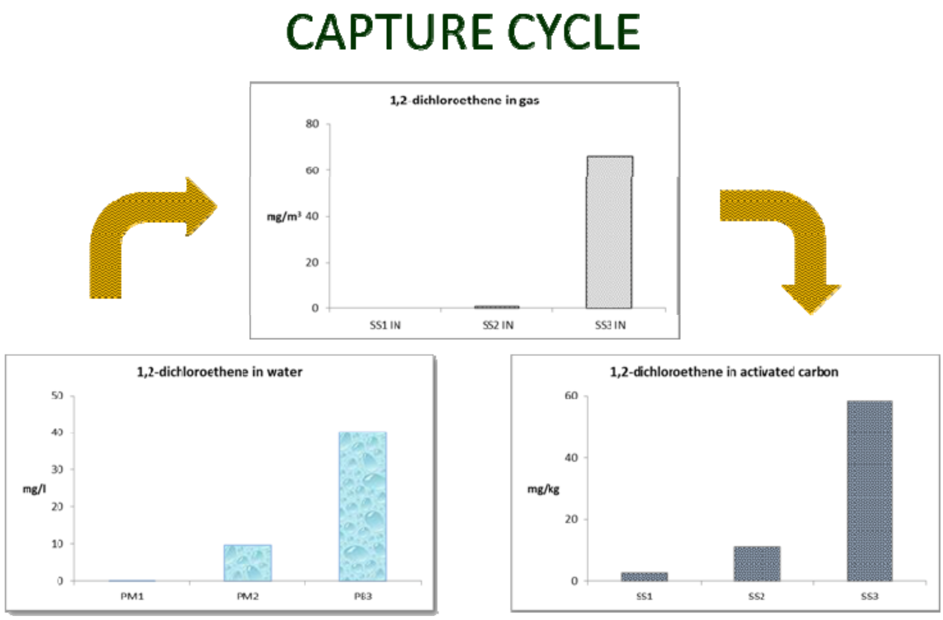


Fig. 2. Capture cycle of the contaminants operated by the technology (PM1, PM2 and PB3 are the three treatment points with different concentrations of contamination)

The parameter 1,2-dicloroetilene initially present in groundwater migrates to gaseous phase as a result of the stripping generated by the circular closed air cycle of the remediation technology and is captured by the activated carbon filters, in proportion to the concentrations initially present in groundwater. The technology efficiency is based on the closed air circuit equilibrium and is mainly function of the following parameters that determine the characteristics and the settings of the installations: permeability of saturated soil, air permeability of un-saturated soil, soil characteristics and groundwater level.

The technology is suitable to remove organic compounds (VOC and sVOC), characterized by a vapour pressure >0.5 mm and Henry's constant greater than $1.93 \cdot 10^{-4}$ atm·m³/mol and boiling point < 280 °C at +1atm. Low water solubility of contaminants improve their phase transition to vapour.

2.2. Bench scale experiment

The application of this technology for each specific site is supported by a comprehensive modelling and lab scale experiments for an optimal design of removal of volatiles as a function of operational parameters, from which air flow is the most relevant. In the present work, a combination of hydrodynamic and mass transfer model is developed and calibrated with specific laboratory tests.

The hydrodynamic model allows to obtain a region of air bubbling considered continuously stirred that defines a perfectly mixed volume (Vr) where an exchange between liquid and air phases due to mass transfer is assumed (Levenspiel, 1999).

Inside this volume, a gas flow extracts the contaminant (stripping). Furthermore, there exists a lateral input due to the gradient between the initial concentration of contaminant in aquifer (Co) and the concentration of the bubbling zone (C). Under steady-state conditions the lateral flux is equal to the flux of extracted volatile through the gas flow. By using these elements, three mass balances of volatile contaminant could be performed in the bubble-water interface, in the water and in the air. From these balances, the rate of removal of volatile contaminant, the concentration (C) and the partial pressure (p) of volatile contaminant in the exit flow gas could be obtained as a function of time.

The developed model was calibrated by using an in-situ stripping lab experiment consisting in a plastic vessel filled with sand and an aqueous solution of ethanol 1.2·10-3 mol.L-1 in which air was bubbled at 1.3 $L \cdot min^{-1}$. The dissolved organic carbon was measured at different times for 25 days. The volume Vr was calculated assuming a conical bubbling shape. Experimental data was fitted to the model by using the Polymath Software 6.20 to solve the differential equations and obtain values for mass transfer coefficients.

2.3. Software simulation

Numerical simulation by means of the finite elements method (CFX-ANSYS®) was used to simulate the hydrodynamic behavior of the technology considering the input parameters: well configuration, soil properties and operating parameters, as shown in figure 3 for the simulation of the air velocity around the well. The effect of each parameter on the size and shape of the zone of influence (ZOI) was studied in order to identify the relevant properties in the performance of the stripping process.

Output parameters of the hydrodynamic model were then fed to the mass transfer model. This model was based on the assumption that the stripping takes place in the ZOI and that the diffusion is the most relevant process in the area surrounding the ZOI. The mass transfer model considered two main transfer coefficients: mass transfer in the stripping and diffusion.

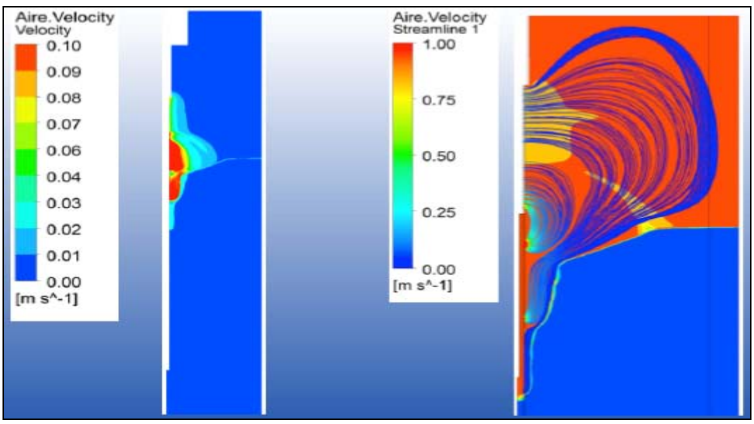


Fig. 3. Simulation of the air velocity in the saturated and vadose zone around the well

An experimental setup at bench scale was designed and built in order to calibrate the mass transfer parameters for each contaminant for specific soil properties. Moreover, the work was complemented by the simulation of the granular activated carbon filters contaminants absorption curves with the software MATLAB.

3. Conclusions

This Green Remediation technology decontaminates the underground trough a circular air flow avoiding groundwater extraction and substances release into the environment.

About the protection of the subsoil water resource, this technology allows significant groundwater savings. In fact, considering remediation cycles with carbon filters of 600 kg (with removal capacity of contaminants slightly lower of 50% of weight) and an average concentration of organic contaminants in groundwater about 10,000 µg/L, the extraction of approximately 300 kg of contaminants for each cycle is equivalent to a volume of water purified, and not extracted from the subsoil, of approx 30,000 cubic meters/cycle.

Acknowledgements

European commission co-founded this project under the initiative Eco-Innovation, a financial project for the development of innovative and green technologies (ECO/10/277350/SI.599553).

References

Caridei F., (2007), System and method for remediation of subsurface, Italy Patent No. *0001378816.*

EC Directive, (2010), Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (Integrated Pollution Prevention and Control), *Official Journal of the European Union*, **L334**, 17-119.

EC, (2014), Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions Towards a Circular Economy: A zero waste programme for Europe, European Commission, On line at: http://ec.europa.eu/environment/circular-economy/

Law 152 (2006), Legislative Decree No. 152 of the 03 April 2006, Environmental Regulations, *Official Journal*, No. 88 of the 14 April 2006 – Ordinary Supplement No. 96.

Levenspiel O., (1999), *Chemical Reaction Engineering*, Wiley, New York.

Suthersan S.S., (1999a), *Air Sparging, Remediation Engineering, Design Concepts*, CRC Press, Boca Raton,

Suthersan S.S (1999b), *Soil Vapor Extraction, Remediation Engineering, Design Concepts*, CRC Press, Boca Raton.

Wilson D.J., Norris R.D, Clarke A.N., (1996), Groundwater cleanup by *in situ* sparging: air channeling model for nonaqueous phase liquid removal, *Separation Science and Technology*, **31**, 915-939.

Procedia
Environmental Science, Engineering and Management
http://www.procedia-esem.eu

Procedia Environmental Science, Engineering and Management **1** (2014) (2) 109-113

18th International Trade Fair of Material & Energy Recovery and Sustainable Development, ECOMONDO, 5th-8th November, 2014, Rimini, Italy

NETWORKING AND DISSEMINATION - Products and green organizations "most vital" thanks to "life plus"?

EU LIFE+ PROGRAM FOR FOUR PROJECTS TO CONTRIBUTE TO MAKE THE TANNING A "GREEN" PROCESS: ECOFATTING (LIFE 10 ENV/IT/364), PODEBA (LIFE 10 ENV/IT/365), BIONAD (LIFE12 ENV/IT/352), ECODEFATTING (LIFE13 ENV/IT/470)*

Emilia Bramanti[1], Alessandro D'Ulivo[1], Massimo Onor[1], Massimo Corsi[2], Roberto Bianchini[2], Marco Bonanni[2], Marco Mazzoni[3], Alice D'Allara[4]**

[1]National Research Council of Italy, C.N.R., Istituto di Chimica dei Composti Organo Metallici-ICCOM-UOS Pisa, Area di Ricerca, Via G. Moruzzi 1, 56124 Pisa (Italy)
[2]Department of Chemistry "Ugo Schiff", Via della Lastruccia 3-13, 50019, Sesto Fiorentino, Florence (Italy)
[3]Gruppo Biokimica, Via dei Conciatori 44, Santa Croce Sull'Arno Pisa (Italy)
[4]ENEA UTTMATF, Via Ravegnana 186, 48018 Faenza (Italy)

Abstract

Tanning is the complex process of treating skins of animals to produce leather. This process has more than 10 sequential steps and requires the employment of more than 200 different chemical products. For this reason the tanning industry has a big impact on the environment.
The LIFE program is the EU's financial instrument supporting environmental and nature conservation projects. In the last three years this program funded 4 projects aimed to contribute to make the tanning a more "green" process, through the development and the employment of natural products, the reduction of water consumption and the reduction waste water production.

Keywords: deffating, dyes, environmental impact, leather production,

[*]Selection and peer-review under responsibility of the ECOMONDO
[**]Corresponding author: bramanti@pi.iccom.cnr.it; Phone: +39 050 3152293, Fax:+39 050 315 2555

1. Introduction

The leather production was originally governed by an eco-friendly industrial process, because slaughter house waste such as the hides/skins discarded as waste material, is processed into useful materials such as leather goods, footwear and garments. Currently, the European tannery industry, 95% of which is composed by small-medium enterprises, produces each year 163.320.000 m^2 of cattle/calf leather and 43.416.000 m^2 of sheep/goat leather, which means approximately 235.000 tons of leather per year. This production, which takes place mainly in Spain and Italy is characterized by a high environmental impact due to the wide use of polluting chemical agents in the tanning cycle.

Fig. 1 shows a scheme of the leather production process and the Life+ EU projects During the leather making process, tanning is one of the most important operations, which improves the durability and practicability of leather products and prevent putrefaction, in which the tanning agents react with the collagen molecule, stabilizing the triple helical structure of collagen matrix; thereby the leather acquiring resistance towards chemical, thermal and microbiological degradation (Kipnis et al., 1972; Orlita, 2004).

Usually, the tanning process primarily employs inorganic tannins such as chromium, aluminum, titanium, iron, zirconium and organic tannins such as aldehyde and high molecular weight vegetable tannins (hydrolyzable and condensed), synthetic tannins and above mentioned combinations.

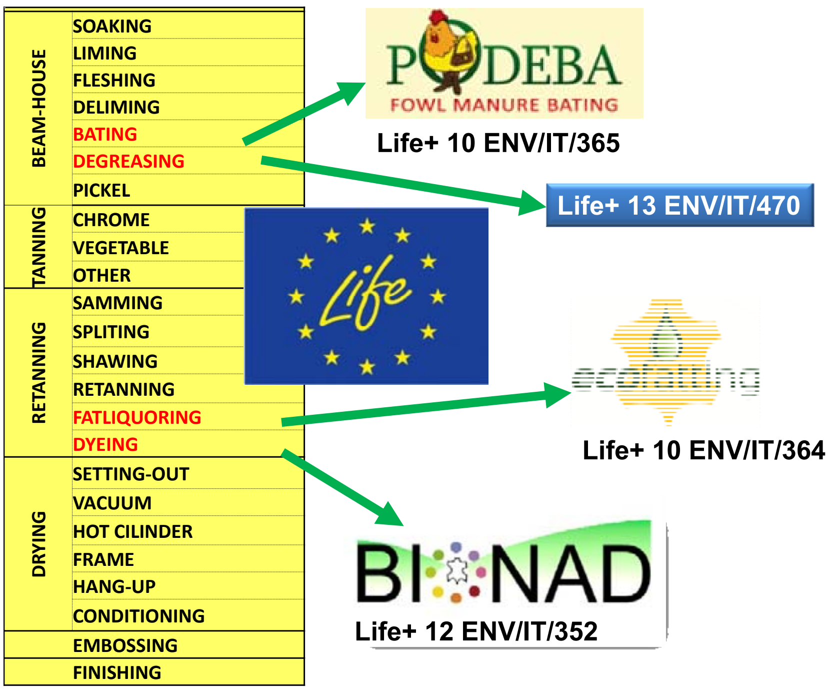


Fig. 1. The LIFE+ Projects and the leather's production process

2. Material and methods

Raw material used for leather processing was pickled goat/sheep/cow skins processed from wet salted skins. The chemicals employed in subsequent operations were those normally used in leather industry and the new natural products developed in each project. In

ECOFATTING and BIONAD projects the natural products were produced by SERICHIM (Torvergata, Udine). ECODEFATTING project will begin in November 2014.

3. Experimental

The PODEBA method demonstrated the innovative use of poultry manure in the bating phase of leather tanning, which is the phase causing the production of most of the ammonium and nitrogen present in the leather manufacturing waste. The bating phase involves an enzymatic reaction which has the purpose of loosening the fibrous structure of the leather, in order to facilitate the removal of skin pigments (melanin) and of hair roots which are still present in the skin. This procedure results in softer and smoother leather, ready for the next tanning phase.

4. Results and discussion

4.1. PODEBA Project

The PODEBA project was conducted to demonstrate an innovative, natural and sustainable process, capable of providing the same results as traditional bating techniques, while at the same time cut-ting the environmental impact of tanneries and reducing water consumption. The PODEBA project objective has been the demonstration of the use of an innovative material, a recycled waste (poultry dejection) for the bating phase in the leather tanning process, for the production of new leather products with a significantly higher eco-sustainability profile.

The environmental impact of the project is evidenced through the following means: (i) recycling and use in an innovative application of a waste, poultry dejection, characterized by high environmental problems of management and disposal, (ii) application of an innovative treatment able to deodorize the poultry dejection; (iii) application of innovative formulations on polyfunctional substrates for regulation through controlled-release active principles, (iv) use of recycled waste instead of industrial products with high saving of economical costs and energy and water consumption, (v) drastic reduction of the high environmental impact of tannery wastewater by using a natural product instead of traditional industrial products in the bating phase. The results included a significant reduction of the environmental impact: 80% reduction of the smell impact in the bating agent production phase; 40% reduction of the conductivity of the water sludge in the bating phase;

More than 40% reduction of the nitrogen and ammonium load and 80% reduction of the sulphide load. The quality evaluation of the final product verified that the leather bated with the natural product would satisfy the quality standards of leather products.

4.2. ECOFATTING Project

This innovative technology is based on the use of a new category of natural products, derived from vegetable oils, capable of substituting entirely the chloroparaffins, which account for 24% of the chemical products used in the leather tanning cycle to impart softness. Chloroparaffins are widely used in the leather fatting process mainly due to their chemical stability, low cost and good application performance, but their employment is raising increasing concern due to their high chlorine content and low biodegradability, responsible for their bioaccumulation.

Chloroparaffins accumulate mainly in aquatic animal tissues, and they are enzymatic disrupters which alter the hormonal system of living beings. Excessive exposure to CPs may affect the kidney, liver and thyroid gland, and may cause cancer, especially the short chain

CPs (SCCPs, with chain leght up to 13). In the EU, the use of SCCPs is restricted in REACH (Regulation EC 552/2009, amending ANNEX XVII). The implementation of the method proposed in ECOFATTING project will contribute to the protection of the environment and sustainable growth of the tanning industry thanks to the use of fatliquoring natural agents which are in compliance with the European laws and with the European eco-label parameters. The biodegradability of the new products is improved by 40% and their performances lead to minor amounts in tanning formulations.

It is worth noting that the new natural molecules developed in ECOFATTING may be used in the same plants used in the fatting with CPs. Thus, they don't require the investment of additional resources from tanning industries. Besides enhancing the safety and eco sustainability of the tanning cycle, the natural product developed increases the penetration of fat in the leather, resulting in a finished product of higher quality in terms of aesthetics, softness, fullness and flexibility.

The determinations of physical and chemical parameters in accordance with standard test have shown to be compliant with the limits required for footwear manufacture. Also, there was a reduction by 43% in the fogging test on natural products with respect to CPs and by 75% with respect to SCPs, which is a significant improvement by natural products compared to synthetic ones. The determination of the heavy metals (Arsenic, Cadmium and Lead) contained in the natural fatliquoring products showed the conformity with the limits established in the European Ecolabel for footwear.

4.3. BioNaD Project

The BioNaD project aims at demonstrating the use of innovative dyes in the leather manufacturing industry, combining the tinctorial power of organic dye molecules with the water solubility and biodegradability of the natural sugar lactose. In particular, the dyes and lactose are chemically bonded, generating new and independent chemical species through a strategy of chemical synthesis named naturalization.

The main actions of the project are: the comparison of naturalized dyes with commercial acid dyes in leather dyeing, the synthesis of the naturalized dyes at laboratory and kilogram-scale, the use of naturalized dyes in leather dyeing at laboratory, pilot and semi-industrial level, the epuration of dyeing effluents (obtained from the use of naturalized dyes) by *Escherichia coli* bacteria leading to the recycle of water for further dyeing operations.

4.4. Ecodefatting Project

The Ecodefatting project aims at demonstrating the use of an innovative technology for the defatting phase of the leather tanning process, with the goal of producing new or existing products with a significantly eco-sustainability profile. The project will demonstrate the use of glycerol diacetate and its long-chain carboxylic acid ester derivatives, capable of replacing the chlorinated paraffins currently used in the defatting phase within the leather tanning cycle.

The main actions of the project are: the comparison of glycerol diacetate and its ester derivatives with commercial chlorinated products in the defatting phase at laboratory level, the synthesis of glycerol ester derivatives at laboratory and kilogram scale, the use of glycerol products to remove fat from the hides at semi-industrial and pre-industrial level, the treatment of defatting wastewaters (from the use of glycerol species) with Escherichia coli to minimize the environmental impact of the effluents, the use of hides treated with glycerol species, for the manufacture of leather products.

4. Conclusions

Despite the complexity of pre-tanning and tanning processes and their environmental impact, the LIFE program is favoring the technological transfer of known technologies and research products in "in field" applications, through the demonstration actions at laboratory, semi-industrial and industrial level.

References

Kipnis A.B., Levenko P.I., Strakhov I.P., Shifrin I.G., (1972), Minimization of degradation of leather and Hide materials byradiationsterilization, *Atomic Energy*, **33,** 1085–1087.

Orlita A., (2004), Microbial biodeterioration of leather and its control: a review, *International Biodeterioration & Biodegradation*, **53**, 157–163.

Procedia
Environmental Science, Engineering and Management
http://www.procedia-esem.eu

Procedia Environmental Science, Engineering and Management **1** (2014) (2) 115-119

18th International Trade Fair of Material & Energy Recovery and Sustainable Development, ECOMONDO, 5th-8th November, 2014, Rimini, Italy

BIOBASED INDUSTRY - Research and innovation in integrated biorefineries

PRODUCTION OF LIGNOCELLULOSIC ENZYMES FROM DIFFERENT AGRO-FOOD WASTES BY SOLID STATE FERMENTATION[*]

Dayanne Christine Masutti[**], Alessandra Borgognone, Fabio Scardovi, Claudio Vaccari, Leonardo Setti

Dept of Industrial Chemistry «Toso Montanari» - University of Bologna, Viale Risorgimento,4, 40136, Bologna, Italy.

Abstract

In this paper we have studied the production of different kinds of lignocellulosic enzymes, induced by the growth of *Pleurotus ostreatus* in solid state fermentation (SSF) by agro-food wastes (grape stalks and wheat bran) as substrates.
For each substrate, the solid state fermentations were carried out in three different fermenters and monitored taking samples at different frequency of time.
The enzymatic activities produced by fermentation were strictly dependent to the periodic removal of the enzymes produced.
The dynamic SSF with mechanical treatments of extrusion of the substrate is able to promote the fermentation conditions and to influence the enzyme activity produced.

Keywords: lignocellulosic enzymes, *Pleurotus ostreatus,* solid state fermentation

1. Introduction

In Italy, wheat and grapes are among the most produced crops and therefore of great importance in the agro-industrial sector. The grape stalks and wheat bran were then used in this research in solid state fermentation (SSF), as substrates for the growth of *Pleurotus ostreatus* that using the enzymes produced by the degradation of the complex vegetable

[*]Selection and peer-review under responsibility of the ECOMONDO
[**]Corresponding author: dayanne.masutti@unibo.it

matrix, free the substances necessary for its development. This process provides an alternative avenue and value-addition to these otherwise under- or not-utilized residues.

The arylesterase such as feruloyl esterases is a family of extracellular esterases which are capable to release hydroxycinnamates from cell wall material. These cinnamic acids can be converted in important compounds of industrial applications. Phenolic residues into the plant tissues including ferulate and cumarate are rarely present in the walls of dicotyledones (Ishii, 1997). Ferulic acid appears to be the basis of important links within the polysaccharide networks of cell walls, being key contributor to cell wall integrity due to its dimerization inter arabinose side chains (Migné et al., 1998). Dynamic solid state fermentation offered greater advantages to the static SSF in industrial enzyme productions; it could not only improve enzyme activities produced, but also shorten the fermentation period (Masutti et al., 2014).

The aim of this work was to study the production of arylesterase as well as of various enzymatic activities such as cellulase, xylanase and laccase by the growth of *Pleurotus ostreatus* on agro-food wastes as substrate, such as wheat bran and grape stalks.

3. Materials and methods

3.1. Solid state fermenter

Fifty grams of dry weight of wheat bran or 9,1 g of grape stalks as such in a Pyrex bottle with a cotton cap were wetted with 50 mL of distilled water and sterilized by autoclavin. This substrate was inoculated using 9 g of *Pleurotus ostreatus* grow on malt extract agar. The fermentation takes place at 25 °C, in absence of light for a period of 28 days. Three different fermenters were monitored taking samples at different frequency of time with different time every 7 days and 14 days as well after 28 days, respectively. About the sampling, the substrate was mixed with a specific quantity of water and the extract (free-water) was recovered, centrifuged for 5 minutes at 13000 rpm and the enzymatic activities were determined. The third fermenter was, instead, opened after 14 days for the addition of water to maintain moisture into the substrate. The enzymatic activities of the substrates calculated per mL, were multiplied by the total volume of extract recovered to determine the total activity obtained, eliminating in this way the effects of dilution due to the different conditions of recovery.

3.2. Determination of enzymatic activities:

Cellulose functionalized (Poincelot and Day 1972), cellulose reducing sugars (Bailey et al., 1992), peroxidase (Setti et al., 1998), laccase (Setti et al., 1999), xylanase (Bailey et al., 1992) and arylesterase activities were determined in a quartz cuvette were added 0.9 mL of buffer, 0.1 mL of methyl ferulate or methyl caffeate and 0.05 mL of the extract. Immediately after adding the extract, is reading a time drive at a spectrophotometer at 335 nm, in which was detected the disappearance of methyl ferulate or methyl caffeate. The method was modified with respect to that reported by (Giuliani et al., 2001).

4. Results and discussion

The SSF using wheat bran and grape stalks showed an absence of peroxidase activities in both substrates while the cellulose activity presented scarce values in both substrates with respect to the others enzymes. All the yields of the enzymatic activities per dry weight of substrate obtained with grape stalks were higher than that with wheat bran (Fig. 1 and Fig. 2).

Arylesterase activities were the prevalent products on both the substrates, in particular, the feruloyl esterase activity. The more significant yields were found on grape stalks, even if hydroxycinnamates are rarely present in the plant cell walls of dicotyledons when compared to monocotyledons (Fig. 1 and Fig. 2) (Willats and Knox, 2003).

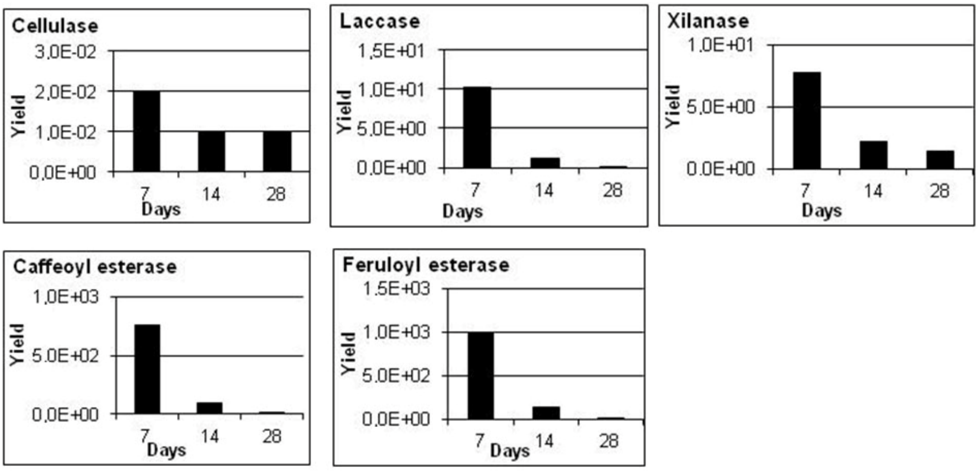


Fig. 1. Ligninolytic activities yields (μmol/min*g) per gram of dry weight of wheat bran on the total recovered samples at different frequency of times (7, 14 and 28 days) after 28 days of fermentation

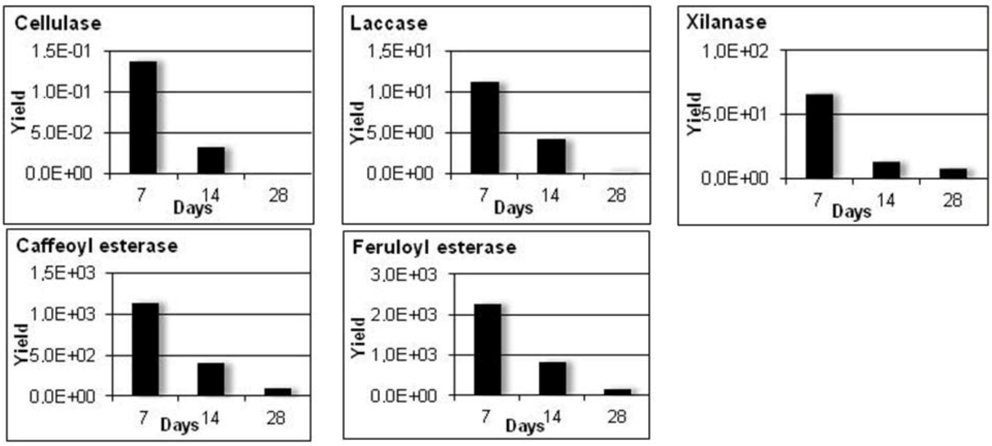


Fig. 2. Ligninolytic activities yields (μmol/min*g) per gram of dry weight of grape stalks on the total recovered samples at different frequency of times (7, 14 and 28 days) after 28 days of fermentation

On the opposite, the enzymatic activities of arylesterases and xylanase, calculated per mL of the total recovered samples, resulted higher in wheat bran with respect to grape stalks (Table 1 and Table 2). The enzyme production by *Pleurotus ostreatus* in SSF showed a significant dependence on the frequency of sampling. The yield per dry substrate was higher when the frequency of the sampling was higher: every 7 days with respect to 14 and 28 days. It is mean that the production of the enzyme seemed to be induced when the produced enzyme was frequently removed from the substrate. One can therefore assume a mechanism in equilibrium between the biosynthesis of the enzyme and the free enzyme in solution.

These higher enzymatic activities were probably affected by both the addition of fresh water and the mixing of the substrate for the sampling even if a correlation between the enzymatic production and the frequency for the removal of the bio-digestate from a SSF was not yet evidenced.

Table 1. Enzymatic activity of wheat bran per mL of water waste on the total recovered samples at different frequency of times (7, 14 and 28 days) after 28 days of fermentation

Enzymatic activity	*Frequency of recovery of the samples*		
	Every 7 days	*Every 14 days*	*After 28 days*
*Cellulase (μmol/min*mL)*	0.05	0.03	0.02
*Laccase (μmol/min*mL)*	34.85	1.81	0.21
*Xylanase (μmol/min*mL)*	26.18	5.33	4.25
*Caffeoyl esterase (μmol/min*mL)*	2729.37	198.24	9.45
*Feruloyl esterase (μmol/min*mL)*	3440.43	297.99	7.77

Table 2. Enzymatic activity of grape stalks per mL of water waste on the total recovered samples at different frequency of times (7, 14 and 28 days) after 28 days of fermentation

Enzymatic activity	*Frequency of recovery of the samples*		
	Every 7 days	*Every 14 days*	*After 28 days*
*Cellulase (μmol/min*mL)*	0.08	0.02	--
*Laccase (μmol/min*mL)*	7.54	2.97	0.22
*Xylanase (μmol/min*mL)*	44.24	8.72	5.77
*Caffeoyl esterase (μmol/min*mL)*	780.15	280.35	71.4
*Feruloyl esterase (μmol/min*mL)*	1544.55	594.3	144.9

5. Conclusions

Induction of arylesterase activities in *Pleurotus ostreatus* was demonstrated using lignocellulosic material as substrate, in fact a growth substrate such as the wheat bran could to be thought a better inducer of feruloyl esterase because of the presence of large amount of ferulic acid into the plant cell wall. Our findings evidenced that the highest arylesterase activities were detected in both of substrates, even if, the grape stalks in relation of wheat bran, seems to be the most suitable since we have better yields with this. Moreover, the enzyme production by *Pleurotus ostreatus* in SSF showed a significant dependence on the frequency of sampling.

The choose of the growing substrates and the design of the bioreactor undoubtedly play a key role in enzyme production as well as the oxygenation of the substrate by the mechanical process of mixing for the recovery of the added water for the sampling.

Acknowledgements
All the yields of the enzymatic activities per dry weight of substrate obtained with grape stalks were higher than that with wheat bran. Arylesterase activities were the prevalent products on both the substrates. The enzyme production by Pleurotus ostreatus in SSF showed a significant dependence on the frequency of sampling.

References

Bailey M.J., Biely P., Poutanen K., (1992), Interlaboratory testing of methods for assay of xilanase activity, *Journal of Biotechnology*, **23**, 257-270.

Giuliani S., Piana C., Setti L., Hochkoeppler A., Pifferi P.G., Williamson G., Faulds C.B., (2001), Synthesis of pentylferulate by a feruloyl esterase from *Aspergillus niger* using water-in-oil microemulsions, *Biotechnology Letters*, **23**, 325-330.

Ishii T., (1997), Structure and function of feruloylated polysaccharides, *Plant Science*, **127**, 111-127.

Masutti D.C., Borgognoni A., Scardovi F., Vaccari C., Setti L., (2014), *Production of Lignocellulosic Enzymes from Different Agro-Food Wastes by Solid State Fermentation*, Proc. of 5th International Conference on Engineering for Waste and Biomass Valorisation - Rio de Janeiro, Brazil.

Migné C., Prensier G., Utille J.P., Angibeaud P., Cornu A.E., Grenet E., (1998), Immunocytochemical localization of para-coumaric acid and feruloyl-arabinose in the cell walls of maize stem, *Journal of the Science of Food Agriculture*, **78**, 373-381.

Poincelot, R.P., Day, P.R., (1972), Simple dye release assay for determining cellulolytic activity of fungi, *Applied and Environmental Microbiology*, **23**, 875-879.

Setti L., Giuliani S., Spinozzi G., Pifferi P.G., (1999), Laccase-catalyzed oxidative coupling of 3-methyl 2-benzothiazolinone hydrazone and methoxyphenols, *Enzyme Microbial Technology*, **25**, 285-289.

Setti L., Scali S., Degli Angeli I., Pifferi P.G., (1998), Horseradish peroxidase-catalyzed oxidative coupling of 3-methyl 2-benzothiazolinone hydrazone and methoxyphenols, *Enzyme and Microbial Technology*, **22**, 656-661.

Willats G.T.W., Knox J.P., (2003), *Molecules in Context: Probes for Cell Wall Analysis*, In: *The Plant Cell Wall, Annual Plant Reviews 8*, Rose J.K.C. (Ed.), CRC Press, 92-106.

Procedia
Environmental Science, Engineering and Management
http://www.procedia-esem.eu

Procedia Environmental Science, Engineering and Management **1** (2014) (2) 121-125

18th International Trade Fair of Material & Energy Recovery and Sustainable Development, ECOMONDO, 5th-8th November, 2014, Rimini, Italy

ECOINNOVATION1 - Tools for evaluating the sustainability of products / processes

LIFE CYCLE ASSESSMENT OF ELECTRICITY PRODUCTION FROM ANAEROBIC DIGESTION OF ANIMAL SLURRY IN A FARM SCALE PLANT*

Jacopo Bacenetti, Marco Fiala**

Department of Agricultural and Environmental Sciences - Production, Landscape, Agroenergy, Università degli Studi di Milano,Via Giovanni, Celoria 2, 20133, Milano, Italy

Abstract

The aim of this study is to assess the environmental profile of electricity production from an AD plant fed with cattle slurry (100 kW). Using LCA method, the environmental performance of electricity production from biogas has been evaluated using 1 kWh of electricity as functional unit.
For the definition of the environmental profile, all processes involved as well as the processes avoided by the biogas production system (e.g. thermal energy production) were evaluated. The most critical stages were identified. The results show that livestock slurries are a good feedstock for AD plants from an environmental point of view.

Keywords: anaerobic digestion, biogas, environmental performance, renewable energy, sustainability

1. Introduction

During the past 20 years, agricultural biogas production considerably increased, and nowadays, more than 1,100 agricultural biogas plants are running mainly in northern Regions (Negri et al., 2014). At the end of 2012, the installed electrical power was 756 MW and 1.65% of the Italian electric consumption has been produced by agricultural biogas plants. Most of these biogas plants are located in Northern Italy.

---

*Selection and peer-review under responsibility of the ECOMONDO
**Corresponding author: jacopo.bacenetti@unimi.it

However, over the years, the spread of AD plants, often concentrated in specific areas (such as the provinces of Cremona, Lodi and Mantua in Lombardy), resulted in the growth of concerns about the fact that more and more agricultural land is tilled for feeding the digesters. In 2013 growing seasons, about 10% of the overall Italian maize area (approximately 10.000 km^2) (Negri et al., 2014) is earmarked to biogas production.

Therefore, the public incentives framework for electricity production from biogas has been updated with the Ministerial Decree of 6 July 2012 (MDE, 2012). In general, the incentives have been reduced (15-35%) and more importance has been paid to the heat valorization and the by-products utilization, by means of the introduction of bonus prices. From the January 1 2013, the highest incentives are granted to small plants (electrical power < 300 kW) mainly fed with by-products (minimum 70% of the biomass introduced into the digesters). As a consequence, big AD plants completely fed with energy crops aren't profitable while, on the contrary, good economic performances can be achieved through small AD plants fed with animal slurries.

Nevertheless these feedstock are though characterized by low specific biogas productions (approximately 5-25 times smaller than maize silage) (Negri et al., 2014). The feeding of the AD plant with these slurries only, allows getting the highest subsidy even though, on the other hand, it requires the construction of big digesters with consequently higher costs; in addition to this, it might turn out to be necessary the involvement of long transport distances for the feedstock.

Electricity generation by AD technology does not necessarily lead to sustainable practices (Whiting and Azapagic, 2014). The GHG savings get by the substitution of EE generation by fossil sources can be offset by the GHG emissions during the production transport and transformation of the biomass. The environmental performances of EE produced by AD plants should be carefully evaluated by means of scientific and robust methodologies. In this context the Life Cycle Assessment (LCA) allow a fair and complete evaluation of the biomass-to-electricity process. Over the years, several LCA studies have been published with regards to this topic (Bacenetti et al., 2013; Dressler et al., 2012; Lansche and Muller, 2012; Lijo et al., 2014a; Lijo et al., 2014b) but few studies are focused on EE generation in small AD plants fed only with animal slurries.

2. Objectives

The main aim of this study is to evaluate the environmental sustainability of electricity produced in a small AD plant located in Cremona District (Lombardy) and completely fed by cow slurry. Secondarily alternative scenarios able to mitigate the environmental load have been evaluated.

3. Materials

The AD Plant has electrical power of 100 kW, is located in Cremona district (Lombardy Region), it has 1 digester and is fed only with cow slurry. Animal slurry is firstly transported by a slurry tank coupled with a tractor for 0.1 km. After that it is pumped into a continuously stirred tank reactor with a global volume of 1885 m^3. Daily, 35 t of cow slurry are digested. Inside the digester, the organic matter keeps homogenous by means of a single central mixer (18.5 kW). The reactor operates at a mesophilic temperature of 42^o C with an organic loading rate (OLR) of 1.6 kg VS$\cdot$ m$^{-3}\cdot$day^{-1}. The biogas produced is stored separately from the digester in a tank of 150 m^3 of capacity.

Previously to feed the CHP engine the biogas is desulphurised and dehumidified. Digestate is stored in an open-air lagoon from which both ammonia and methane are released.

These emissions are assumed at 8.9 kg/MWh for methane and 0.23 kg/MWh for ammonia (Whiting and Azapagic, 2014).

The EE needed to run the biogas plant (selfconsumption) is taken from the grid while thermal energy to heat the digester comes from the CHP engine. Globally electric self consumption reaches the 7% of gross EE produced.

Regarding the heat cogenerated by the CHP engine, part (55%) is used to heat the digester. The surplus heat is partially wasted (13%) and partially valorized in the farm for 2530 hours each year (32%). In more details, 2 h/day it is used for hot water production while, from 15 October to 15 March, it is used (12 h/day) to heat farm buildings (farmer house, offices, etc.).

4. Methods

Considering that the function of the system is electricity supply to the national grid 1 kWh of electricity produced has been chosen as Functional Unit. The system boundary includes cow slurry transport and anaerobic digestion, electricity generation and digestate storage. Cow slurry production has been excluded from the boundary because it is a waste belonging to the milk production process. The emissions from the digestate application are similar to the ones from slurry application; therefore, this process has been excluded too. The surplus heat valorized offset the production of the same thermal energy by a natural gas boiler.

The midpoint impact assessment methods recommended by ILCD Handbook were used in the study. The following impact categories have been evaluated: Climate Change (CC), Ozone Depletion (OD), Photochemical Ozone Formation (POF), Acidification (AC), Freshwater Eutrophication (FE), Marine Eutrophication (ME), Mineral, Fossil and Renewable resource Depletion (MFRD).

5. Results and discussion

Table 1 reports the environmental performance for 1 kWh of EE produced by the AD plant. For 3 out of the 8 evaluated impact categories (OD, FE and MFRD) the score is negative; therefore the EE presents an environmental benefit. This is due to the valorization of surplus heat that avoid the generation by a fossil fuel source (natural gas). Without the heat valorization, the scores for all the impact categories turn out to be numerically positive with a negative environmental load. The main hotspots of the system are: (i) the digestate storage for CC and TE due to the emissions of methane and ammonia; (ii) the CHP emission for POF, TE and AC; (iii) the anaerobic digestion for FE. The transport, thanks to the short distance, has a little impact for all the impact categories.

Table 1. Environmental performances for the FU (1 kWh)

Impact category	***Unit***	***AD***	***Digestate Storage***	***CHP emission***	***Transport***	***Heat Valorisation***	***Total score***
CC	kg CO2 eq	0.041	0.235	0.105	0.001	-0.110	0.271
OD	kg CFC-11 eq	$3.76 \cdot 10^{-9}$	0.00	0.00	$7.98 \cdot 10^{-9}$	$-1.69 \cdot 10^{-8}$	$-1.31 \cdot 10^{-8}$
POF	kg NMVOC eq	$1.07 \cdot 10^{-4}$	$9.49 \cdot 10^{-5}$	$2.93 \cdot 10^{-3}$	$5.63 \cdot 10^{-6}$	$-1.06 \cdot 10^{-4}$	$3.03 \cdot 10^{-3}$
AC	molc H+ eq	$2.36 \cdot 10^{-4}$	$6.95 \cdot 10^{-4}$	$1.54 \cdot 10^{-3}$	$4.93 \cdot 10^{-6}$	$-1.12 \cdot 10^{-4}$	$2.36 \cdot 10^{-3}$
TE	molc N eq	$3.60 \cdot 10^{-4}$	$3.11 \cdot 10^{-3}$	$8.86 \cdot 10^{-3}$	$1.97 \cdot 10^{-5}$	$-2.46 \cdot 10^{-4}$	$1.21 \cdot 10^{-2}$
FE	kg P eq	$5.19 \cdot 10^{-8}$	0.00	0.00	$1.81 \cdot 10^{-8}$	$-1.29 \cdot 10^{-7}$	$-5.85 \cdot 10^{-8}$

ME	kg N eq	$3.22 \cdot 10^{-5}$	$2.12 \cdot 10^{-5}$	$8.09 \cdot 10^{-4}$	$1.78 \cdot 10^{-6}$	$-2.24 \cdot 10^{-5}$	$8.42 \cdot 10^{-4}$
MFRD	kg Sb eq	$4.62 \cdot 10^{-8}$	0.00	0.00	$3.44 \cdot 10^{-8}$	$-1.17 \cdot 10^{-7}$	$-3.63 \cdot 10^{-8}$

Two alternative scenarios (AS) able to reduce the environmental impact of EE have been evaluated. In AS1 all the surplus heat is valorized and it substitutes thermal energy produced by the natural gas; in AS2 the digestate storage tank is covered and, therefore, methane and ammonia emissions are reduced (-80%). Fig. 1 reports the comparison among the different scenarios. The two alternative scenarios improve the environmental performance of EE. In particular, the full utilization of surplus heat causes considerable improvement for OD, FE and MFRD while to store the digestate in covered tanks reduces significantly CC (-70%) but also AC (-24%) and TE (-21%). The two AS achieve only little impact reductions for POF and ME, which are mainly due to CHP emissions.

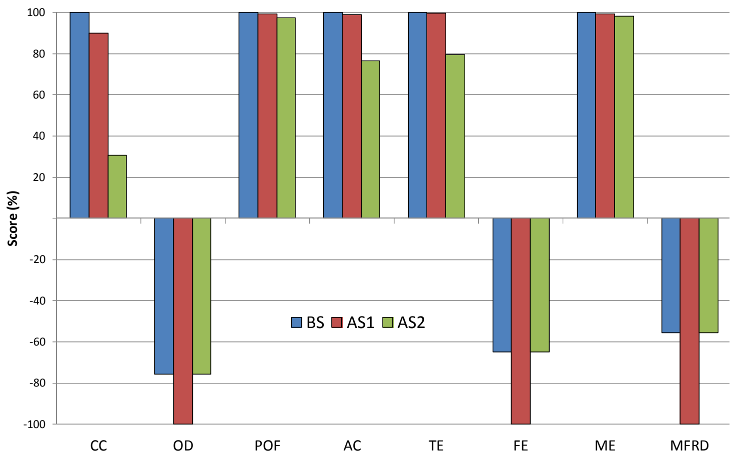


Fig. 1. Comparison among the three different alternative scenarios

6. Conclusion

The results of this study indicate that livestock slurries are a good feedstock for AD plants from an environmental point of view. Benefits for the environment are achieved avoiding heat production from fossil fuel. Furthermore, a full exploitation of thermal energy cogenerated and the covering of the digestate storage tank can lead to significant reductions in most impacts of electricity from anaerobic digestion.

References

Bacenetti J., Negri M., Fiala M., Gonzalez Garcia S., (2013), Anaerobic digestion of different feedstock: impact on energetic and environmental balances of biogas process, *Science of the Total Environment*, **463-464**, 541-551.

Dressler D., Loewen A., Nelles M., (2012), Life cycle assessment of the supply and use of bioenergy: impact of regional factors on biogas production, *The International Journal of Life Cycle Assessment*, **17**, 1104-1115.

Lansche J., Müller J., (2012), Life cycle assessment of energy generation of biogas fed combined heat and power plants: Environmental impact of different agricultural substrates, *Engineering in Life Sciences*, **12**, 313-320.

Lijó L., González-García, S., Bacenetti J., Fiala M., Feijoo G., Lema J.M., Moreira M.T., (2014), Life Cycle Assessment of electricity production in Italy form anaerobic co-digestion of pig slurry and energy crops, *Renewable Energy*. **68**, 625-635.

Lijó L., González-García S., Bacenetti J., Fiala M., Feijoo G., Moreira M.T., (2014), Assuring the sustainable production of biogas from anaerobic mono-digestion, *Journal of Cleaner Production*, **72**, 23-34.

MDE, (2012), Incentives for energy from renewable sources non photovoltaic, Ministerial Decree of July 6, 2012, Ministry of Economic Development, Rome, Italy.

Negri M., Bacenetti J., Manfredini A., Lovarelli D., Maggiore T., Fiala M., Bocchi S., (2014), Evaluation of methane production from maize silage by harvest of different plant portions, *Biomass and Bioenergy*, **67**, 339-346.

Whiting A., Azapagic A., (2014), Life cycle environmental impacts of generating electricity and heat from biogas produced by anaerobic digestion, *Energy*, **70**,181-193.

Procedia
Environmental Science, Engineering and Management
http://www.procedia-esem.eu

Procedia Environmental Science, Engineering and Management **1** (2014) (2) 127-130

18th International Trade Fair of Material & Energy Recovery and Sustainable Development, ECOMONDO, 5th-8th November, 2014, Rimini, Italy

COMPARISON OF URBAN WASTE COLLECTION SYSTEMS VIA LIFE CYCLE ASSESSMENT: CASE STUDY IN THE BOLOGNA AREA*

Silvia Bamonti, Alessandra Bonoli**

University of Bologna, Department of Civil, Chemical, Environmental and Material Engineering, Italy

Abstract

The waste framework Directive 2008/98 of the European Parliament states that a recycling at least equal to 50% has to be the target for the primary flows, i.e. those related to materials such as paper, glass, plastic and metals. Collection systems play a crucial role, affecting the volume of recyclable materials and the consequent possibility of recovery and reuse. In this context, the aim of the work consists in identifying the most profitable collection system in terms of efficiency and environmental impact. This is done via life cycle analysis by comparing diverse strategies in the area of Bologna (Italy).

Keywords: energy recovery, life cycle assessment, material recovery, municipal waste

1. Introduction

Waste management is a complex sector involving legislative (laws, rules, guidelines, etc.), environmental (natural resources management), economic and urban planning aspects (Bamonti et al., 2011). Generally, regulations impose targets regarding material recovery but do not indicate the optimal strategy to achieve them. The waste framework Directive 2008/98 of the European Parliament states that a recycling at least equal to 50% has to be the target for the primary flows, i.e. those related to materials such as paper, glass, plastic and

*Selection and peer-review under responsibility of the ECOMONDO
**Corresponding author: e-mail: silvia.bamonti2@unibo.it

metals. In this context, waste collection systems play a crucial role, affecting the volume of recyclable materials and the consequent possibility of recovery and reuse.

Currently, in the area of Bologna (Italy), that is the object of this study, the recovery target has not been achieved yet (ISPRA, 2012). Hence, it is useful to compare different collection systems of municipal waste in order to understand the best strategy in terms of efficiency and impact reduction. In particular, we compare the door to door collection system (DtD) and the kerbside recycling service (KRS). The analysis is carried out on four municipalities in the area of Bologna, in which wastes are managed through one of these two approaches. These municipalities are characterized by similar number of inhabitants and served surface.

2. Objectives

The aim of this work consists in comparing the DTD system and the KRS in order to identify the most profitable in terms of efficiency and environmental impact. This is done via life cycle assessment (ISO 2006a,b), by analyzing different scenarios.

3. Materials and methods

The analysis proposed in this work is based on the adoption of Life Cycle Assessment (LCA) to compare the efficiency of diverse urban waste collection systems. Waste materials are considered in this methodological framework from the moment in which the materials become waste, till the moment in which these are collected and then lead to either landfills or plant treatments.

Four case studies in the area of Bologna have been selected, taking into account the correspondent urban waste management as system function. In the following, the normalization step of LCA is first realized by considering, as functional unit, the tons of waste produced in each selected urban area per capita per year. Hence, in order to derive results not affected by the number of inhabitants, the functional unit is modified in one ton of waste produced per year.

LCA is pursued in this study resorting to the software SimaPro (Goedkoop, 2006). We employ as databases ECOINVENT 1.0, BUWAL 250 and also the Italian I-LCA. Data related to the collection, transport and, eventually, treatment of wastes have been considered starting from the available data. In case of transport to final destination, landfill or incineration plant, without any treatment, we consider the consequent specific emissions into the air, water and soil. Emissions are also considered in case of waste recycling as well as the avoided products.

The approach based on the Eco-Indicator 99 is employed to evaluate the environmental impact of each waste management strategy. The inventory has been redacted with the information related to the collection strategies of the four urban areas. Specifically, two of these employ a door to door (DtD) collection system, while the others resort to a kerbside recycling service (KRS). These two diverse approaches include several phases related to the collection of each single kind of waste (i.e. paper, plastic, glass, organic and solid urban waste).

Note that all waste materials, such as paper, organic, glass, etc., are sent to treatment plants, except for the plastic material for which pre-treatments are provided. Solid urban wastes can be sent directly at the incinerator plant or treated in order to separate the organic and inorganic components and then send to landfills. Relevant input data are also identified in the quantity of waste produced, the collection frequency, the kind of vehicle employed for the collection, and the distances to be covered. Table 1 resumes the main characteristics associated with the four selected urban areas employed in the analysis.

Table 1. Waste production and percentages of separate collection in the four selected urban areas

Case study	*Collection System*	*Waste Produced (Tons per capita per year)*	*Separated Collection (Percentage)*
1	*DtD*	0.49	71.9
2	*DtD*	0.49	80.7
3	*KRS*	0.62	46.6
4	*KRS*	0.67	47.6

4. Results and discussion

The approach based on the ECO INDICATOR 99 allows to derive results related to impact and damage categories. When the tons of waste produced in each selected urban area per capita per year is employed as functional unit, results show that municipalities adopting a KRS are affected by greater impacts than those employing the DtD system (see Fig.1). If we then consider one ton of waste produced per year as functional unit, results change significantly since the analysis is no more influenced by the demographic variable.

Through detailed analysis, pursued at different levels, it has been derived that the collection system with less environmental impact is the KRS as shown by the data included in Table 2.

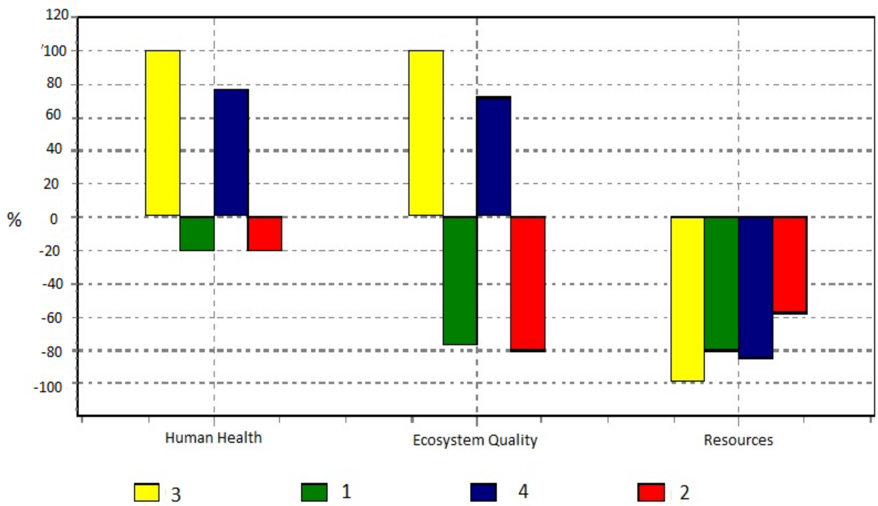


Fig. 1. Damage categories associated with the four urban areas, considering the tons of waste produced per capita per year as functional unit.

Table 2. Impact categories associated with two of the four urban areas, considering the one ton of waste produced per year as functional unit

Impact category	*Unit*	*Case study 1 (DtD)*	*Case study 4 (KRS)*
Carcinogens	DALY	8.940E-05	7.890E-05
Climate change	DALY	3.480E-05	2.960E-05
Ecotoxicity	PDF*m^2*yr	1.490	0.784
Land use	PDF*m^2*yr	0.402	0.424

General evaluations are in line with these results, highlighting that the DtD system induces mechanisms such as waste migration. The corrected overall quantification of waste production in a given urban area tends to confirm the results we obtained.

5. Concluding remarks

The LCA analysis and indicators provided in this study have demonstrated the greater efficacy of the KRS in comparison to the DtD system, when environmental impacts are considered. It is also important to highlight the best efficiency even form a logistical point of view of the KRS, which is preferable for the lower impact on the quantification of the paths that have to be traced and for the assets involved in the collection.

References

Bamonti S., Bonoli A., Tondelli S., (2011), Sustainable waste management criteria for local urban plans, *Procedia Engineering*, **21**, 221-228.

Goedkoop M., (2006), *SimaPro 7 Demo Manual*, PRé Consultants, The Netherlands.

ISO, (2006a), *Environmental management – Life cycle assessment – Principles and* framework (ISO 14040: 2006), European Standard EN ISO 14040, The International Organization for Standardization, Geneva, Switzerland.

ISO, (2006b), *Environmental management – Life cycle assessment – Requirements and Guidelines (ISO 14044: 2006*), European Standard EN ISO 14040, The International Organization for Standardization, Geneva, Switzerland.

ISPRA, (2012), *Waste Report*, Edition 2011, Institute for the Protection and Environmental Research.

Procedia
Environmental Science,
Engineering and Management
http://www.procedia-esem.eu

Procedia Environmental Science, Engineering and Management **1** (2014) (2) 131-135

18th International Trade Fair of Material & Energy Recovery and Sustainable Development,
ECOMONDO, 5th-8th November, 2014, Rimini, Italy

LIFE CYCLE ASSESSMENT AND LEED: THE ECOLOGICAL INNOVATION OF PRODUCTS IS AN INSTRUMENT TO SPREAD ENVIRONMENTAL SUSTAINABILITY ASSESSMENT FOR BUILDINGS*

Patrizia Milano[1], Massimo Guido[1], Francesca Intini[2], Gaetano Contento[3]**

[1]ECO-logica srl, 258, Corso Alcide De Gasperi, 70125, Bari, Italy
[2]University of Basilicata, Italy
[3]Master srl, Conversano, Italy

Abstract

This paper presents the experience of Master srl, an Apulia company that produces accessories for windows, and addressed its production toward low environmental impact policies.
The increasing interest on the environmental policies of the products and on the environmental sustainability certifications carried the Master to study the environmental performances of its products and to communicate the results to their customers.
The used methodology was the LCA; Master also examined the performance of its products with reference to the requirements of the LEED (Leadership in Energy and Environmental Design), one of the most used Environmental Sustainability Assessment for Buildings.

Keywords: accessories for windows, eco building LEED, LCA, sustainability

1. Introduction

The policies of the products have always been aimed to create products good for their functionality, design and innovation. Actually, as energy and natural resources become

---

*Selection and peer-review under responsibility of the ECOMONDO
**Corresponding author: pmilano@eco-logicasrl.it

scarcer and more expensive, and as climate change becomes a growing concern, companies are investing in eco-friendly products and technologies.

Most consumers are aware that their purchases can contribute to protect the environment and, consequently, they are more careful to read the labels of the products in order to make the right choice. It is necessary a **new product policy** which rewards consumers' eco-friendly behaviours and producers' best products.

The approach of the Commission's Communication of 18 June 2003 entitled "Integrated Product Policy — Building on Environmental Life-Cycle Thinking", which is one of the major innovative element of the Sixth Community Environment Action Programme, aims to reduce the environmental impacts of products across the whole life cycle, including the selection and use of raw materials, manufacturing, packaging, transport and distribution, installation and maintenance, use and end-of-life. The ecodesign of products is a crucial factor in the Community strategy on Integrated Product Policy. As a preventive approach, designed to optimize the environmental performance of products, while maintaining their functional qualities, it provides genuine new opportunities for manufacturers, consumers and society as a whole (EC Directive, 2009).

The LCA is the main instrument of the Integrated Product Policy; it also represents the basis of the environmental labeling and declarations (Ecolabel, EPD) and the Environmental Management Systems (EMAS, ISO 14000).

In the last twenty years, methods of assessing green building design and sustainable living has received increased attention between consumers and professionals. One of the predominant environmental assessment methods for buildings in the world is the LEED® system (Leadership Energy and Environmental Design), developed in the United States by the US Green Building Council (USGBC).

To obtain LEED certification, projects must meet prerequisites (PR) and credits (CR) across 6 categories; one of these is the category "Materials and resources" which concerns with the environmental quality of the products and materials used in the building. The environmental characteristics of the products can help the building to gain points in the "Materials and resources" category; therefore, professionals and contractors have the necessity to know the environmental characteristics of the products when using them in the project and the construction.

LEED is not an environmental label for products, but products can help the building to obtain the certification: Therefore the technical sheet of the products must contain all the information necessary to calculate the points for the LEED certification.

In this context the main objective of the present paper is to explain how a company can analyze the environmental impact of their products and improve their performance towards the environmental sustainability.

2. Materials and methods

In this study, the methodology used is the LCA technique, based on ISO 14040 and ISO 14044 (2006). This assessment methodology is based on the identification of energy and materials used and emissions released to the environment. The core of the concept is the assessment of the impacts at each stage of the product life cycle (De Benedetto et al., 2009). LCA evaluates all stages of a production chain and it is characterized by interdependent phases: one operation leads to the next. One of the main reasons why an LCA is applied is to make comparisons and choose among alternatives (e.g. comparison of electricity production from biomass and from coal). Information collected is critical to the success of any LCA study.

The present LCA focuses on the environmental impacts (both direct and indirect) of the accessories for windows, in term of Global Warming Potential (GWP100): the ratio between the global warming caused by a certain type of greenhouse gas in a period of 100 years and the warming caused by the same mass of carbon dioxide (whose GWP is by definition 1) in the same period (Solomon et al., 2012). The functional unit of the study, consistent with the objective is an window handle.

For the time boundaries, the data are considered on an annual scale and for the year 2012 using an approach "from cradle to gate". For the production and use of materials all the stages are included in the system from the extraction of raw materials. In the case of transport, the study considered all the necessary supply of semi-finished products and supplies. The waste treatment is included in the impact. The electricity mix includes a share of energy from self-produced photovoltaic. The transport of the finished product is excluded because the market is characterized by customers all over the world for which it is difficult to make predictions or assumptions of localization. Also the maintenance of the systems and processes of infrastructure, machinery and molds are excluded. The data collection was carried out at the plant, with values obtained exclusively by operators of the system. For all processes and materials in the inventory have been identified related items within the database of the software SimaPro (Ecoinvent, 2010).

The window handle is composed from extruded components in plastic, in zamak and aluminum. The raw materials undergo any mechanical extrusion, casting, painting, cleaning-house with a large consumption of energy and natural gas.

Referring to LEED, the first step is to analyze the requirements of the LEED; Master srl analyzed the following LEED rating systems:

- The US LEED for New Construction and Major Renovation (LEED US NC 2009) (www.usgbc.org);
- The Italian LEED for New Construction and Major Renovation (LEED Italia NC) (www.gbcitalia.org).

The performances of the Master's products referring to LEED's requirements concerns with the Recycled content (MRc4), the regional materials (MRc5) and the Innovation in Design (ID c1) which refers to the LCA's studies.

In order to assess the conformity to LEED's requirements the content of the product in terms of raw materials was examined, referring to their content of recycled material through a "recycled content claim" released under the responsibility of the producer**.**

The recycled content was expressed in terms of "**Postconsumer recycled content valued as a percentage determined by weight**", which is defined as waste material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product, which can no longer be used for its intended purpose, and "**Preconsumer recycled content valued as a percentage determined by weight**", defined as material diverted from the waste stream during the manufacturing process.

3. Results and discussion

The general framework of a Life Cycle Impact Assessment (LCIA) method is composed of two mandatory elements (i.e., classification and characterisation) that convert LCI results into an indicator for each impact category. Optional elements (i.e., normalization and weighting) lead to a unique indicator across impact categories using numerical factors based on value-choices. Results of the LCA are often used for process optimisation. The impact of a single window handle is 2,930 kgCO_2eq. The contribution of each step of the production process in terms of Global Warming Potential (GWP) has been investigated (see Fig. 1). The major contribution is given by the production of the aluminium handle and zamak stainless. The energy utilities account for about 20% of the overall GWP impact.

The result is constituted by the Report of compliance of each product with LEED's requirements. The Report contains the outline of the standard LEED and of the products, and a schedule for each code of the product describing the performances in terms of post-consumer and pre-consumer recycled content (percentage determined by weight), in terms of regional materials content and of reduction of environmental impact referring to LCA study. The Master produced a **recycled content claim** for each product, annexed to the Report and a label on the packaging of the product with the values of the performances referred to LEED's requirements (Fig. 2).

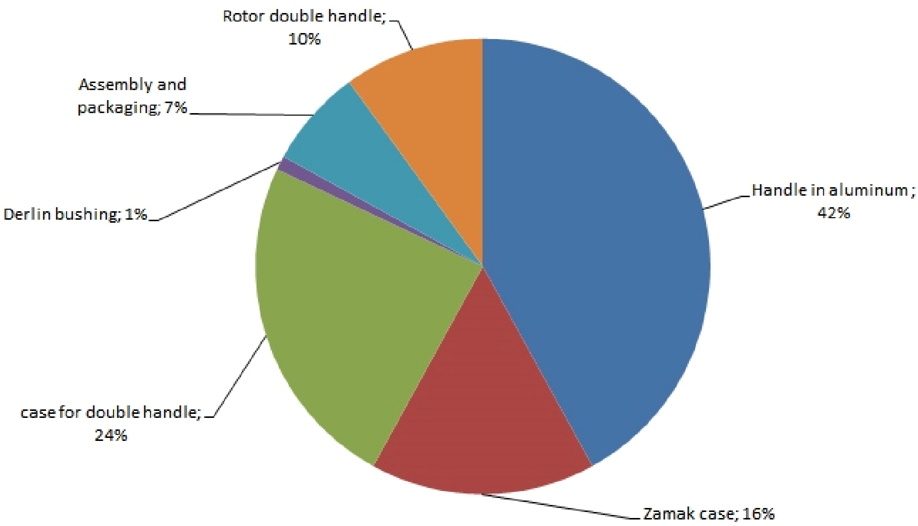


Fig. 1. The relevance of the processes in terms of GWP

MASTER

CONFORMITÀ DEL PRODOTTO CODICE □□□□□.□□ AI REQUISITI DEI CREDITI LEED
STANDARD LEED:
LEED Italia Nuove Costruzioni e Ristrutturazioni (NC – I)
LEED 2009 for New Construction and Major Renovation (NC – US)

CREDITO	PUNTEGGIO MASSIMO
MRc4 – Contenuto di riciclato (NC – I) MRc4 – Recycled content (NC – US)	1-2 punti
MRc5 – Materiali estratti, lavorati e prodotti a distanza limitata (materiali regionali) (NC – I) MRc5 – Regional Materials (NC – US)	1-2 punti
IPc1 – Innovazione nella progettazione (NC – I) IDc1 – Innovation in design (NC – US)	1 punto

Fig. 2. The label on the packaging

4. Concludig remarks

The LCA is useful to define the environmental profile of the product, but it is important to know that the environmental quality of the products does not necessarily mean eco-efficiency of the product in the building (Campioli et al., 2007).

The performances of the building and its components depend on climate, place, and type of use. The performance of the components changes depends on the role of the components in the building. Therefore, to give value to the LCA methodology the building sector we should start to insert the life cycle analysis in the energy efficiency certification schemes.

Besides, it is important to inform the consumer about the environmental performances of the product on the packaging in order to facilitate their use in projects spreading environmental sustainability certification for buildings.

Acknowledgements

The authors would like to thank the Master srl for technical data kindly offered.

References

Campioli A, Lavagna M, (2007), *Life Cycle Design in Building and Construction Sector,* 3rd International Conference on Life Cycle Management, From analysis to implementation, Zurich, Switzerland.

De Benedetto L, Klemeš J., (2009), The environmental performance strategy map: an integrated LCA approach to support the strategic decision-making process, *Journal of Cleaner Production,* **17**, 900-906.

EC Directive, (2009), Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009, establishing a framework for the setting of ecodesign requirements for energy-related products (recast), *Official Journal of the European Communities*, **L 285**/10, Brussels.

Ecoinvent, (2010), The Swiss Centre for Life Cycle Inventories. Ecoinvent V2.2.

Solomon S., Qin D., Manning M., Chen., Marquis M., Averyt K.B., Tignor M., Mille H.L., Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, *Eds. Cambridge University Press, Cambridge, United Kingdom and New York,* NY, USA. Errata were published in June 2012 http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-errata.pdf.

UNI EN ISO 14040, (2006), Environmental Management – Life Cycle Assessment – Principles and Framework, International Standard of Organization, Geneva.

UNI EN ISO 14044, (2006), Environmental Management – Life Cycle Assessment – Requirements and Guidelines, International Standard of Organization, Geneva.

Procedia
Environmental Science, Engineering and Management
http://www.procedia-esem.eu

Procedia Environmental Science, Engineering and Management **1** (2014) (2) 137-141

18th International Trade Fair of Material & Energy Recovery and Sustainable Development, ECOMONDO, 5th-8th November, 2014, Rimini, Italy

POZZI LEOPOLDO SRL: A CASE STUDY OF ETV "ENVIRONMENTAL TECHNOLOGY VERIFICATION "FOR RCR, THE ROTATING HEAT RECOVERY SYSTEM FOR POLLUTED EFFLUENTS*

Alberto Pozzi, Maria Antonella Leone**

BScH POZZI LEOPOLDO SRL, Via Paganini,14
I - 20825 Barlassina (MB)

Abstract

The paper evaluates the reasons behind the need of obtaining a verified performance claim according to the rules of the European Pilot Programme ETV – Environmental Technology Verification, supported by the European Commission – Climate Change & Environment. A brief explanation of the product RCR – a rotating heat recovery system for highly polluted effluents with certifications as best innovation and best practice granted by independent energy organizations in various European countries – and the analysis of the changing demands of the present market globally support the urgency of being environmentally certified in order to offer a reliable proof of the high-quality performance of this technology while being sustainably effective

Keywords: eco-innovation, energy, fouling, rotating heat exchanger

1. Introduction

The urgency to be verified by reliable programmes supporting and promoting eco-innovations and sustainable consumptions corresponds to the stronger and stronger demand for evaluation tools to certify the sustainability of products/processes both as a trustworthy parameter for investors in the industrial market worldwide and as an enabling tool for manufacturers.

---

*Selection and peer-review under responsibility of the ECOMONDO

**Corresponding author: e-mail: alberto.pozzi@pozzi.it

The ETV claim responds to the need of Customers to avail themselves of a proven sustainable technology. This is the case in countries like India, Bangladesh, Pakistan, China, and Indonesia, where companies are increasingly required to fit their energy consumption within certain parameters in order not to shut down or to be able to take advantage of particularly enticing benefits granted to those who effectively act towards a "greener" production, and where buyers from the Western world demand environmentally-aware production choices. Even locally, that is in Italy and in other European countries, where the so-called "White Certificates" are granted for every saved Ton of Oil Equivalent (TOE), ETV enables manufacturers to provide a reliable verification tool. RCR, a rotary heat exchanger with a long history of successful sale achievements as a valuable energy efficient tool, further distinguishes its performance thanks to the added value of certified energy saving and reduced thermal pollution as verified by the Environmental Technology Verification, an initiative under the Eco-Innovation Action Plan of the European Commission, Department of Climate Change and Environment.

2. RCR and ETV – A Case Study

2.1. What is RCR?

RCR (the acronym stands for rotating heat exchanger in Italian) is a heat recovery system intended to treat discharged dirty hot effluents (Fig. 1) and was invented in the early '80s when Europe experienced a deep energy crisis due to the high price and shortage of oil (Pozzi, 2014).

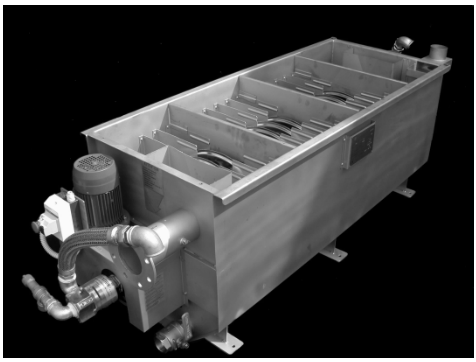


Fig. 1. RCR, Rotating Heat Exchanger

Contrary to all other existing heat exchangers (such as shell-and-tube or plate exchangers, for instance), RCR is dynamic, not static, and exactly the rotation of the shaft onto which the heat exchanging steel discs are mounted creates a turbulence and a centrifugal force which keep the unit self-cleaning, fouling-free and, practically, maintenance-free as well. These advantages result in a constantly highly efficient unit that guarantees averagely over 70% energy saving with no hustle.

In case of discharged water being processed, the recovered heat is transferred to fresh cold water that becomes pre-heated and used for the next production cycle, making it a very advantageous and profitable application in countries such as India, Pakistan, Bangladesh, China, Indonesia, where textile dye-houses work 3 shifts 24 hours a day, often encountering big problems as for how to get your fuel for energy production and where a stricter and stricter rule enforcement against pollution of all types is implemented, facing the risk of total shut down of the factory.

When analyzing on a graph the efficiency rate of standard types of exchangers working with mechanically polluted fluids, a line with the shape similar to a saw-tooth results from the variable heat recovering ability of the exchangers due to the accumulation of fouling (Fig. 2). When averaging this line, mean efficiency drops to lower than a mere 50%. At that point, the production process must be interrupted to perform adequate cleaning maintenance, which often brings about other nuisances such as changing gaskets that might break during the process of opening and closing the system, just to mention one. This does not happen with RCR, which typically keeps running, uninterruptedly, 24 hours a day, 365 days a year.

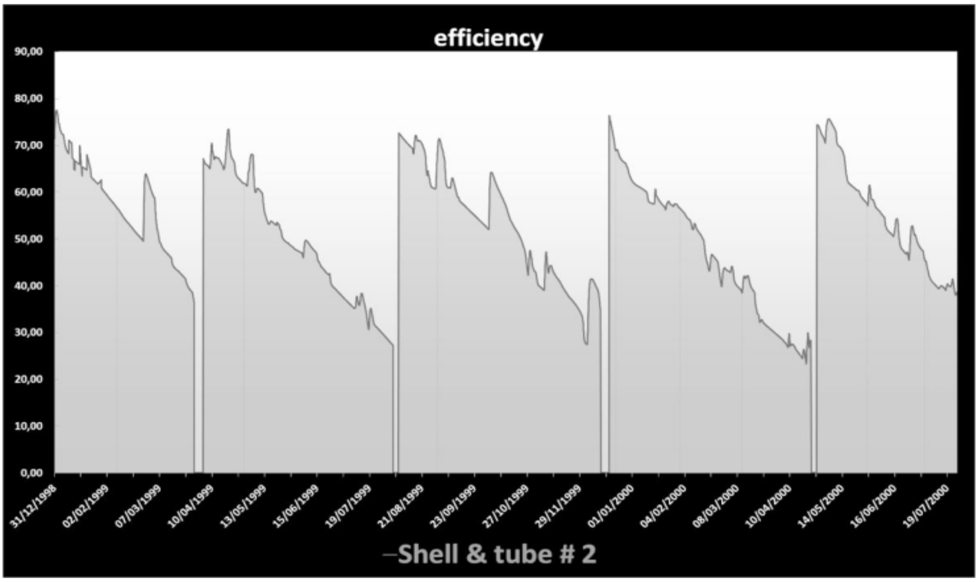


Fig. 2. Typical fouling effects on efficiency of static heat exchangers

2.2. A certified product history responding to nowadays' call for sustainability with another verification

One can safely state that RCR was "the" pioneer sustainable technology in textile industry and still proves unbeaten and winning approval and recognition as far as energy saving and efficiency are concerned, so much so that it is used in other industry fields, such as tank cleaning, food processing, tanneries, PET recycling and so on, that is wherever there is a discharge of hot and very dirty effluents which would certainly foul other types of exchanger.

RCR was patented and certified by various independent energy organizations in Italy (ENEA), France (Centre Textile de Mulhouse) and England (British Standard Best Practices) for its exceptional energy-saving performance and for its working reliability. Another way of certifying its high performance rate is acknowledging the various attempts to copy it in China, Turkey, the Netherlands, Egypt, to mention a few.

Although several thousand such units have already been sold in all continents and improvements have been added to RCR over the years in order to make it a renewed and mature product, what RCR was more recently lacking was the proof of what makes this heat recovery system really different from all others: this product is not affected by fouling and really allows for constantly efficient energy saving. This performance characteristic was not fully covered by existing certification standards. No one had ever thought of testing the resistance to fouling of a machine to certify its performance rating. ETV has allowed to pin point those parameters which could become a standard verification procedure in similar cases, emphasizing the added value represented by the fouling-free ability of RCR.

2.3. The EU ETV Programme

The EU-ETV Pilot Programme, operating as one of the initiatives under the Eco-Innovation Action Plan of the European Commission, set out to establish the foundations for a true European-level tool supporting and promoting eco-innovation, mainly in highly dynamic and innovative Small and Medium-sized Enterprises (SMEs). The programme is targeted at environmental technologies whose value cannot be proved through existent standards or certification schemes and whose claims could benefit from a credible verification procedure as a guarantee to investors (JRC, 2014)

The ETV pilot programme requires following adequate standards of quality. Organisations undertaking the verification of environmental technologies under the ETV pilot programme (Verification Bodies) shall be accredited by national accreditation bodies (EU ETV, 2014), using the ISO/IEC Standard 17020 for type A inspection bodies (ISO/IEC 17020, 1998). Analytical laboratories shall be accredited according to ISO/IEC 17025 (2005) (for the relevant methods of analysis (EU ETV, 2014).

3. Conclusions

What has really changed in the world over the years is the awareness towards the health of our planet in its various forms and the related demand for proven “green” technologies that effectively help responding to the more and more demanding needs of the present industrial society. Proven technology means independently certified technology. RCR environmental certification adventure started when POZZI LEOPOLDO found out that the “Green Label” provided to members of the Italian association of machinery manufacturers to which the Company belongs could not be easily granted to RCR, in spite of its pioneering sustainable contribution, because the same parameters normally used to endorse the energy efficiency of textile machines could not be adopted to certify the technology of RCR.

In this respect, ETV is a valuable tool helping Customers understand the significant addition towards sustainability which this product offers by proving its reliability in achieving specific results, such as lowering the thermal pollution of water, recovering heat and reducing the overall CO_2 emissions, doing so in the harshest of environments.

This being a pilot programme, it is not yet possible to exactly quantify all the benefits deriving from showing the ETV Verified Performance Claim. It is certain, however, that an independent verification of what makes a product or technology different from others on the market undoubtedly contributes effectively to easily convince a potential customer of the reliability of the verified product, having been endorsed at a European level and according to international standards. Seeing the trend of a more and more sustainability-conscious society, in an aggressive and competitive world market, this verification can smooth the way for trustworthy choices in terms of energy efficiency and “ever-green” eco-innovations like RCR.

References

EU ETV, (2014), *EU Environmental Technology Verification pilot programme - Paragraph A.1 of the General Verification Protocol Version 1.1 – July 7th, 2014*, On line at: http://iet.jrc.ec.europa.eu/etv/sites/etv/files/files/documents/GVP/etv_gvp_rev1_text.pdf

ISO/IEC 17020, (1998), General criteria for the operation of various types of bodies performing inspection, International Standardization Organization, Geneva, Switzerland.

ISO/IEC 17025, (2005), General requirements for the competence of testing and calibration laboratories, International Standardization Organization, Geneva, Switzerland.

JRC, (2014), *ETV Programme,* Joint Research Centre, Institute for Energy and Transport, On line at: http://iet.jrc.ec.europa.eu/etv/about-etv

Pozzi A., (2014), RCR vs Other Heat Recovery Systems: A Comparison between POZZI Rotary RCR and Other Types of Heat Exchanger, rev.2, copyright of POZZI LEOPOLDO SRL, On line at: https://www.dropbox.com/s/823rhk9bq82k5i1/RCR_vs_Other_Heat_Recovery_Systems.pdf

Procedia
Environmental Science, Engineering and Management
http://www.procedia-esem.eu

Procedia Environmental Science, Engineering and Management **1** (2014) (2) 143-147

18th International Trade Fair of Material & Energy Recovery and Sustainable Development, ECOMONDO, 5th-8th November, 2014, Rimini, Italy

WATER FOOTPRINT IN STRATEGIC WATER MANAGEMENT AT THE URBAN LEVEL: THE URBAN_WFTP EUROPEAN PROJECT*

Antonio Scipioni[1], Alessandro Manzardo[1], Andrea Loss[1], Valentina Rosa[1], Wiesław Fiałkiewicz[2], Stanisław Czaban[2], Anna Kolonko[3], Paweł Malinowski[3], Guenther Leonhardt[4], Wolfgang Rauch[4], Christin Haida[5], Katrin Schneider[5], Stefan Neuner, Katharina Wohlfart[6], Robert Schmidt[6], Marco Vigo[7], Donato Bedin[7], Andras Kis[8], Valéria Szabó[8]**

[1]CESQA University of Padua, Department of Industrial Engineering,
Via Marzolo 9, 35131 Padua, Italy
[2]Wroclaw University of Environmental and Life Sciences, Poland
[3]Municipal Water and Sewage Company S.A. in Wroclaw, Poland
[4]Unit for Environmental Engineering, University of Innsbruck, Austria
[5]AlpS GmbH, Austria
[6]Nuremberg Chamber of Commerce, Germany
[7]Fondazione Centro Produttività Veneto, Italy
[8]ENEREA, Észak-Alföldi Regionális Energia Ügynökség, Hungary

Abstract

This paper presents the first results of the project "Urban_WFTP: Introduction of Water Footprint Approach in Urban Area". Founded by the Central Europe Programme"; it started in 2012 and involved nine partners organizations from five European countries (Italy, Poland, Germany, Hungary, Austria). The project, grounding on the concept of the Water Footprint assessment, developed an innovative approach to support water management and best-practices adoption at urban level. This model has been successfully applied in three Central Europe cities. First results outlined the main water issues in the three test areas and set the basis to determine water use improvement plans.

Keywords: urban planning, water footprint, water management, water quality

---

[*]Selection and peer-review under responsibility of the ECOMONDO

[**]Corresponding author: scipioni@unipd.it

1. Introduction

In recent years world population growth and economic development have put a lot of stress on the availability of natural resources for present and future generations (Bates et al., 2008; El Ghonemy, 2012). Among these, water is currently at the centre of international debate. The main concerns are related to the fact that water, even if renewable, is present in a limited quantity on earth. As a consequence a growing number of countries are dealing with the issue of water scarcity and have limited access to good qualitative water resources (UN, 2005; EU, 2012). Also in Europe there are evidences of this significant issue; recent estimates show that 10% of the European population and the 20% of the territory are suffering of the consequences of limited water availability. Considering that 75% of European citizens live in cities, the management of this resource at urban level is recognized to be a priority (EU, 2011).

To address the social, economic and environmental issues related to water, the European Union in 2011 launched a policy document titled “Roadmap to a Resource Efficient Europe” (EU, 2011) and identified the need to apply innovative scientific approaches to guarantee the correct management of local water resources. One of these tools is the Water Footprint (WF) assessment (Hoekstra et al., 2011). This method, developed starting from the concept of virtual water of Allan (1997), has been presented by Hoekstra et al. (2011) and has been widely applied to determine the appropriation of water resources of populations and industrial processes (Mazzi et al., 2014). However no experiences of the application of such method at urban level can be identified. Main reasons are recognized to be the limited data availability (Hoekstra et al., 2011).

2. Objectives

In this context take place the project titled “Urban_WFTP: Introduction of Water Footprint Approach in Urban Area”. Founded within the central Europe Programme, it started in 2012 and involves 9 partners from 5 European Countries. The objective of the project is to develop a central Europe common approach to guarantee better water use and management at urban level. The objective of the research presented in this paper, is to verify if the Water Footprint Assessment method can be applied at urban level and if it can support the identification of local water management hot-spots.

3. Outline of the work

The activities presented in this paper, took place within work package three of the mentioned Central Europe projects that is named “Water use and management” baseline assessment according to Water Footprint approach and sharing of results among partners. The work presented in this paper is structured in two parts: adaptation of the water footprint approach at urban level and its application in three test area: Vicenza in Italy, Innsbruck in Austria and Wroclaw in Poland.

4. Materials and methods

The WF according to Hoekstra et al. (2011) is defined as a multi dimension indicator that measure freshwater use showing water consumption volumes by source and polluted volumes by type of pollution.

Three components can be identified: the blue water footprint, related to the ground and surface water consumption, the green water footprint, related to green water consumption and grey water, defined as a measure of water pollution characterized through a dilution approach.

To allow the application of such method at urban level it was decided to develop a multilevel approach in order to meet the data availability of the different cities involved in the project (Fiałkiewicz et al. 2014). As a result 4 models were determined. The first model (Model A) represents the most simplified approach and supports a first assessment: it considers the urban areas as a black box and provides the calculation with an input-output approach. The second model (Model B) is focused on the optimization of the urban water cycle: it considers the contributions of the different urban surfaces to the total urban WF and it allows the geo-localized calculation through the integration of the GIS technology. The third model (Model C) allows assessing the results of the total WF in function of different water saving technologies: it assess the contribution to the total WF of different types of buildings, structures and of different citizen behaviours. The fourth model (Virtual Water) is applied in a transversal way to the previous models and it allows assessing the entity of the Virtual Water flux generated by the product consumption of citizens.

Green and grey water indicators were applied as determined by Hoekstra et al. (2011), Blue water definition was integrated to include evaporation from impervious surfaces (such as roads, car parks, roofs etc.) that characterize the urban area.

To verify the applicability of the proposed approach it was decided to apply model A in each of the three test area and then to run pilot applications of the other different models according to data availability and specific management needs (Table 1). In the assessment arable areas were excluded because not considered within urbanized boundaries.

Table 1. Pilot applications

Position	*Management Needs*	*Model pilot application*
Wroclaw	Optimization of overall urban water cycle including emergency events (e.g. flooding)	B
Vicenza	Develop new requirements to support urban regulation and development	C
Innsbruck	Make people aware of their indirect water use	Virtual Water

5. Results and discussion

All the different models have been successfully applied in the different cities. Application of model A outlined some main water management hotspots that negatively affect water footprint indicators; for example in the case of Vicenza the main issue that emerged were the significant volumes of runoff water that influence the value of blue and grey water and the contribution of wastewater pollutant concentrations to the final water footprint.

In the case of Innsbruck model A supported the small relevance of real water fluxes management and therefore supported the importance of working on Virtual Water; in the case of Wroclaw application of model A confirmed water management issues such as risk of flooding due to the overbuilt city centre and also the loads of nutrients that influence grey water indicator.

Model B was successfully applied in Wroclaw and allowed to spatially identify where in the urban area the different water footprint indicators are higher; this knowledge allows a better understanding of priority actions and interventions plan to improve water management.

Model C was successfully applied in Vicenza. In this case results were able to outline the importance to improve rainwater management.

In fact such volumes are only partially managed and result in lower efficiency of the wastewater treatment in the city and therefore high grey water values. Virtual Water was applied in the city of Innsbruck and served as basis to plan training activities for citizen and schools.

The results of this application have been used as a baseline to determine water management improvement plan in the three test cities of Vicenza, Innsbruck and Wroclaw. Based on the outcomes of these pilot applications it was possible to produce a WF central Europe common approach to be applied in different local contexts.

The adoption of a multilevel approach resulted to be effective in the analysis of the water footprint of the different cities. Such a solution in fact allowed to answer specific needs of the cities understudy and allowed also to better analyze the main water management hot-spots emerged during the application of model A.

The choice of adopting a multilevel approach allowed also giving flexibility to the application of the WF according to different data availability. During the application of the different models also some key methodological points emerged: to support a better understanding of water management issue the model should not include only the blue, green and grey water footprints but also other indicators such as water withdrawals or specific characteristics of the city and extensions of impervious surfaces. It has to be noted that arable area (agriculture) was excluded from the assessment; as a consequence green water footprint results volumes are less significant.

6. Concluding remarks

This paper presents the first results of the project "Urban_WFTP: Introduction of Water Footprint Approach in Urban Area" that addresses water management in urban areas through the application of the WF assessment.

Through the adoption of a multi-level model it was possible to adapt and apply WF at urban level and to identify water use and management hotspots under different data availability conditions.

Project activities are now focused on the implementation of local improvement plans. Future development of the research could focus on the application of water impact assessment according to recent published references such as ISO 14046 (2014).

Acknowledgements

The funding of the URBAN_WFTP project by the European Regional Development Fund through CENTRAL EUROPE programme is gratefully acknowledged.

References

Allan J.A. (1997), *Virtual Water: A Long Term Solution for Water Short Middle Eastern Economies*?, Paper presented at the 1997 British Association Festival of Science, University of Leeds, 9 September , Leeds, UK.

Bates B.C., Kundzewicz Z.W., Wu S., Palutikof J.P., Eds., (2008), Climate Change and Water, Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, On line at: http://www.ipcc.ch/pdf/technical-papers/climate-change-water-en.pdf.

El-Ghonemy A.M.K., (2012), Future sustainable water desalination technologies for the Saudi Arabia: A review, *Renewable and Sustainable Energy Reviews,* **16**, 6566–6597.

EU, (2011), Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Roadmap to a Resource Efficient Europe, COM(2011) 571 final, Brussels, On line at: http://ec.europa.eu/environment/resource_efficiency/pdf/com2011_571.pdf.

EU, (2012), Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Report on the Review of the European Water Scarcity and Droughts Policy, COM(2012) 672 final, On line at: http://ec.europa.eu/environment/water/quantity/pdf/COM-2012-672final-EN.pdf.

Fiałkiewicz W., Czaban S., Kolonko S., Konieczny T., Malinowski P., Manzardo A., Loss A., Scipioni A., Leonhardt G., Rauch W., Haida C., Schneider K., Wohlfart K., Schmidt R., Chilò L., D., András Kis K. (2014), *Water Footprint as a New Approach to Water Management in the Urban Areas*, In: Water Supply and Water Quality, Dymaczewski Z., Jeż-Walkowiak J., Nowak M. (Eds.), PZITS, Poznań, 431-439.

Hoekstra A.Y., Chapagain A.K., Aldaya M.M., Mekonen M.M., (2011), *The Water Footprint Assessment Manual. Setting the Global Standard,* EarthScan, London, Washington DC.

ISO 14046, (2014), Water footprint - Principles, requirements and guidelines, International Organization for Standardization, Geneve, On line at: http://www.bsigroup.com/en-IN/ISO-14046-Water-footprint/.

Mazzi A., Manzardo A., Scipioni A., (2014), *Water Footprint to Support Environmental Management: An Overview,* In: *Pathways to Environmental Sustainability: Methodologies and Experience,* Salomone R., Saija G. (Eds), Springer International Publishing AG, Cham.

UN, (2005), Millenium development goals, On line at: http://www.un.org/millenniumgoals/.

Procedia
Environmental Science, Engineering and Management
http://www.procedia-esem.eu

Procedia Environmental Science, Engineering and Management **1** (2014) (2) 149-153

18th International Trade Fair of Material & Energy Recovery and Sustainable Development, ECOMONDO, 5th-8th November, 2014, Rimini, Italy

ECO-EFFICIENT MANAGEMENT OF CONSTRUCTION AND DEMOLITION WASTE*

Isabela Maria Simion[1], Sara Zanni[2], Silvia Bamonti[2], Alessandra Bonoli[2], Maria Gavrilescu[1,3], Maria Chiara Bignozzi[2]**

[1]"Gheorghe Asachi" Technical University of Iasi, Faculty of Chemical Engineering and Environmental Protection, Department of Environmental Engineering and Management, 73 Prof.Dr. docent Dimitrie Mangeron Street, Iasi 700050, Romania
[2]University "Alma Mater Studiorum" Bologna, DICAM - Department of Civil, Chemical, Evironmental and Materials Engineering, 28 Terracini Street, 40131 Bologna, Italy
[3]Academy of Romanian Scientists, 54 Splaiul Independentei, RO-050094 Bucharest, Romania

Abstract

This study is focused on the analysis and evaluation of environmental impacts generated by construction and demolition waste (C&DW) in Europe. The presence of this type of special waste in the environment became an important issue in the world in the last years, while it accounts for about 25% - 30% of the whole quantity of waste produced in the EU.
In order to evaluate some specific features of current and future circumstances of C&DW management we proposed and assessed various management scenarios, considering both actual C&DW management systems in two European countries: Italy and Romania, as well as future potential to reduce the environmental impact of C&DW together with the consumption of natural resources. All scenarios were evaluated in terms of various environmental impact categories based on Life Cycle Analysis methodology, assisted by GaBi and SimaPro software, so as to establish the most suitable and eco-efficient scenario for implementation in both countries.

Keywords: environmental impact, LCA, recovery, special waste

*Selection and peer-review under responsibility of the ECOMONDO
** Corresponding author: e-mail: tissabela@yahoo.com; mgav_ro@tuiasi.ro

1. Introduction

The growth of waste generation rates is an important issue in the whole world. In this context the recycling of the valuable components from waste is among the most sustainable options implemented so as to establish a balanced world system. According to Waste Framework Directive (WFD) one of the key issues of a continuous progress related to eco-efficient waste management consists in ensuring the sustainable management of prevention, control and remediation processes relative to the environmental components, associated in particular to waste minimization and valorization, according to waste management hierarchy. Waste management hierarchy comprises the most and less favorable options for waste management (Ghinea and Gavrilescu, 2010). Recycling prevents the emissions of gases (GHG), water pollutants, conserves resources and stimulates the development of clean technologies. Energy recovery, known also as waste-to-energy, is carried out through the conversion of non-recyclable waste into fuel, electricity, heat etc. Unfortunately, materials resulting from construction and demolition are often considered as waste for disposal, rather than resources for processing and reuse (Simion et al., 2013). They have negative impacts on environment, economy, public health and social life (SARMA, 2011).

2. Objectives

The main objective of this study is to analyze the environmental sustainability for the current construction and demolition waste management system in the two locations selected for the study: Iasi and Bologna, based on environmental impact indicators, and to propose and asses the sustainability of some C&DW management scenarios as potential alternatives to the actual system.

In this context, four different scenarios were proposed for the management of C&DW: the current waste management system for each country and scenarios which include various options according to waste management hierarchy in both countries (temporary storage, collection and transport, sorting with recycling of metals and glass, landfilling with leachate treatment).

3. Outline of the work

This work is divided in three main parts:

- selection of case studies: Iasi County, in Eastern Romania (Iasi City), and Emilia Romagna region in Northern Italy (Bologna city) and data collection regarding the amount of *C&DW* generated and managed for each country;
- evaluation of the current waste management systems in the selected locations using sustainability indicators derived from Life Cycle Analysis and comparison of the results in terms of environmental impact categories and size; development of *C&DW* management scenarios and assessment of their environmental sustainability, considering similar waste composition and quantities;
- analysis of results, drawing conclusion and formulation of recommendations for policy and decision makers in the sector of C&DW.

4. Materials and methods

The assessment of environmental impacts of C&DW management scenarios is carried out for each location taken in analysis, using methodologies proposed by Ecoinvent database, specific to the selected software (GaBi and SimaPro).

GaBi software supports every stage of an LCA, starting with data collection and the organization of results to be presented and for the stakeholder engagement (PE International, 2011). SimaPro software was developed in the nineties (1990) for LCA process only, to facilitate the quantification of the environmental impact of a product's life-cycle and since then, it has been used by many companies worldwide and it has been the market–leading life cycle solution all over the world (Goedkoop, 2006; Kerkhof and Goedkoop, 2010).

GaBi and SimaPro tools use the same methodology for translating an emission into an environmental impact and comply with the ISO requirements for LC. Assuming that the goal and scope of both programmers are similar, the results of an LCA performed with GaBi are therefore compatible with those in SimaPro.

We planned the analysis of sustainability of C&DW waste management scenarios, identifying the purpose of the study, and the issues to be solved, meaning the direction of the study and the benchmarks (PE International, 2011).

5. Results and discussion

This paper presents an important study regarding the environmental impact of construction and demolition waste throughout the LCA methodology following his phases: goal and scope definition, inventory analysis, impact assessment and interpretation (JRC European Commission, 2011). In this context, we established the functional unit to be the total amount of construction and demolition waste generated in Iasi and Bologna in 2009.

For the evaluation of the impact on the environment of *C&DW*, we have established also the composition of this special waste. The impact is generated by the each component of certain type of waste. However, *C&DW* has a very inconsistent composition according to local building techniques, climate, economic activities, and technological development in the area, available raw materials (Table 1).

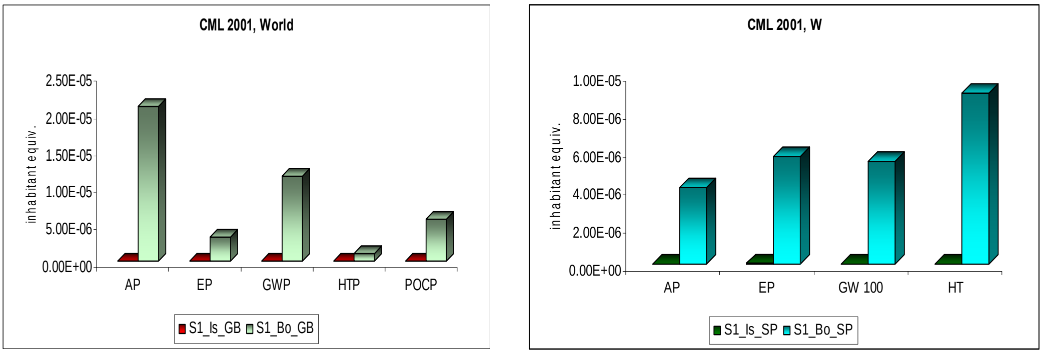
Table 1. Compositions of C&DW in Europe (EPA, 2002)

Material	***Percentage of total fill (%)***
Concrete	20-50
Bricks	5-20
Timber	5-20
Steel	5-15
Soil	15-70
Green Waste	5-20
Plastic	5

In this study, we applied six methodologies for data processing with each software tool used. The results were normalized in accordance with each software database as to can be compared. The evaluation of the four scenarios proposed indicated the most suitable scenario to be implemented for improving the actual waste management system. In Fig. 1 it can be observed the impact of *scenario 1*, scenario that comprises temporary storage, collection and transport and landfilling, for each country from this study, taking into account the same methodologie CML 2001.

After using GaBi software the comparison of environmental impacts of current *C&DW* management systems in Iasi and Bologna according to CML method indicates that the most important environmental indicators are: acidification potential (AP) and global warming (GW), indicated by the amount of nitrogen oxides, sulfur dioxide and carbon dioxide released into the production phase of construction materials and the use of constructions.

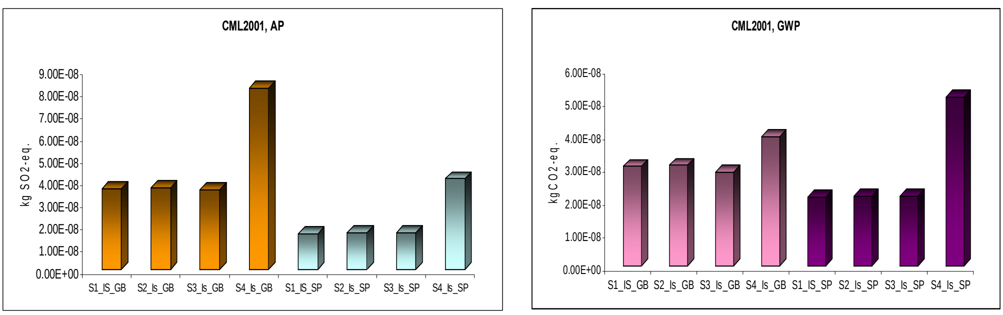
In the case of developing SimaPro software it can be observed that *scenario 1* developed for Bologna city has a major impact on the environment. The negative impact can be explained by the composition and the higher amount of *C&DW* in Italy, and by the specific of *scenario 1* that, at this point does not reduce the amount of this waste. The impact indicators that have the highest impact are the potential for eutrophication in Iasi and human toxicity potential for the city of Bologna, noted that the differences between the indicators are lower.



a) b)

Fig. 1. Comparison of environmental impacts of current *C&DW* management systems in Iasi and Bologna: a) GaBi software and b) SimaPro software

Fig. 2 illustrates the differences between the results after the evaluation of the proposed scenarios with GaBi and SimaPro software. It can be observed that they indicate a negative impact for all indicators. Irrespective of the software applied in data processing, after the evaluation of the results with both tools, it was found that *scenario 3*, which includes: temporary storage, collection and transport, sorting with recycling of metals and glass, landfill and leachate treatment could be considered as the most suitable scenario for *C&DW* management system from the environmental point of view.



a) b)

Fig. 2. Environmental impact for the same scenario with GaBi and SimaPro software, with method CML2001: a) acidification Potential; b) global warming potential

6. Concluding remarks

The evaluation of sustainability using environmental impact indicators derived from LCA has been performed for construction and demolition waste management systems in two European areas: Iasi city from Iasi County, Romania and Bologna from Emilia Romagna Region in Italy.

The LCA methodology was applied considering four scenarios: *scenario 1 (S1)*, describing the situation of C&DW management in Romania and Italy in 2009 (current, reference scenario) and new developed management scenarios, for both cities, *scenarios 2-4* (S2-S4).

Depending on the methodology and indicators selected, the value of some impact could be different. The differences come due to the presence of incineration together with collection and transport of C&DW as unitary processes in some management scenarios, which demonstrate a major impact when SimaPro software is used for data processing.

For the reduction of C&DW impact in the environment, an improvement of the eco-efficiency of the existing waste management system is essential.

Acknowledgements
This paper was elaborated with the support of a grant of the Romanian National Authority for Scientific Research, CNCS – UEFISCDI, project number PN-II-ID-PCE-2011-3-0559, Contract 265/2011.

References

EPA, (2002), *Construction and Demolition Waste*, Waste Management and Resource Use Opportunities, Queensland Environmental Protection Agency.

Ghinea C., Gavrilescu M., (2010), Decision support models for solid waste management – an overview, *Environmental Engineering and Management Journal*, **9**, 869-880.

Goedkoop M., (2006), *SimaPro 7 Demo Manual*, PRé Consultants, The Netherlands.

JRC European Commission, (2011), *Supporting Environmentally Sound Decisions for Construction and Demolition (C&D) Waste Management*, A practical guide to Life Cycle Thinking (LCT) and Life Cycle Assessment (LCA), On line at: http://lct.jrc.ec.europa.eu/pdf-directory/ReqNo-JRC65850-LB-NA-24916-EN-N.pdf.

Kerkhof A.C., Goedkoop M.J., (2010), *The Application of Input-Output Analysis and Hybrid Analysis in SimaPro LCA Software*, In: *The Sustainability Practitioner's Guide to Input-Output Analysis,* Murray J., Wood R. (Eds.), Common Ground Publishing LLC, 145-151.

PE International, (2011), *Handbook for Life Cycle Assessment (LCA) using the GaBi Education Software Package*, Stuttgart, Germany.

SARMA, (2011), *The Production of Recycled Aggregates from Inert Waste*, Bressi G., Volpe G., Pavesi E. (Eds.), Tecnitalia Consultants, Milan, Italy.

Simion I.M., Fortuna M.E., Bonoli A., Gavrilescu M., (2013), Comparing environmental impacts of natural inert and recycled construction and demolition waste processing using LCA, *Journal of Environmental Engineering and Landscape Management,* **21**, 273-287.

Procedia
Environmental Science, Engineering and Management
http://www.procedia-esem.eu

Procedia Environmental Science, Engineering and Management **1** (2014) (2) 155-160

18th International Trade Fair of Material & Energy Recovery and Sustainable Development, ECOMONDO, 5th-8th November, 2014, Rimini, Italy

CONSTRUCTION & DEMOLITION WASTE: A COMPARATIVE CASE STUDY TOWARD ECO-DESIGNED CONCRETE*

Sara Zanni[1], Isabela Maria Simion[2], Silvia Bamonti[1], Alessandra Bonoli[1], Maria Gavrilescu[2,3], Maria Chiara Bignozzi[1]**

[1]DICAM - Department of Civil, Chemical, Evironmental and Materials Engineering, 28 Terracini street, 40131 Bologna, Italy
[2]"Gheorghe Asachi" Technical University of Iasi, Faculty of Chemical Engineering and Environmental Protection, 73 Prof. Dr. docent Dimitrie Mangeron Street, Iasi 700050, Romania
[3]Academy of Romanian Scientists, 54 Splaiul Independentei, RO-050094 Bucharest, Romania

Abstract

Construction and demolition wastes (CDW) represent a large amount of the total special waste produced in Europe. The last EU directive for waste management (98/2008/CE) suggest an objective of the 70% at least by 2020 for CDW recycling: innovative reuse and recycling solutions represent a challenging field inside the "end of waste" perspective promoted in Europe. This research has been carried out on concrete recycling, testing several kind of CDW, evaluating their recycling performances both by technical and environmental point of view. A comparative LCA study of concrete with aggregates and cement replacement has been performed to identify the most suitable recipe toward sustainability.

Keywords: building materials, CDW, concrete, LCA, recycling, solid waste, sustainability

1. Introduction

Construction and demolition wastes (CDW) accounts for about 10-30% of the controlled waste in EU (i.e. 1 billion tones in EU27, which means about 180 million tonnes

---

*Selection and peer-review under responsibility of the ECOMONDO
**Corresponding author: e-mail: sara.zanni7@unibo.it

per year, ISPRA, 2012), representing a challenging field of application for reduction and reuse solutions, since, at a global level, 60% of the raw materials extracted from the lithosphere are used for civil works and building construction. In the present scenario of CDW management, about 28% is recycled, while the rest of 72% is disposed (Bressi and Puia, 2000; EPA, 2002; Pittalis , 2009; Poon, 2007; Simion, 2013). The Bologna background study of construction and demolition wastes management system, in a sustainability perspective, has lead to conclude that the most suitable scenario for CDW treatment would include temporary storage, collection and transport, sorting with recycling of some specific wastes, landfill and leachate treatment (Simion, 2013).

2. Objectives

The aim of the work is to test the environmental suitability of different CDW, once their technical performance has been tested, to be implemented in sustainable recipe for foundation concrete, the reduction of natural resources exploitation and rationalization of energy and water consumption.

3. Outline of the work

Provided that the market requires a profitable recycling outcome identified for CDW in order to implement the desirable scenario of CDW management, the present study, performed in partnership with a Bologna mining company, focused on the possibilities offered in concrete production by the recycling of CDW as replacement for natural aggregates as well as identifying suitable replacement for cement among different kind of wastes, interesting for the high availability or intrinsic environmental risk of their disposal. On this basis, several productive opportunities, outlined and verified for their technical performance, have been examined, through LCA, to prove their contribution toward concrete production sustainability and CDW recycling.

4. Materials and methods

Focusing on waste reduction, an eco-design of building materials has been studied following the ideal supply chain from demolition (which represents the end of the first life of concrete) to new construction sites (the beginning of a second life) through a virtuous case study provided by Concave, a quarry company settled in Bologna which partnered the study. The common purpose was to find suitable replacement for both natural aggregates and cement, both regarded as environmental concern: the former for their non-renewable nature and potential hydrogeological impact, the latter for the relevant impact generated during its production phase.

Natural aggregates have been substituted with different percentage of construction and demolition wastes collected, sorted and treated in the Bologna's surroundings, while ceramic wastes and flying ashes from waste incineration were validated as suitable replacement for cement. Six different concrete recipes, selected as the most suitable ones deriving from mechanical performance tests, were proposed and evaluated with LCA, performed accordingly to ISO 14040 and 14044 standard (ISO, 2006a, b).

A comparative LCA study has been performed with the application of Simapro software and Impact 2002+ was chosen as methodology in order to obtain a comprehensive impact assessment, combining midpoint impact categories and endpoint damage evaluation.

System boundaries were outlined in a *cradle-to-gate* perspective, taking into consideration from raw materials, both primary and secondary (i.e. CDW, ceramic scraps and fly ashes), to the distribution of the finished product (Fig. 1).

Table 1. Different concrete recipes evaluated in the present study. Mix1= traditional commercial concrete; Mix2= commercial concrete with partial replacement of cement with fly ashes from waste incineration; R15= concrete with 15% replacement of natural aggregates with CDW; R25= concrete with 25% replacement of natural aggregates with CDW; CS= concrete with 25%natural aggregates replacement with C&DW and partial replacement of cement with ceramic scraps; FA= concrete with 25%natural aggregates replacement with C&DW and partial replacement of cement with fly ashes from waste incineration

	Mix 1	*Mix 2*	*R15*	*R25*	*CS*	*FA*
natural aggregates	100%	100%	85%	75%	75%	75%
CDW aggregates	0	0	15%	25%	25%	25%
cement	100%	83%	100%	100%	78%	78%
filler	0	17%	0	0	22%	22%

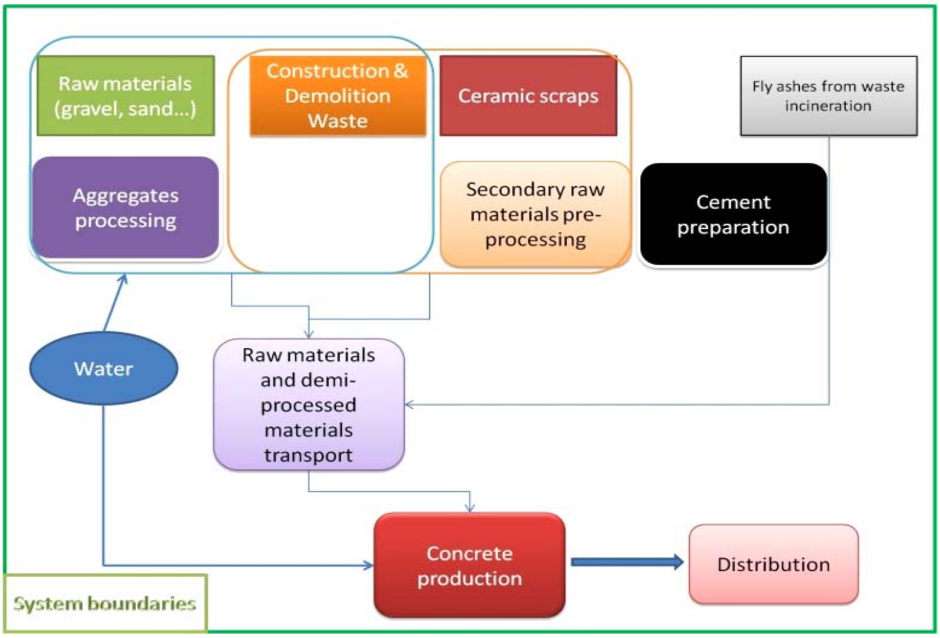


Fig. 1. LCA: System boundaries

The functional unit which the LCA was based on is 1 m^3 of finished product (i.e. 1 m^3 of foundation concrete ready for pouring). The processing phase of natural aggregates was modeled basing on specific energy consumption data collected on Concave's plant, as well as CDW processing, while average EU inventory data have been used for outsourcing product, such as cement. For the fluidizer additive, EPD provided by the supplier was implemented, fitting it to the case-study necessity.

A key step of the study has been the tentative modeling of the CDW use as raw materials in the concrete production process: since Simapro software does not accept waste materials as input for production process, a Chinese boxes procedure has been applied in order to make the software elaborate CDW and ceramic scraps management, collection, sorting and processing in a chain of subsequent steps, considering the avoided impact generated by the avoided landfilling phase for the secondary raw materials and the avoided exploitation of natural resources and energy consumption for aggregates processing as well as cement production.

5. Results and discussion

The first intermediate step of the LCA evaluation has been identified comparing the environmental impact of natural and CDW aggregates processing, reported in Fig. 2. The negative impact due to natural resource exploitation emerges clearly through indirect indicators, which are *ecosystem quality* and *human health*, while the apparently direct damage category *resources*, draws attention to a limit of the calculation method applied, which is the large predominance of non-renewable energy consumption over mineral extraction.

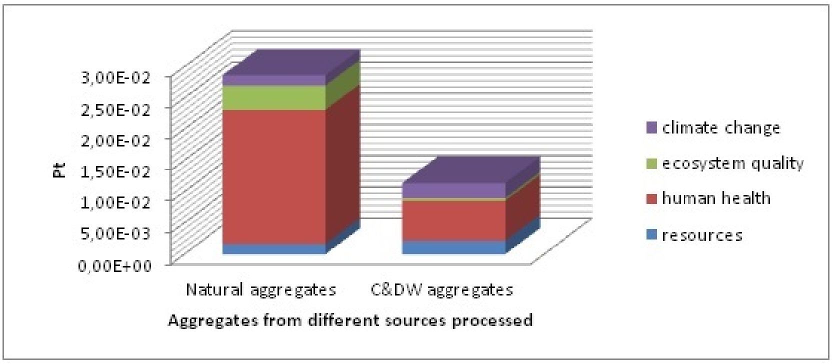


Fig. 2. LCA results: Impact attributed to processing of 1 ton of aggregates of natural origin and from CDW

Focusing, then, on the concrete production, the comparison among the six recipes proposed has returned results identifying the replacement of cement as crucial factor for climate change damage reduction, since only 13% of damage reduction is to be attributed to CDW replacement in R15 and 1% reduction is obtained by a 10% additional replacement of natural aggregates with CDW form R15 to R25 concrete. On the other hand, a 17% replacement of cement with fly ashes in commercial foundation concrete granted a 25% abatement of the climate change damage indicator in Mix 2 (Fig. 3).

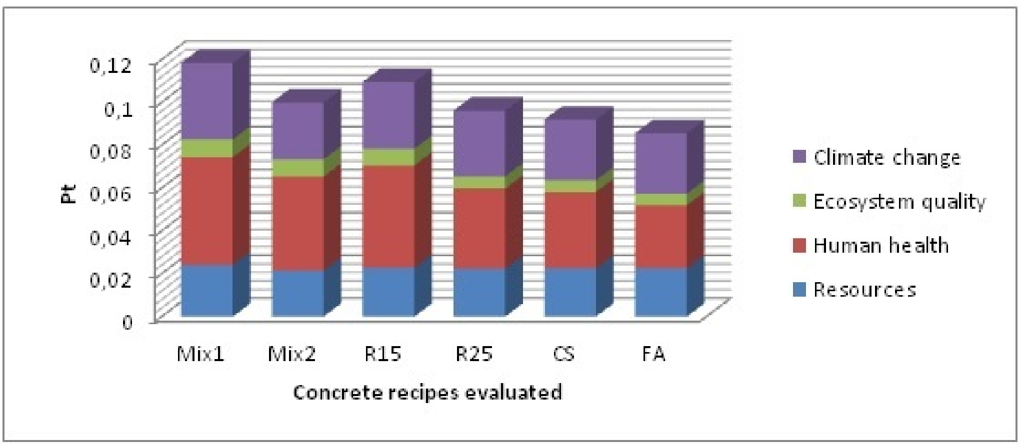


Fig. 3. LCA results: Impact attributed to manufacturing 1 m^3 of concrete from different recipes

This can be attributed to intrinsic problems manufacture of cement has in the large quantities of $CO_2$and NO_x emitted because of the massive amount of limestone used and the high processing temperatures (Satis, 1997). The environmental improvement due to cement replacement confirmed Lund University's conclusions (Sjunnesson, 2005), which identified cement production as the main contributor to raw materials impact, even thought more efficient technologies and use of renewable energy sources decreased sensibly its environmental impact during the last twenty years.

The human health damage indicator, in particular, stressed the improvement potentially introduced with the use of a more sustainable foundation concrete (Fig.4) in a perspective of great interest for decision and policy makers, since it takes into consideration both carcinogenic and non-carcinogenic effect.

In this case, a two-ways sustainable concrete (with replacement of both natural aggregates and cement) affects the human health damage indicator, decreasing it by more than 40%: this can be attributed to calculation method, considering respiratory effects caused by inorganic substances emitted into air (Humbert et al., 2012) and promoting the choice of fly ashes from waste incineration as filler and cement replacement, partially due to the avoided impact of their disposal as special waste.

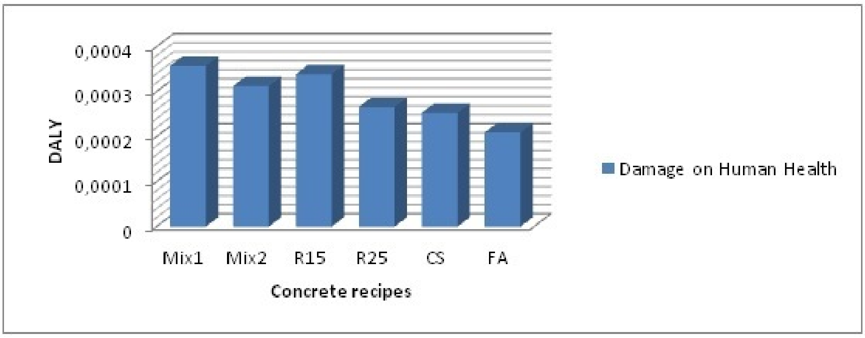


Fig. 4. LCA results: Damage evaluation for human health due to different concrete recipes proposed

6. Concluding remarks

Life Cycle Assessment has proven to be an effective mean of comparison among different opportunities in concrete recipes, presenting replacement for natural aggregates (CDW) and cement (ceramic scraps or fly ashes). The application of Simapro software as LCA tool proved to be not immediate due to difficulties in letting the second life of CDW emerge properly. Nevertheless, the procedure returned encouraging results about environmental performance of sustainable concretes with peculiarity related to the specific replacement elements, proving that materials destined to become special wastes (such as flying ashes) can represent a win-win solution for both construction and waste management industry.

Acknowledgements

The Authors wish to thank CONCAVE (Bologna, Italy), manufacturer of recycled products by CDW treatment, for technical data providing and cooperation.

References

Bressi G., Puia P., (2000), Aggregates from recycling: logistics and environmental issues in the economic evaluation of their use, Report, Magenta, Milano, 30 November 2000 (in Italian).

EPA, (2002), Construction and Demolition Waste, Waste Management and Resource Use Opportunities, Queensland Environmental Protection Agency.

Humbert S. et al. (2012), *Impact 2002+ User Guide*, Quantis sustainability counts.

ISO, (2006a), *Environmental management – Life cycle assessment – Principles and framework (ISO 14040: 2006*), European Standard EN ISO 14040, The International Organization for Standardization, Geneva, Switzerland.

ISO, (2006b), *Environmental management – Life cycle assessment – Requirements and Guidelines (ISO 14044: 2006*), European Standard EN ISO 14040, The International Organization for Standardization, Geneva, Switzerland.

ISPRA, (2012), *Waste Report*, Edition 2011, Institute for the Protection and Environmental Research.

Pittalis C., (2009), *Inert waste from C&D: technologies for recycling and application of LCA methodology for the production of stabilized inert 0/30 mm*, PhD Thesis, Alma Mater Studiorum University of Bologna, Italy.

Poon C.S., (2007), Management of construction and demolition waste, *Waste Management*, **27**, 159-160.

Satis C., (1997), *Waste materials used in concrete manufacturing,* Division of Concrete Structures Chalmers University of Technology, Goteborg, Sweden. Ed.Noyes Publication, Westwood, NJ USA.

Simion I.M., (2013*), Sustainability indicators in solid waste management*, *PhD. Thesis,* Technical University of Iasi, Faculty of Chemical Engineering and Environmental Protection, Iasi, Romania.

Sjunnesson J., (2005), *Life Cycle Assessment of Concrete, Master thesis,* Lund University - Department of Technology and Society, Environmental and Energy Systems Studies.

Procedia

Environmental Science, Engineering and Management

http://www.procedia-esem.eu

Procedia Environmental Science, Engineering and Management **1** (2014) (2) 161-165

18th International Trade Fair of Material & Energy Recovery and Sustainable Development, ECOMONDO, 5th-8th November, 2014, Rimini, Italy

ECOINNOVATION3 - Pathways and tools for disseminating

TRANSITION THINKING SUPPORTING SYSTEM INNOVATION TOWARDS SUSTAINABLE UNIVERSITY: EXPERIENCES FROM THE EUROPEAN PROGRAMME CLIMATE-KIC[*]

Francesca Cappellaro[1,2], Alessandra Bonoli[1]**

[1]DICAM Department of Civil, Chemical, Environmental and Materials Engineering, University of Bologna, via Terracini 28, 40138, Bologna Italy

[2]ENEA Italian National Agency for New Technologies, Energy and Sustainable Economic Development, UTVALAMB-LCA, via Martiri Monte Sole 4, 40129 Bologna, Italy

Abstract

Transitions or system innovations towards sustainability has become urgent and fundamental in order to tackle the dynamic, complex factors fuelling the global crisis of our days. Because their potential for system innovation change, sustainability transitions are a valid research field to stimulate both technological and organizational changes toward sustainability systems. In the framework of Climate-KIC European Programme, this paper has analyzed practical and inspiring cases of transition experiments in the university domain. Actually, university plays a key role of learning organization where it is possible to develop innovations and to reach a successful transformation in place of sustainability. The result is the creation of living laboratory of sustainability where to experiment and to co-create sustainability processes and solutions.

Keywords: living - laboratory, system innovation, sustainability, transitions, university

[*] Selection and peer-review under responsibility of the ECOMONDO

[**] Corresponding author: e-mail: francesc.capellaro2@unibo.it

1. Introduction

According to the most recent Annual Report of European Eco-innovation Observatory (2013), "there is an untapped potential for eco-innovation in Europe and the intensity of eco-innovation in not yet enough". Besides, the recent global crisis has put in evidence systemic problems as systemic lock-ins and market failure, which affects strategic operations and inhibit eco-innovation efforts (EIO, 2013, Loorbach and Huffenreuter, 2013). Therefore the urgency of a systemic transformation is required which means a transformative change in the entire system of practices and provisions.

There is the need to identify the roots of systemic problems and to adopt a systemic approach for enhancing eco-innovation in order to shift toward sustainability in a coordinated way. Eco-innovation should go beyond stand-alone innovations and combine product, process, organizational, marketing, and social eco-innovation towards a transformative system eco-innovation. According to OECD (2012), transformative system eco-innovation aims at building up a shared understanding of how and why systems work in order to integrate all the system components and to move the entire system towards sustainability.

In order to achieve that, system innovations should be not only technology-driven, but need to involve social and structural aspects. The ambition is to achieve 'socio-technical innovation', a radical change at level of multi societal and multi-actor (Geels, 2010). Over the past 15 years, numerous conceptual frameworks have been developed for the study of system innovation and sustainability transitions has been recognized as a *research field for long-term, multi-dimensional, and fundamental transformation processes through which established socio-technical systems shift to more sustainable modes of production and consumption* (Markard, Raven and Truffer, 2012).

In this context, transitions experiments are small-scale experiments with a high potential to contribute to transitions (Raven et al., 2010). Consequently, the implementation of transitions experiments in various application domains can provide a fruitful support to the urgent need of making sustainability transitions happen.

2. Objectives

With the aim of demonstrating how to be successful applied sustainability transitions perspective, this paper has investigated practical and inspiring cases of transition experiments at university domain. The experimental framework is provided by the Climate KIC: European initiative aimed at providing the innovations, entrepreneurship, education and expert guidance in order to shape Europe's ambitious climate change agenda. In this context, the study has analyzed the establishment and execution of transition experiments. The final objective is to validate transition experiments as key instruments for stimulating sustainability transitions.

3. Outline of the work

In the first section, the paper presents an overview of sustainability transitions experiences. Mainly, the study focuses on the approach adopted by the Pioneers into Practice programme (PiP) in the framework of Climate-KIC. According to the numerous research lines on system innovation and transitions, PiP promotes the development of transition experiments towards low-carbon system innovation.

Section two illustrates the analysis of transition experiments implemented at university domain during the PiP programme. Starting from sustainability campus issues, the paper shows two initiatives implemented by the University of Kassel (Germany) and

University of Bologna (Italy). The last sections show how the results of transition experiments and the future perspectives that support the university's ongoing transition to sustainability.

4. Materials and methods

In presence of the growing needs of sustainable innovation, sustainability transitions have been recognized as a promising knowledge for fundamental change in cultures, structures, and practices towards sustainability. A large number of instruments and studies have been emerged with the aim of addressing the various aspects of the challenges posed by sustainability transitions and sustainable development (Elzen et al., 2004). In the context of sustainability transitions, the role of experimenting has recognized as crucial (Schot and Geels, 2008). An effective initiative which promotes the experimentation of transition thinking is Climate-KIC (http://www.climate-kic.org) and especially its bottom-up regional programme Pioneers into Practice (PiP). PiP aims at developing regionally based transition platforms on low-carbon innovations.

Thanks to a learning-by-doing programme, the PiP participants, called *pioneers*, have the opportunity to develop their knowledge and understanding on transition thinking in a variety of environments from business to government and research. With this intention, PiP provides transition practitioners with a guidance of competences developed through a mentoring programme. Particularly, pioneers are supported by leading European experts on transition and systems thinking, such as the Dutch Knowledge network and research programme for System Innovation and Transitions KSI (http://www.ksinetwork.nl) and the international Sustainability Transitions Research Network STRN (http://www.transitionsnetwork.org). The core of the PiP programme is the placement, a working period during which the pioneers can develop hands-on experience of low carbon innovations within the host organizations. Definitely, PiP programme promotes the experimentation of low-carbon transformative innovations

5. Experimental

This paper investigates sustainability university experiences, carried out by the authors during the PiP placements in 2012 and in 2013 at the University of Kassel (Germany) and at the University of Bologna (Italy). Both experiences are relevant because provide opportunities for analyzing through the lens of transition thinking a novel and significant transition domain as university is. In Table 1, two examples of transition experiments are described.

According to UNEP toolkit (2013), the previous transition experiments can be considered models of living-lab of sustainability. Actually university can become places where the university community becomes experienced in the theory and in the practice of sustainability (Cappellaro et al., 2014).

6. Results and discussion

This paper has analysed the role of transition experiments towards sustainability, particularly focussed on sustainable university.

Both the University of Kassel and the University of Bologna experiences have shown practical examples of transition experiments which identify models for integrating campus operations within learning and teaching.

Table 2. Examples of transition experiments at university domain

	University of Kassel	*Univeristy of Bologna*
Transition experiment	**Nachhaltige Abfallsysteme** Study project "Sustainable Waste Systems"	**Laboratori in Transizione** Students Laboratory on Sustainability Transitions
Actors	Department of Waste Management of University of Kassel Bachelor and master students of different faculties	DICAM - Department of Civil, Chemical, Environmental, and Materials Engineering of University of Bologna Engineering Students
Description	Interdisciplinary study project focused on campus sustainability, especially in the field of waste.	Inclusion of campus sustainability measures in an existing course.
Goals	To solve practical issues in the field of waste management, such as: recycling, biological waste treatment, key figures for waste management, reporting of waste streams, incentives for changes in behavior.	To engage students in the design of practical measures strictly connected with Environmental Sustainability Plan of University of Bologna.

The results are the connection of stand-alone initiatives, increased engagement of university community and the enhancement of university commitment toward sustainability. Next steps are addressed to broad and to scale-up transition experiments with the purpose of establishing a network of sustainable campuses.

7. Concluding remarks

With the intention of understanding and analysing the context of present eco-innovations, sustainability transition emphasizes the key role of transition experiments. Correspondingly, the Pioneers into Practice Climate KIC Programme provides the opportunity to put into practice the transition thinking and to implement transition experiments.

This paper has described two example of transition experiments in the university domain. The analysis has supported the identification of barriers and opportunities for sustainability innovations at university domain. Moreover the systemic approach of transition has helped of going beyond individual and separate initiatives in order to achieve a transformation at system level.

As a consequence a real opportunity for sustainability transition of university is initiated. All in all, the experience of Climate KIC in the adoption of transition thinking is revealed an effective framework where to generate solutions and strategies promoting the fulfilment of sustainability.

Acknowledgements

The authors would like to thank the Pioneers into Practice colleagues of Competence Centre of Climate Change Mitigation and Adaption (CliMA) of University of Kassel, Fernando Mateo Cecilia, pioneer of Valencia region of Spain. Unibo, Suzanne van den Bosch, PiP mentor and ASTER Emilia Romagna RIC ASTER. We gratefully acknowledge the support of the members of the Transition Team of University of Bologna.

References

Cappellaro F., Bonoli A., (2014) *University in Transition: How to transform campus into living laboratory of sustainability.*, 5th International Conference on Sustainability Transitions, Utrecht, 26-29 August 2014.

EIO, (2013), *Europe in Transition: Paving the Way to a Green Economy through Eco-innovation*, Eco-innovation observatory Annual Report 2012, January 2013, On line at: http://www.eco-innovation.eu/images/stories/Reports/EIO_Annual_Report_2012.pdf.

Elzen B., Geels F.W., Green K., (2004), *System Innovation and the Transition to Sustainability: Theory, Evidence and Policy*, Edward Elgar, Cheltenham.

Geels F.W., (2010), Ontologies, socio-technical transitions (to sustainability) and the multi-level perspective, *Research Policy*, **39**, 495-510.

Loorbach D., Huffenreuter R.L., (2013), Exploring the economic crisis from a transition management perspective, *Environmental Innovation and Societal Transitions*, **6,** 35-46.

Markard J., Raven R., Truffer B., (2012), Sustainability transitions: an emerging field of research and its prospects, *Research Policy*, **41**, 955-967.

OECD, (2012), *The Future of Eco-innovation: The Role of Business Models in Green Transformation*, Organization for Economic Co-operation and Development Publishing, Paris.

Raven R.P.J.M., van den Bosch S., Weterings R., (2010), Transitions and strategic niche management, Towards a competence kit for practitioners, *International Journal of Technology Management, special issue on Social Innovation*, **51**, 57-73.

Schot J., Geels F., (2008), Strategic niche management and sustainable innovation journeys: theory, findings, research agenda, and policy, *Technology Analysis and Strategic Management*, **20**, 537–554.

UNEP, (2013), Greening Universities Toolkit, United Nations Environment Programme 2013, On line at: http://www.unep.org/training/docs/Greening_University_Toolkit.pdf.

Procedia
Environmental Science,
Engineering and Management
http://www.procedia-esem.eu

Procedia Environmental Science, Engineering and Management **1** (2014) (2) 167-171

18th International Trade Fair of Material & Energy Recovery and Sustainable Development, ECOMONDO, 5th-8th November, 2014, Rimini, Italy

POLICIES FOR ENCOURAGING BUSINESS MODELS ORIENTED TO SUSTAINABLE CONSUMPTION AND PRODUCTION: AN OVERVIEW ABOUT THE EUROPEAN MEDITERRANEAN COUNTRIES*

Marino Cavallo

Partner Project ECO SCP MED, email: marino.cavallo@provincia.bologna.it

Abstract

The contribution is aimed to illustrate the main results of the analysis that has been recently carried out within the European project ECO SCP MED. The project, funded by the European MED Programme, aims to identify the strategic factors able to encourage new policies dealing with green-oriented development and sustainable consumption and production in the main European countries of the Mediterranean: Italy, Spain, France, Greece, Slovenia, Croatia.
This analysis firstly tries to redefine, in theoretical and methodological terms, the concept of policies, with an emphasis on procedural and evolutionary features characterizing the new generation of environmental policies.

Keywords: consumption, policy, recommendations, sustainability

1. Introduction

This paper is focused on the policy challenges for Sustainable Consumption and Production and on the SCP policy recommendations to be spread within Mediterranean countries. The project involves the following partners: IAT (Andalusian Institute of Technology, CERTH (Centre for Research and Technology Hellas), ENEA (Italian National Agency for new technologies, Energy and sustainable economic development, Province of Bologna, Avitem (Agency for sustainable Mediterranean cities and territories), Sostenipra – Universitat Autònoma de Barcelona, Cro CPC (Croatian Cleaner Production Centre Institute

*Selection and peer-review under responsibility of the ECOMONDO for Promoting Cleaner Production), SRC Bistra Ptuj (Public Institution Science Research Centre Bistra Ptuj), Scuola Superiore di Studi Universitari e di Perfezionamento Sant'Anna, Chamber of Commerce and Industry Nice Côte d'Azur.

The definition of policy itself may be a topics of discussion, considering its cross-cutting implications and in this paper policy will be considered as a set of laws and legislation, principles and associated guidelines, tools and strategies designed and enforced mostly by governing bodies, but even by innovative businesses, business associations, research bodies and training centres, to direct and address actions for achieving long-term collective goals. On the base of this definition, the paper will highlight how policies can count on the use of a large range of resources and techniques wider than the mere legislative power. Policy makers may generate a satisfying outcome with a smart and coordinated use of instruments and tools such as negotiation, campaigns, incentives, habits and social norms, even absence of norms, with no recourse to a new legislative production, often the cause of a normative over-production that affects negatively policies' suitability.

This paper will focus on a joint package of policy recommendations in the field of Sustainable Consumption and Production, with respect to three focus areas of "Production processes", "Products and consumption" and "Industrial areas" and on the experience of the european project Eco-Scp-Med aimed at capitalizing, sharing and transferring within the mediterranean area the actions and strategies addressed to sustainable consumption and production.

In addition to the definition of policy, it is worth identifying what we mean by sustainable consumption and production. At the beginning of the debate around SCP, the sustainable Consumption and Production was explained through ideas and concepts like 'eco-efficiency' (promoted by the World Business Council for Sustainable Development) or cleaner production' (adopted by the United Nations Environment Programme). The concept of Sustainable Consumption and Production was then enriched by contributions provided by businesses, governments and NGOs at the 1992 Rio de Janeiro Earth Summit and at the 2002 World Summit on Sustainable Development (WSSD) in Johannesburg.

The United Nations World Summit on Sustainable development pointed out some highlights in order to define SCP and its boundaries. SCP are aimed at promoting social and economic development within the carrying capacity of ecosystems by addressing and, where appropriate, de-linking economic growth and environmental degradation through improving efficiency and sustainability in the use of resources and production processes.

2. Material and methods

The project Eco-Scp-Med is aimed at enforcing sustainability of the supply chain of the main products and services within the Mediterranean area. "Its cornerstone is raising knowledge on SCP and fostering eco-innovation and competitiveness through transnational cooperation and especially through the capitalization of main achievements, activities and cooperation practices already developed in the Mediterranean space". In the paragraphs below we will provide a description of the steps carried out during the Project and the main conclusions that is possible to drawn about SCP.

Within the project Eco-Scp-Med a specific phase was devoted to the harmonization of policy recommendations resulting from the previous projects that had been carried out by the project partners and, more in general, from their experience. This phase was led by the Province of Bologna (Italy) with the contributions of all the project partners and it was composed of a screening activity, an in-depth analysis and of networking activities.

Screening all the projects through the lens of the policy has been based on three sources of data and information: desk analysis for in-depth investigation on the capitalised European projects; information provided by the partners, based a set of tools provided by the province of Bologna; revision and second reading of the information gathered with respect to the three focus areas identified within the project, “Production processes”, “Products and consumption”, “Industrial areas”; finally, set of interviews with external experts and stakeholders throughout the Mediterranean with relevant skills in the treated issue.

3. Experimental and analysis

The recommendations identified can be divided into four main areas of intervention: policies integration and harmonization (sustain green economy in support of re-development; key role of the EU for SCP policies development; implement the integrated approach as a key factor for SCP policies future; support the improvement of IPPC Directive measures and voluntary actions; implement an integrated approach for the supply chain; support the sustainable industrial areas); awareness, dissemination and education on SCP (Vocational training as the key to provide development opportunities; An education framework in support of SCP policies and IAs management skills; provide technical support to firms; firms’ responsible behaviour must be awarded and famed; implement social marketing campaigns); networking as an instrument to raise the system competitiveness (Continuous involvement of local authorities; Networking as the key for international competitiveness; Integrate, develop and harmonize inventories and databases; Create networks to share BPs and BATs; Cooperation among research centres, SMEs and local bodies), and, finally, a relevant area of intervention to push SCP policies regards the issue of tools (Revise the public grants and incentives system; support SMEs through innovative financing systems; Promote ecodesign processes, LCA, carbon footprint, total material footprint, and GPP; Apply SCP through pilot actions).

As for a deeper description of these policy recommendations, some details are provided below:

The policies belonging to the first area, can be summarized as below:

- Sustain green economy in support of re-development: it is necessary to promote, stimulate and invest in the green economy, in order to overcome this economical crisis;
- The key role of the EU for SCP policies development: EU must favour a harmonization of standards and norms, circulating BATs and information on projects and plans, and designing benchmarking on SCP policies in each sector;
- Implement the integrated approach as a key factor for SCP policies future: SCP policies must evolve towards a higher integration in both senses of subsidiarity among European, national, and regional levels, and of concurrent use of different instruments;
- Support the improvement of IPPC Directive measures and voluntary actions: it is important to improve the IPPC Directive implementation in the Mediterranean area to enforce gradual voluntary actions rather than introducing additional legally binding or costly requirements to the industry;
- Implement an integrated approach for the supply chain: a widespread integrated approach to sustainability has to be stimulated not only in the production and consumption segments, but even in that fundamental intermediate segment given by supply chain;
- Support the sustainable industrial areas: sustainable industrial areas with a managing body have to be encouraged, in particular when offering common environmental infrastructures and innovative services.

As for the second area dealing with awareness, dissemination and education on SCP:

- Vocational training as the key to provide development opportunities: vocational training is a main heal to contrast the crisis and provide opportunities for employment and development
- An education framework in support of SCP policies and IAs management skills: we need to integrate SCP issues and IA managers skills with university curricula, such as master

degrees, to have in the future experts and managers on integrated SCP policies;

- Provide technical support to firms; the lack of knowledge on SCP policy among firms is a major problem; there is a need to develop training programmes and support tools and provide technical support to businesses;
- Firms' responsible behaviour must be awarded and famed; one of the best ways to do this is promoting CSR as an opportunity and long term competitive advantage;
- Implement social marketing campaigns; albeit having demonstrated that social marketing initiatives and campaigns have a great impact in reducing behaviour opposite to SCP, they showed to be insufficient. So, they must be implemented.

The policy recommendations belonging to the third area related to networking as an instrument to raise the system competitiveness can be described as below:

- Continuous involvement of local authorities; higher and continuous involvement of local authorities must be pursued, since SCP policies are pivotal to regional sustainable development;
- Networking as the key for international competitiveness; networks increasing the possibilities for SMEs to compete on international markets must be stimulated. At this aim, collaboration among IAs, enterprises, Local Authorities and Territory/Local community is very important;
- Integrate, develop and harmonize inventories and databases; integrating, developing, and harmonize inventories and databases is a main issue to improve the productive sectors of the Mediterranean area, taking into consideration the data quality, that needs to be harmonized;
- Create networks to share BPs and BATs; creating Mediterranean or European platforms and networks promoting the transfer of technologies and best environmental management practices for eco-innovation;
- Cooperation among research centres, SMEs and local bodies an improvement in cooperation among research centres, SMEs and local bodies could help bridging the gap between theoretical research and territorial needs, and deal with the lack of knowledge on SCP policies among firms; this task could be profitably played by IA's managers.

Finally, as for the thematic area dealing with the issue of tools:

- Revise the public grants and incentives system; the public grants and incentives system needs a revision, in order to reward the targeted organization in a stable way, and not exclusively in monetary form; to allow the implementation of experimental operations corresponding to a long term strategy and aiming at being then disseminated;
- Support SMEs through innovative financing systems; innovative financing instruments should be designed in order to support SMEs and SCP policy development.
- Promote ecodesign processes, LCA, carbon footprint, total material footprint, and GPP; local and national administrations should promote ecodesign processes, LCA, carbon footprint, total material footprint, and GPP by applying these methodologies into their services.
- Apply SCP through pilot actions; pilot actions should be promoted and funded for transferring and replicating SCP tools and practices in different contexts, for showing the benefits.

4. Results and discussion

On the base of the information and activities described above, we can identify three different socio-political approaches to the theme of SCP: ecological modernisation, a mix of governance and technology that creates the conditions for the diffusion of eco-innovations by scaled networks (nutshell, regime, landscape) that are the levels of transition theory; «ecogovernmentality», procedures, institutions, and legal forms that compel common people to internalize ways of knowing and conduct, reproducing and extending the influence and constitutive force of neoliberal doctrines (marketed regulation, participation, and rational decision-making) within and between local socio-natures; political Economy of environment, the most promising approach to understand the actual form and stringency of environmental measures appears to be one which tries to understand how various interest groups interact in specified political settings with environmental policies as the outcome.

None of the previous approach could be considered satisfying, since all of them consider sustainable and environmental policies as the outcome of a restricted interaction. To change this picture, an effort has to be done in the direction of communication, raised awareness, and participation both at the institutional and at the individual levels. This issue has been stressed at each step of the Eco-Scp-Med project, and particularly in the networking phase that highlighted how SCP policies have to be sustained only by a collective intelligence.

6. Concluding remarks

In the era of *wiki* and 2.0 attitude, to be effective sustainable policies must originate not only from the acts of policy makers and institutions but also from the day-by-day requests, provisions and actions by administrations, firms, citizens, communities, associations, different kind of organizations.

References

Baumol W., Oates W., (1988), *The Theory of Environmental Policy*, Cambridge University Press, New York.

Cavallo M., (2014), *Harmonization of Policies recommendations for the integration of Sustainable consumption and production in the MED area*, BUP Press, Bononia.

Cavallo M., Degli Esposti P., Kostantinou K., (2012), *Handbook of Green Communication and marketing*, Milan-Thessaloniki, F. Angeli, Milan.

Freeman, E., (1984), *Strategic Management: A Stakeholder Approach*, Cambridge University Press, New York.

Kolstad C., (2000), *Environmental Economics, Oxford University Press*, New York.

Lowi T.J., 1975, *What Political Don't Need to Ask About Policy Analysis*, Lexington Press, Lexington (Mass.).

Pauli G., (2010), *The Blue Economy, 10 Years, 100 Innovations, 100 Millions of Jobs. Report to the Club of Rome*, Paradigm Publications, Taos.

Rose R., (1989), *Ordinary People in Public Policy: A Behavioural Analysis*, Sage, London.

Thaler R. H., Sunstein C., (2008), *Nudge: Improving Decisions About Health, Wealth, and Happiness*, Yale University Press, New Heaven.

UNIDO, (2011), *Readiness of the region's private and public sectors for the EU CSR policy framework*, Research Study UNIDO, Nairobi.

Procedia
Environmental Science, Engineering and Management
http://www.procedia-esem.eu

Procedia Environmental Science, Engineering and Management **1** (2014) (2) 173-178

18th International Trade Fair of Material & Energy Recovery and Sustainable Development, ECOMONDO, 5th-8th November, 2014, Rimini, Italy

PRELIMINARY EVALUATION OF POTENTIAL FOR RECOVERY AND REUSE OF CONSTRUCTION MATERIALS AND BUILDINGS[*]

Antonello Monsù Scolaro[**], Francesco Spanedda

Università degli Studi di Sassari, Dipartimento di Architettura, Design ed Urbanistica di Alghero (SS)
Palazzo del pou Salit, p.zza Duomo, 6, 07041 ALGHERO (SS)

Abstract

The paper presents the first results of a research path actually in progress in order to determine in advance the potential for recovery and reuse of construction materials and existing buildings. On the basis of the period of construction, technology and the materials used, there are new operational possibilities in the field of building restoration. On the other hand, the different types of construction materials from existing buildings, offer different design possibilities, technological performances and different qualities of the architectural space.
The authors propose an experimental methodology referred to international framework to give a contribution for lower environmental impact building.

Keywords: architecture reuse, construction materials recovered, spatial quality, technological properties

1. Introduction: wasted buildings as a resource

Human beings, among all the animals, build up the biggest quantity of stock, according to "urban metabolism" theorists (Brunner and Rechberger, 2002). While the material footprints of other species are relatively small, humans build huge cities and infrastructures. Where most of the species use mainly renewable materials from the surroundings, humans have a penchant for complicated constructions. Last century left,

[*] Selection and peer-review under responsibility of the ECOMONDO
[**] Corresponding author: amscolaro@uniss.it

mainly in the western world, a huge quantity of abandoned buildings and building elements mostly made out of new artificial materials (Levi Strauss, 1962).

The European economy consumes minerals, metals, concrete and wood, and burns fossil fuels and uses land to satisfy the needs of its citizens. In addition, at the end of the materials chain, we generate about six tons of waste per person every year. Today, the 51.5 % of waste is disposed and the 43.6% is recycled (Schmidt, 2010). While Europe imports raw materials (1800 million tons) the need to optimize the resource waste is increasing (recycled and reclaimed materials). Using wasted materials the environmental impacts can be significantly reduced. Apart from the well known environmental and economic reasons, recycling could be thought as the reuse of this huge quantity of stock material.

The many possibilities in reusing this great amount of abandoned material within a building process lay down a multilayered approach that spans from the choice of the site to the choice of building materials and details. The very first level is choosing the appropriate site. Ground is a non-renewable resource, so great attention should be paid to avoid wasting it, mainly choosing land that has been used already. In the last century, industrialization and growth of the cities left behind a considerable extension of brownfields requiring a huge work of reclamation that could be carried out building on them again.

The following level is the reuse of existing buildings. These are mostly built with heavy materials holding great amounts of grey energy, thus their reuse could help in reducing the total energy use. We could therefore think of the massive elements of existing buildings as *ready-mades* able to help us to reduce the energy required in the building phase, if properly used inside a design scheme. This could be an extremely fruitful concept that could help us to shift the idea of heritage from mere cultural value to an environmental value. Recycled materials could be effectively employed to add additional strata providing the physical proprieties lacking in heavily-built existing building, like thermal insulation and glazing, both enhancing the sustainability and spatial richness of the design.

The third level is the reuse of existing part of buildings not yet at the end of their lifecycle. This should bring the advantage of requiring a minimal effort in handling materials, thus reducing the impact of further treatments on the sustainability of the whole building process. This way of recycling is also known as “superuse”. According to 2012 Architects (van Hinte et al., 2007), there are four types of “super usable” materials: collection waste, materials withdrawn from the traditional recycling flow in various stages, products that actually reached their “end of use”, and “dead stock”. The main problem in using waste is, that there is usually no attention in the demolition phase to carefully remove parts that did not end their lifetime. The most interesting products from this point of view are objects temporarily used for a limited amount of time during the building process. They usually endured a short service time and are easy to dismantle.

Components withdrawn from the recycling flow could also have had a short use, or even being scrapped because of changes in laws or regulations. Products at the end of their use are not more belonging to any recycling workflow, but they can be “downcycled” to match other, less demanding functions, like roof battens could beused as parapets or railings. “Dead stock” parts are the result of the industrial production of parts or products that are no longer required by the market.

“Reclamation, reuse and recycling are not new ideas” (Addis, 2006). In European Community wastes of construction and demolition activities account for 70% of all waste generated. The most common recycled materials are concrete, bricks, tiles and asphalt, also soils.

By 2020 the new Waste Framework Directive provides that the level of re-use, recycling and recovering of non hazardous construction and demolition waste will be 70% of total wastes. “The highest waste prevention potentials were estimated for construction and demolition waste by better planning of construction activities, extended use of off-site construction methods and an extension of the lifetime of buildings" (Massmann et al., 2009). In the field of constructions, as an alternative to recycling or parallel, it is possible to think to recovery the already existing materials and reuse them in the same site. However, if you can be sure of the reduction of environmental impacts, we need to ask ourselves what is the right method to recovery to reuse them? Which technological performance expect by recovered and reclaimed materials? What improvement of architectural space?

2. Material and methods

Today it is always easier to find construction materials obtained from recycling processes pre and post consumer (Morabito and Bianchi, 2010); gradually, designers and construction companies use materials and products almost unknown until a few decades ago. The European regulatory framework is evolving: there are many protocols for the evaluation and calculation of the environmental impacts of design choices both in the production phase of the materials and in the territory transformation and buildings construction. The hierarchy of norms in the new Waste Framework Directive (EC Directive, 2008) ranked in first place the waste recovery activities, and promotes the activities of materials reuse and pre and post consumer products. Improvement of the management of construction and demolition waste is a mega trend of SOER 2010 that will be enhanced in SOER 2015. Technological innovation is oriented to the improvement of separation processes of recycling materials, processing techniques and the reduction of related energy consumption. Schmidt (2010) shows that the generic recycling of construction and demolition waste does not determine significant reductions in the industrial economic and energetic costs with respect to the use of raw materials; the savings are achieved by using specific techniques for specific materials (steel, aluminum, glass; paper; wood etc). The recycling and reuse may take place both within the same manufacturing processes that elsewhere, by reducing the exploitation of raw materials and on the other hand the reduction of the volumes in landfill (real added value). The recovery of construction materials performed particularly at the building site, (thanks to limited movements of materials and low transformation energy expenditure for reuse), becomes an alternative instrument to recycling of high environmental value.

From the report of the ACHP in1979 to the recent guidelines issued by the European project EeBGuide Project (*Operational Guidance for Life Cycle Assessment Studies of the Energy Efficient Buildings Initiative*) the environmental sensitivity in the field of buildings and the understanding of the energy preservation of the building are increased. Discussing on refurbishing of existing buildings and recovering of their materials, we recall the procedure of the EeBGuide that promotes the application of LCA method and calls other European regulations, as the EN 15804 and EN 15978 (EeBGUIDE, 2014).

Our reference scenario is completed by: the recalling of Net WRAP Tool document (which provides useful information to compare the economic value of the wasted materials to the use of additional reuse and recycling materials within the project) and the invoking of operational criteria contained in the standards of the EN 15643-1:2010 "Sustainability of construction works - Sustainability assessment of buildings - General framework".

3. "Buildings as quarries": outlines of an experimental methodology

The experimental methodology proposed here originates from both building process issues and spatial features. It stems from the evidence that the spatiality of a building is in many ways linked to its own building process. In this particular case we explore the idea of a very tight relationship, emphasising the role of reuse, recycle, super use, and connected practices, in order to investigate a kind of "spatiality of recycling".

Starting from the operational scenarios that the EN 15978 proposes for the application of the LCA to the recovery of existing buildings, in an innovative way with respect to the rules and guidelines mentioned, the experimental methodology examines the following "hidden aspects":

- the quality of the architectural space;
- the adequacy of the building;
- the residual performance of the technical elements and the already existing materials.

The evaluation of existing buildings is a complex process that should take in account the objective spatial qualities of the building, how these qualities match the proposed function, or the potential flexibility of the existing spatial configuration to host a range of future functions. This step is aimed to understand if the building could be reused as a whole, only in parts, or it should be definitively dismantled to reuse or recycle its elements.

The methodology provides a process of analysis and knowledge of the building divided into two major phases:

- a first step of analysis of the characteristics of the site and planimetric and spatial configuration of the building;
- a second step of breakdown and analysis of the technical elements and constituent materials in relation to technological characteristics and performance.

The results of the first and the second phase will help to understand the methods of reuse and the necessary transformations on the basis of the related environmental impact. The building will be reused entirely or in parts: its spatial quality, the spatial and technological quality of some construction elements, or finally the quality of the materials, can be valued.

The first phase considers:

- the analysis of the site in relation to environmental characteristics (geological, climatic and vegetation);
- the analysis of the spatial and architectural quality in relation to the size and functionality of the spaces;
- the comparison between the sizes of the existing spaces and the new destinations of use;
- the evaluation of environmental impact of transformations and the relative affordability of the refurbishment and reuse of the building.
- The second phase considers:
- the breakdown and analysis of the technical elements and constituent materials (in particular according to the UNI 8290, faced to user satisfaction) and the verification of structural and technological performances (horizontal and vertical structures, pillars, beams, masonry, or thermal insulation; thermal inertia; hygroscopic properties, etc);
- the volume measurement of preexisting materials due to building progressive collapse and the evaluation of the potential for reuse, recovery and recycling on the basis of the new Waste Framework Directive (EC directive, 2008);
- the volume measurement of preexisting materials that will be possible to remove, recover and reuse (wood; brick; iron; aluminum; stone and many other) if structural and technology performances are not appropriates.

It will give a preliminary evaluation of the various volumes of materials classified as:

- to recover and reuse - on site- (with handmade refurbishment);
- to recover and reuse elsewhere (with industrial refurbishment);
- to recycle;
- to give to landfill.

In this second phase, where are two concepts that could play a prominent role even as a trigger for spatial inventions. The first is the “downcycling”. As a response to the difficult processes to provide new classifications for building element, elements whose performance is usually critical, like bearing structures or part of the building envelope, could play less critical roles, as inner partition, shades, furniture.

The second could be called “downsizing”. As the reusable elements are often smaller than the original ones (i.e. wooden beams whose ends are rotten or damaged in the demolition process), they could be used again within different structural schemes, where form plays a major role in establishing the stiffness of the structures (as in Amateur Architecture Studio, *Decay of a Dome*, Venice Biennale 2010).

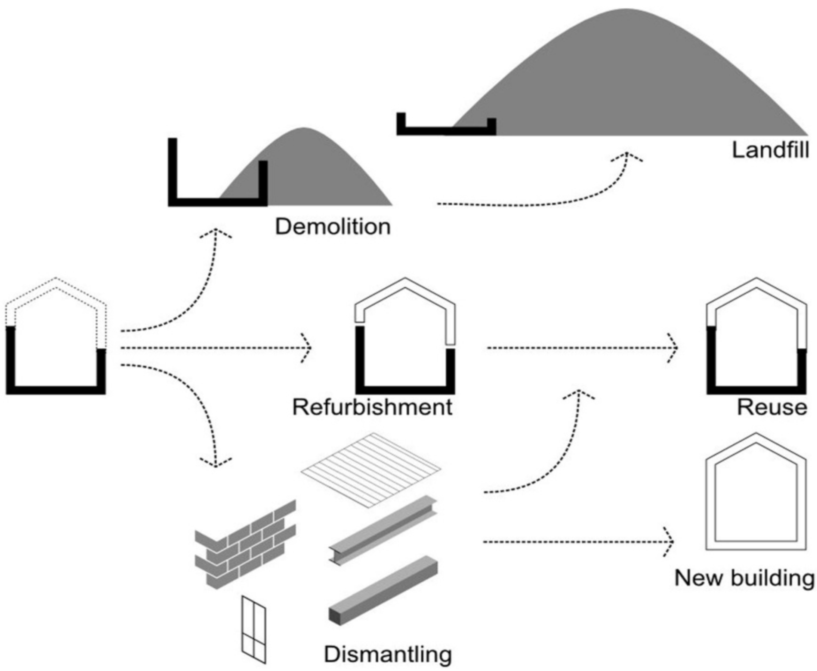


Fig. 1. Flowchart of alternative ways of reuse buildings and preexisting materials

4. Results and discussion

The presented methodology is in the process of implementation and the results may be discussed only in terms of expectations. Currently, we believe that the reflections allow a new perspective on the actual environmental opportunities to reuse of existing buildings, considering both the spatial quality that the technological performances, in addition to the energy embodied of existing building materials.

A process that has a double value: on the one hand it is useful to understand that the existing buildings occupy ground if unused, and therefore adversely affect the environmental balance of the territory (they can be considered as sets of waste to be managed); on the other hand, the existing buildings are potential quarries of materials to be recovered, then able to reduce the environmental impacts of extraction processes of raw materials and production of new products.

Finally, we appreciate that the methodology can be used also by public administrations to know the amount of construction materials to recover and reuse in disused buildings of public property. Thus, it could contribute to achieving the goals of environmental sustainability of the more general European policies in an organic way, thanks to a predictable reduction of both the consumption of primary resources that the construction and demolition waste.

5. Conclusions

From a designer's point of view this attitude implies an attention to designing processes rather than their spatial outcome. Form, structure, materiality of the building have to be reinvented on the base of existing elements, with an attitude similar to the "bricoleur" as described by Levi Strauss in 1962.

The result could be unexpected spaces, bearing the signs of their cultural and technological history, directly growing out of the huge resources of the site and of the surrounding human "stock".

Acknowledgements

Antonello Monsù Scolaro is the author of the paragraphs 2 and 7 of Introduction; of Materials and methods; paragrpahs 2, 4, 5, 6, 7 of Buildings as quarries; of Results and Discussion.
Francesco Spanedda is the author of the paragraphs 1, 3, 4, 5, 6 of Introduction; paragraphs 1, 3, 8, 9 of Buildings as quarries; of Conclusions

References

Addis B., (2012), *Building with Reclaimed Components and Materials,* Earthscan, London.

Brunner P.H., Rechberger H., (2002), *Anthropogenic Metabolism and Environmental Legacies,* In: *Encyclopedia of Global Environmental Change*, Douglas I. (Ed.), John Wiley & Sons, Ltd, Chichester, 54–72.

EC Directive, (2008), Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives, *Official Journal of the European Union*, **L312,** 3-30.

EeBGUIDE, (2014), Final report and results on *Operational guidance for performing life cycle assessment studies of the energy efficient buildings initiative*. Funded under FP7-ENVIRONMENT - FP7 Specific Programme 'Cooperation'- Research Theme: 'Environment (including climate change), On line at: http://cordis.europa.eu/result/rcn/56426_en.html.

Lévi-Strauss C., (1962), *La pensée sauvage,* Plon, Paris

Massmann C., Kosinska I., Pessina, G., Brunner P.H., Buschmann H., Brandt B., Neumayer S., Daxbeck H., (2009), Report chapter with description of three what-if scenarios of waste treatment policies and their interplay with the macro-economic scenarios, On line at: http://forwast.brgm.fr/Documents/Deliverables/Forwast_D53.pdf.

Morabito G., Bianchi R., (2010), *La decrescita prosperosa dell'edificio. Architecture from hight tech to low cost*, (in Italian) Roma Gangemi, 101.

Schmidt J., (2010), *Documentation of the contribution analysis and uncertainty assessment. Results interpretation identifying priority material flows and wastes for waste prevention, recycling and choice of waste treatment options. Policy recommendations,* On line at: http://forwast.brgm.fr/Documents/Deliverables/Forwast_D63.pdf (accessed 11 June 2010)

van Hinte, E., Peeren C., Jongert J.,(2007), *Superuse: Constructing New Architecture by Shortcutting Material Flows,* 010 Publishers, Rotterdam.

Procedia
Environmental Science, Engineering and Management
http://www.procedia-esem.eu

Procedia Environmental Science, Engineering and Management **1** (2014) (2) 179-182

18th International Trade Fair of Material & Energy Recovery and Sustainable Development, ECOMONDO, 5th-8th November, 2014, Rimini, Italy

ECOINNOVATION4 - Eco-innovative solutions for Mediterranean waste and wastewaters

THE NEED FOR A COMMON LAW IN THE MEDITERRANEAN BASIN FOR WASTE, WASTEWATER AND RENEWABLE ENERGY*

Mariagrazia Chianura

Studio Legale Chianura Diritto dell'Ambiente e dell'Energia,
via Giordano n. 23, 74023 Grottaglie (Taranto) Italy, email: avv.chianura@gmail.com

Abstract

The Mediterranean Sea is, for all the countries that surround it, a place of encounter and exchange extremely important. In recent years the attention of Europe has focused on the development of renewable energy in the countries of the southern shore, which are proving to have a very high regional growth in this sector. There is also the opportunity to make grow the business sector of waste from one side to the other of the Mediterranean. What is missing is a common law that is able to ensure legal certainty, and an effective protection of the environment that surrounds us.

Keywords: Mediterranean Sea, renewable energy, waste

1. Introduction

The Mediterranean Sea has always represented an important meeting point of cultures and trade. Over the last century, the intensification of oil transportation by sea has brought the Mediterranean at the center of important trade. However, this revival of trade by sea is also accompanied by the worsening of environmental conditions of the Basin: due to the increased number of trips were also intensified accidents, such as that happened in Genova by the tanker Haven in 1991 (EMSA, 2008).

*Selection and peer-review under responsibility of the ECOMONDO

Certainly, to attribute the worsening environmental conditions of the Basin only to these sensational episodes would be a mistake: pollution is the result of a continuous discharge of hazardous substances into the sea. Bilge water, sewage and industrial non-purified, end up in the sea without controls because they lack effective laws.

2. Context and discussion

2.1. Mediterranean basin for waste, wastewater and renewable energy

The development of mass tourism in coastal areas of the entire basin (in particular Italy, Greece, North Africa) has had negative effects on the marine eco system, due to the exponential growth of the domestic sewage in the sea during the period of greatest influx of tourists.

As the fight against International terrorism, protection of the environment can not be addressed by individual state, because the effects of these problems transcend geographical boundaries: the solution has to come from a shared choice between all countries that face, which should adopt a solution that points to lasting results both in the short term but also in the medium - long term.

In the last year, the Maghreb area has discovered a green vocation, in particular in the areas of renewable Energy and cross-border trade of waste. Both the proximity to the Europe, that similar climatic conditions that favor the development of human activities of the same type (for example tourism and agriculture) have contributed in recent years to a strong commercial interest between the two shores of the Mediterranean. The entire basin is not only an area to be protected from environmental point of view, but also new opportunities for economic development (Bicchi and Gillespie, 2014).

To this, to make it not only possible but real the development opportunities, it is necessary a broader political vision and forward looking, which is possible only with a coherent, effective and shared regulatory system: both environmental protection that economic development can only be achieved if all environmental sectors become part of a unitary project. An environmental law must be coherent and effective: so, it is important that on the basis of general principles widely shared, we face the management of the environment in its totality. With a unified vision of the field it is possible to intervene on a large scale, to address the issue of green taxation, and adopting a system of rewards for all companies that reduce their impact on the environment, and, at the same time, to increase costs of those activities that continue to have a significant impact on the environment due to the use of obsolete technologies, because of the failure to produce Energy from renewable sources, or because of the improper management of their waste. The problem with some emerging economies, such as the Maghreb, is the lack of appropriate regulations that ends up for blocking foreign investment because it does not provide certainty in the application of rules: a situation that bilateral agreements, as they are too specific and transient, are not always able to solve.

Let's make a practical example of cross-border trade of plastic waste from agriculture. For the Maghreb, which has a long tradition in the field of waste collection, it can be convenient to sell them in Europe. The transportation is cost-effective only for large quantities, so this is usually done by sea. But it happens very often that when the ship comes from a non-EU country is blocked, waiting for checks, or seized at European ports - I speak in particular of those of southern Europe because this is my experience – because it is assumed that the origin country does not have the same level of environmental protection, and that the transported waste are not comply with European standards. This results in loss of time and money for businesses who are waiting for the load, at the risk of discouraging exports and imports of waste, which in this case will be allocated to non-EU countries: how these policies can encourage the recovery of waste, as required by the basic principles of European law, we do not know!

Protecting the environment and investing in development policies in the green sector is a possibility of growth of the wealth of a country as demonstrated by the decisions of the European Union in recent decades. European policies on the environment have affected mainly the areas of renewable energy and waste: with regard to the first, through the introduction of the obligation to step up the production of energy from renewable sources by providing economic incentives and applying a penalty system in case of failure. In the second case, it was stated the obligation not to pollute and at the same time to reduce the production of waste: with the rising cost of raw materials, it is convenient to produce goods no longer starting from virgin raw materials, but by secondary raw materials (EU, 2014).

However, the existence on the Mediterranean basin of many different countries, all with their own legislation in this regard, in practice detracts from their efforts. Instead, the benefits that would result from a shared regulatory system are obvious: on the one hand, it would make effective the protection of the Mediterranean basin from the environmental point of view; on the other hand, there would be an opportunity to encourage investment by new opportunities for trade (Scoullos and Ferragina, 2010).

To do this, we need to develop a unified policy across the sector, starting with the idea that protecting the environment is convenient for all: should the environment is a source of economic growth, creates jobs.

There are three sectors with the highest impact on the environment on which we will focus:

a. waste and wastewater

b. production of energy from renewable sources

2.2. Waste and wastewater

In Europe it is mandatory to reduce the production of waste, both liquid and solid, and fostering recovery. The EU countries have almost all achieved satisfactory results from the point of view of the objectives of recycling and reduction of waste at sea, goals that are accompanied by a rigid system of penalties to be charged to the defaulting States, individual citizens and companies.

But if the rules are not shared with the countries of the South, it is not possible to achieve the goal of environmental protection. We have not to forget that the countries of the South, in the summer, attract a lot of tourists in coastal areas, and that their domestic discharges often end up in the sea without any purification treatment. The same fate is applicable for the industrial wastewater and solid waste of companies, which often lack adequate internal rules, and are not properly disposed of or recovered.

The European policies of recent decades have gone to incentivize waste recovery, favoring the production of raw materials from waste recovered, the so-called MPS. Based on these observations, a common environmental legislation in the waste sector should include:

- Same general principles in environmental law, with proportionate penalties against those who violate the law, with the possibility for the individual state, in order to achieve the objectives of environmental quality shared, to adapt the rules to their needs;
- A unique code for the characterization of waste;
- Same quality standards in the differentiation, treatment and recovery of waste;
- Same quality standards in the production of MPS;
- A "seal of quality" and simpler rules for waste that travel from one continent to another: this will make faster controls entry into Europe, and at the same time, will ensure compliance with high quality standards.

2.3. The sector of energy production from renewable sources

Africa and the Middle East are investing heavily in renewable energy sources, the reasons are many, not closely related to the purpose of protecting the environment. These countries are facing a growing domestic demand for energy, both on the part of large urban agglomerations, which by a nascent industrial apparatus. The choice is between a system of energy production of the old type which may not be able to guarantee this result, and the use of renewable energy sources that could provide a limitless energy production. But the lack of local know-how, technology and logistics practice. Above all, there is no industry regulations, which provide incentives consistent with the expected development, and that gives certainty to investors, especially foreigners. A research conducted by the Worldwatch Institute, based on the Annual Report on renewables for 2013 of REN21, pointed out that the Middle East and Africa showed the highest regional growth in 2012, with investments that have exceeded 200% (REN21, 2013).

The opportunities for Europe are clear: in the face of a market, the European one, that due to the current crisis has seen reduced its growth opportunities, also in consideration of the reduction of the incentives that some European countries - including Italy by Decree 91/2014 converted into law - have introduced also retroactively, it is possible to export in emerging markets know-how, technology and human resources.

Common rules in the field of renewable energy should include at least:

- reference to general principles in terms of environmental protection, as provided for waste;
- provision of a development plan of these sources in the area, in accordance with the protection of ecosystems;
- introduction of forms of incentive for the use of energy from renewable sources;
- introduction of a general obligation to achieve the objectives of the use of renewable energy over time.

3. Concluding remarks

A uniform legislation for the protection of the Mediterranean Basin would get a double advantage: environmental protection and economic development. But, to make this, it is important to have a series of shared and accepted norms by all the countries on the Basin.

The certainty of rules means stability and tranquility in funding for investment in the medium to long term. This also means to begin to imagine the future in a different way, by making economically convenient the protection of our environmental resources.

References

Bicchi F., Gillespie RF., (2014), *The Union for the Mediterranean*, Routledge, London.

EMSA, (2008), Maritime Accidents Review, European Maritime Safety Agency, On line at: http://emsa.europa.eu/emsa-documents/download/373/216/23.html.

EU, (2014), Waste as a Resource, European Union, Luxembourg, On line at: http://ec.europa.eu/eip/raw-materials/en/system/files/ged/76%20RTD_FP7_Waste_as_a_Resource.pdf

REN21, (2013), Renewables 2013. Global Status Report, On line at: http://www.ren21.net/portals/0/documents/resources/gsr/2013/gsr2013_lowres.pdf.

Scoullos M., Ferragina E., (2010), Environmental and Sustainable Development in the Mediterranean, European Institute of Mediterranean, Barcelona, Spain, On line: http://www.iemed.org/publicacions/10papers8.pdf.

Procedia
Environmental Science,
Engineering and Management
http://www.procedia-esem.eu

Procedia Environmental Science, Engineering and Management **1** (2014) (2) 183-186

18th International Trade Fair of Material & Energy Recovery and Sustainable Development,
ECOMONDO, 5th-8th November, 2014, Rimini, Italy

EVALUATION OF MEDITERRANEAN WASTES: A CASE STUDY FOR AEGEAN REGION AGRO-INDUSTRIAL WASTES*

Sayit Sargın, Fazilet Vardar Sukan**

Ege University, Faculty of Engineering, Department of Biongineering, 35100, Bornova, İzmir, Turkey

Abstract

Being a part of the Mediterranean basin the Aegean Region of Turkey contributes immensely to the Turkish economy with its agro-industrial infrastructure and consequently enormous amounts of agricultural wastes and surpluses are produced annually. Presently, these materials are very rarely reutilized. The fact that agro-industrial wastes contain economically valuable or microbially metabolizable components enable them to be converted to high value added products through biotechnological methods.
The objective of this study was to develop a data base and to determine the sources, quantities and qualities, the physical, chemical and biological characteristics of the Region's agro-industrial wastes.

Keywords: agro-industry, recycling, reuse, waste

1. Introduction

The Mediterranean region due to its climatic, geographical, economic and agricultural features together with socio-cultural habits has always been a distinctive area and is one of the densely populated parts of the world. The economies of many Mediterranean countries are agricultural and agro-industry based and because of rapid increase in urban populations as well as industrialization in these countries, vast amounts of residues and wastes are generated leading to a high turnover rate of organic material with an undisputable economic potential which is greatly undervalued.

*Selection and peer-review under responsibility of the ECOMONDO
**Corresponding author: fazilet.vardar.sukan@ege.edu.tr

Agro-industrial wastes could provide an abundant and viable source for renewable raw materials for the production of biofuels and green chemicals with high economic value, resulting in a favorable carbon dioxide balance through a biorefinery approach (Fava et al., 2013). Therefore, it is very important to identify feasible recycling and reutilization strategies, taking into consideration the availability, convertibility, cost, existing and potential usages of these waste materials. In addition market completion, investment conditions and socio-economic interactions and appropriate technologies have to be identified.

This study tries to give an overview to the potential valorization of agricultural and agro-industrial wastes through the model data obtained by a project conducted aiming to develop a data base and to propose respective industries, novel processes for utilizing their wastes and surpluses as raw materials for the production of high value added, salable products as an alternative to waste treatment processes (Vardar Sukan, 1993).

2. Materials and methods

The study was geographically limited to an extended Aegean Region also including the provinces, Balıkesir and Çanakkale due to their similar industrial make up. All industrial sectors using agricultural materials as raw materials were included. Data on the types, amounts and existing utilization methods were complied through mailed questionnaires and personal interviews.

The physical and chemical specifications of the wastes were determined through measurements and analyses such as protein, total carbohydrates, acid soluble carbohydrates, crude fiber, moisture, ash, lipids, calorific content and pH. In addition to these, studies were carried out to determine the indigenous microflora of the waste materials and the samples were screened for specific strains naturally adapted to utilize the main carbon source of the waste.

3. Results and discussion

The recycling and reutilization potentials were investigated with respect to the information obtained through questionnaires and the comprehensive literature survey conducted. Wastes were grouped on the basis of their main components, industrial sector and possible products to be produced.

Sixteen different Agro-industrial sectors were studied (Table 1) and 178 different types of wastes were identified. Analyses and measurements were carried out on forty-eight different samples collected as a result of company visits.

Table 1. Sectors included in the study (Vardar Sukan, 1998)

Bakery Products	***Carpets***
Macaroni and Pasta	Leather and Related Industries
Confectioneries and Chocolate	Tobacco and Related Industries
Various Canned Goods	Fig and Raisin Products
Dairy, Meat and Fishery Products	Wood and Related Industries
Oils and Fats	Paper and Publishing Industries
Pickled Foods	Agricultural Supplements
Cotton and Wool, Fibre and Weaving	
Alcoholic and Non-alcoholic Beverages	

The compositions of the wastes, presence of a toxic component, were determined. These data were subsequently used to derive some additional information for C/N ratios, starch, lignin and other material content of the samples (Table 2).

Furthermore, the samples were screened on the basis of genus and species and a total of 597 Isolates were determined out of which 316 were bacteria, 139 fungi and 142 yeasts. Selected organisms were screened for their, amylase, protease, cellulase and lactic acid production capabilities.

Existing conventional methods of reutilization were compared with novel methods used in other countries. Waste/Product ratios and estimated amounts of waste produced annually were presented for all the industrial sectors included in the study.

Table 2. C/N ratios of some waste materials (Vardar Sukan, 1998)

Waste	*Industry*	*C:N ratio*
Wheat straw	Flour	82
Olive cake	Olive oil, Vegetable oil	40.4
Sugar beet bagasse	Sugar	15.8
Malt bagasse	Beer	9.6
Rice husk	Rice	6.8
Tobacco dust	Tobacco	3.2
Sunflower bagasse	Olive oil, Vegetable oil	3.0
Cotton seed bagasse	Olive oil, Vegetable oil	2.9

Accordingly, it may be concluded that large amounts of wastes with high Waste/Product ratios exhibit an attractive potential for reutilization. However, it should be noted that the feasibility of reutilization is also a function of other parameters such as composition and alternative methods of utilization.

4. Conclusion

The study clearly shows that the Aegean Region agro-industrial wastes and surpluses have a very promising potential for reutilization. However, the success of reutilization depends on the regional distribution, seasonality, quantity, economic value, pretreatment requirements of the wastes as well as the scientific and technological know-how within the country, public awareness, governmental regulations and incentives.

It was concluded that, the possibilities for the production of economically valuable, high value added products should be further studied for each waste material, specifically in the light of the project results and the aforementioned limitations.

Acknowledgement
Some of the results of this study is based on the project titled “Development of a Data Base for Aegean Region Agroindustrial Wastes and Investigation the Possibilities of their Re-utilization through Biotechnologies” Project No: 182/S, 1997, supported by Technology Development Foundation of Turkey.

References

Fava F., Totaro G., Diels L., Reis M., Duarte J., Carioca O.B., Poggi-Varaldo H.M., (2013), Biowaste biorefinery in Europe: opportunities and research & development needs, *New Biotechnology,* **12,** DOI: 10.1016/j.nbt.2013.11.003.

Vardar-Sukan F., (1993), *Biotechnology for Agroindustry in Mediterranean Countries*, MED-CAMPUS Course Application of Biotechnology in Food and Chemical Industries, Sept. 6-10, Izmir, Turkey.

Vardar-Sukan F.,(1998), Development of a Data Base for Aegean Region Agroindustrial Wastes and Investigation the Possibilities of their Re-utilization through Biotechnologies, Novel Trends in Environmental and Agricultural Biotechnology NSF Workshop, May 11-14, İzmir, Turkey.

Procedia
Environmental Science,
Engineering and Management
http://www.procedia-esem.eu

Procedia Environmental Science, Engineering and Management **1** (2014) (2) 187-192

18th International Trade Fair of Material & Energy Recovery and Sustainable Development,
ECOMONDO, 5th-8th November, 2014, Rimini, Italy

ECOINNOVATION5 - The industrial symbiosis between theory and practice

INDUSTRIAL SYMBIOSIS DEVELOPMENT IN ITALY: HOW THE REGULATORY FRAMEWORK AFFECTS THE FEASIBILITY OF PROCESSES*

Antonella Iacondini[1], Ivano Vassura[1,2], Ugo Mencherini[3,4], Fabrizio Passarini[1,2]**

[1]University of Bologna, Interdepartmental Centre for Industrial Research "Energy and Environment", Italy
[2]University of Bologna, Department of Industrial Chemistry "Toso Montanari", Italy
3Aster S. Cons. P. A. , Italy
[4]University of Bologna, Department of Industrial Engineering, Italy

Abstract

Industrial Symbiosis is strongly encouraged by European Commission, as described in the COM (2012) 582 - A Stronger European Industry for Growth and Economic Recovery and in related documents.
In this work Italian efforts to introduce the legislation will be analyzed and compared with the international state of the art.

Keywords: circular economy, industrial development, industrial symbiosis, waste regulatory framework, waste valorization

*Selection and peer-review under responsibility of the ECOMONDO
**Corresponding author: antonella.iacondini@unibo.it

1. Introduction

Industrial Symbiosis is strongly encouraged by European Commission, as described in the COM (2012) 582 - A Stronger European Industry for Growth and Economic Recovery and in related documents (EC, 2012).

In this work Italian efforts to introduce the legislation will be analyzed and compared with the international state of the art.

A Stronger European Industry for Growth and Economic Recovery

In 2012 the Commission defined some Priority Action Lines to define European Industry of 21th Century.

The first one is called: “Markets for advanced manufacturing technologies for clean production” and asserts that tomorrow's factories will use highly energy- and material-efficient processes, employ renewable and recycled materials, and increasingly adopt sustainable business models such as Industrial Symbiosis to recover materials and dissipated heat and energy. The Commission considers that these technologies represent an important business opportunity, with a global market that is expected to double in size, to over € 750 billion by 2020.

Policy co-ordination of EU and Member State policies and stakeholder efforts are enhanced through a dedicated Task Force. The Task Force on Advanced Manufacturing for Clean Production is a European Commission working group aimed at fostering the development and adoption of advanced manufacturing for clean production by European industry. It is aimed at providing information about existing measures relevant to advanced manufacturing that have already been implemented in recent months and upcoming actions previously endorsed by the Commission to support advanced manufacturing technologies.

In 2014, the Staff Working Document of the Task Force [SWD(2014)120] reports that more than 1.000 industrial companies participated in the U.K’s National Industrial Symbiosis Programme (NISP), which by promoting the collaboration of different organisations has been able to reap very substantial benefits, both economic (£ 100 million) and environmental (3.4 million tonnes CO_2 reductions) through the coordinated use of materials, energy, water and/or by-products and the sharing of assets, logistics and expertise.

The Annex 1: A Manufacturing Industry Vision 2025 [SWD(2014)120], a study concerning Industrial Symbiosis performed in 2013 by the Joint Research Centre of the European Commission, reports that in 2025 there will be a fully globalised economy. This economy will serve an informed and prosperous global middle class that will require personalized goods and services, based on advanced manufacturing systems enabled by ICT and supplied by European resource efficient and sustainable industries. Clusters of partners offering specialized services will form in certain geographical locations, based on similar technological skills, a common interest in a nearby source of raw materials or shared energy schemes. These partners will act as an ”ecosystem”, applying Industrial Symbiosis, feeding off each other in the value chain, and enabling the “fertilization” of technology (Laybourn and Lombardi, 2012).

Continued investment in R&D for advanced manufacturing technologies is of prime importance for the competitiveness of manufacturing industry in the EU. In Horizon 2020, the EU Framework Programme for Research and Innovation in 2014- 2020, a significant part of the budget (17.6%) will be dedicated to promote leadership in enabling and industrial technologies, including advanced manufacturing technologies. However, investment in R&D is a necessary but not a sufficient condition for industrial leadership. It is not the excellence in research, but the commercialization of research results on the market that generates turnover and jobs in industry.

In general, Europe suffers from weak industrial exploitation of new technologies stemming from research undertaken in the EU, mainly due to the current low growth prospects and insufficient exploitation of the potential of the single market. Industry participation in research programmes plays an important role in improving the industrial exploitation of research results.

High cost and high risk investments in proof-of-concept demonstration projects and pilot lines require public-private partnerships (PPPs) with industry at EU level to ensure timely commercialization. The NER300 funding programme for innovative low-carbon energy demonstration projects and the Sustainable Industry Low Carbon (SILC) grant scheme supporting innovation in greenhouse gas efficiency also play an important role COM(2012) 582 (EC, 2012).

2. Materials and work context

A general landscape of the influencers of a successful implementation of Industrial Symbiosis is reported in Fig. 1 (Iacondini et al, 2014; Jacobsen, 2012).

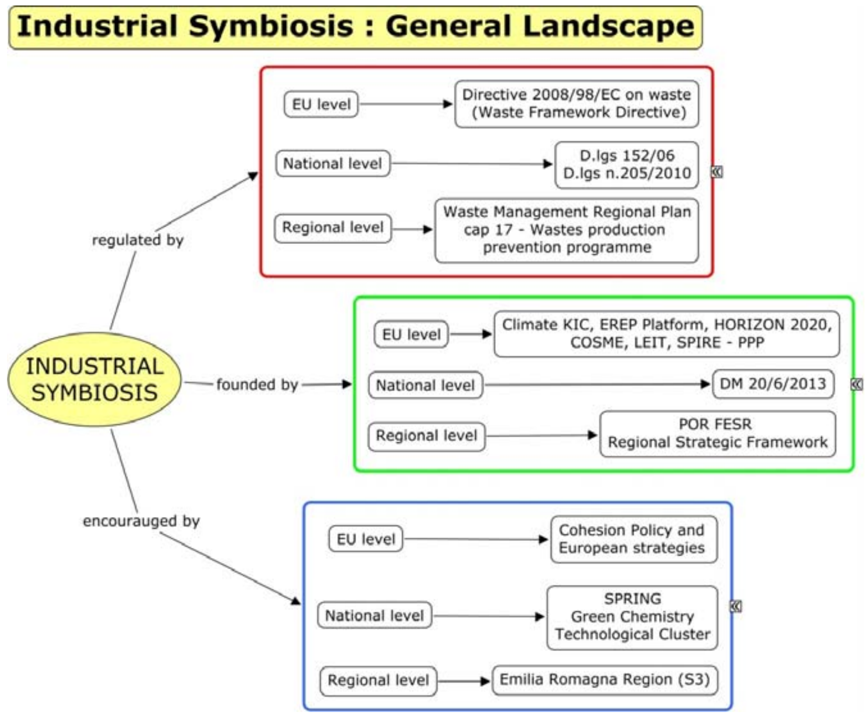


Fig. 1. Factors for successful implementation of Industrial Symbiosis

The Italian situation: light and shade

Even if Industrial Symbiosis is not expressly requested by Italian regulation, it has been recently encouraged and considered as a strategic tool in the Italian Regional Policies: this is the case of S3 Smart Specialization Strategies in Emilia Romagna and Lazio regions.

The new Cohesion Policy 2014-2020 Programming Cycle expect, as an " ex-ante" condition for the use of community resources, that national and regional authorities develop research and innovation strategies aimed at the "smart specialization". This is in order to allow a more efficient use of structural funds and to increase synergies between EU, national and regional authorities.

All the Member States Regions have been called to draw up their Smart Specialization Strategy outlines, based on available resources and attitudes, identifying the competitive advantages and the technological specializations consistent with their potential for innovation and detailing the public and private investments required with particular regard to research, technological development and innovation (Smart Specialization Strategy (SSS), 2014).

Developing operationally the SSS strategies, different technological specializations were decided to be strategic and considered most relevant for a growth strategy of the each territory, taking into account the peculiarities of every area.

Every specialization is characterized by key-subjects decided to be implemented (Invitalia, 2014):

For example, in Emilia Romagna were identified five specializations:

- Agrifood (Industrial Symbiosis, biomasses management, smart water management, sustainable production systems, smart packaging).
- Building (waste valorization, energy efficiency, renewable resources).
- Mechatronics and motor design and manufacture (ecodesign, energy efficiency, critical materials and substitutive).
- Healthiness industries.
- Creative and cultural industries.

As can be seen, in the first three specializations, Industrial Symbiosis and resources management are included as key –subjects, important tools to increase efficiency and sustainability in industrial processes.

The Italian Government finances economic development with a Fund for the Sustainable Growth (DM, 2013). The goal is to promote innovation through research and development projects, performed by SMEs, utilizing defined technologies. These are identified in a list, connected with Industrial Symbiosis purposes, including items such as materials for a sustainable industry, able to facilitate low emission production, energy efficiency, strengthening of industrial processes, recycle, decontamination and reuse of high value-added materials coming from residues and rebuilding (SSS, 2014).

The application of Industrial Symbiosis in Italy is affected by the subordination to the waste legislative framework, first of all, Law 152 (2006) (transposal of the Waste Framework Directive 2008/98/CE, (EC Directive, 2008)) and its amendment, through Law 205 (2010).

The regulatory landscape about waste is quite complex and different kind of wastes are faced in different regulations, for example WEEE (Law 151, 2005), End of Life vehicles (Law 209, 2003), or co-incineration plants (Law 133, 2005); the application of the regulation framework is managed by local authorities, often with different rules in different counties. This complexity often leads to authoritative problems which sometimes discourage the entrepreneurs' attempts to apply sustainable processes to reuse industrial byproducts.

The red tape is the main problem but not the only one. Not always the economic convenience of a process is clear and defined by the industrial researchers, who propose their innovative solutions to industrial stakeholders. A deeper knowledge on economics aspects and a common language between industry and research could help the industrial application of many sustainable processes. Lack or wrong communication towards enterprises is another difficulty. Italian researchers are no used to interact with the commercial and industrial environment and very often their message appears weak and unattractive for business.

Also the collaboration between different enterprises and different production chains has to be improved: industrial symbiosis needs an efficient dialogue between producers and end-users of byproducts. For the same reason also entrepreneurs have to overcome their resistance to spread sensitive data about waste fluxes. All these obstacles to a successful application of Industrial Symbiosis could be avoided through a strong coordination plan from a leader institution. Positive examples of intervention of good policies abroad are known: first of all the NISP project in UK and the Kalundborg Industrial Park in Denmark could be studied. In Italy the first initiative about promoting Industrial Symbiosis has been performed by ENEA in Sicily (Cutaia et al., 2014)

3. Conclusions

Sustainability in waste management and resource efficiency is one of the main goals defined by the European Commission to go towards a Stronger European Industry for Growth and Economic Recovery.

Industrial Symbiosis demonstrated to be a good tool to reach the EC objectives and Italy has to work develop it, following some best practices from the other countries. Public administrations, private enterprises and industrial research are the actors to be involved in this evolution. Starting from good policies, the Government could start a positive pathway able to change the behavior of Public Administrations, industries and researchers, giving them the instruments to activate effective public–private partnership (PPP).

Acknowledgements
This work was carried out by CIRI Energia e Ambiente and Aster, with the cooperation of Emilia-Romagna Region and Emilia Romagna High Technology Network within the POR FESR 2007-2013 funding.

References

Cutaia L., Morabito R., Barberio G., Mancuso E., Brunori C., Spezzano P., Mione A., Mungiguerra C., Li Rosi O., Cappello F., (2014), *The Project for the Implementation of the Industrial Symbiosis Platform in Sicily: The Progress After the First Year of Operation*, In: *Pathways to Environmental Sustainability*, Salomone R., Saija G. (Eds.), Springer, 205-214.

DM, (2013), Fund for sustainable growth. Implementation of interventions for the promotion of research, development and innovation (in Italian), Ministerial Decree No. 228 of 28 September 2013, D.M. 20/6/2013, Rome, Italy.

EC, (2012), Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions A Stronger European Industry for Growth and Economic Recovery Industrial Policy Communication Update, COM(2012) 582, European Commission, Brussels, On line at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2012:0582:FIN:EN:PDF.

EC Directive, (2008), Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives, Official Journal of the European Union, **L31**, 3-28.

Iacondini A., Vassura I., Fanelli A., Cibotti P., Mencherini U. Passarini F., (2014), Feasibility of Industrial Symbiosis in Italy as an Opportunity for Economic Development: Critical Success Factor Analysis, Impact and Constrains of the Specific Italian Regulations, Proc. of SYMBIOSIS International Conference 19-21 June, Athens, Greece, On line at: http://conference2014.esymbiosis.eu/pdf/iacondini_et_al.pdf

Invitalia, (2014), The Map of the Technological Specializations. The regional Framework, On line at: https://www.researchitaly.it/uploads/7553/Mappatura%20specializzazioni_Il%20quadro%20regionale_1.pdf?v=801f04a

Jacobsen N.B., (2012), Industrial symbiosis in Kalundborg, Denmark. A quantitative assessment of economic and environmental aspects, *Journal of Industrial Ecology*, **10**, 239-255.

Laybourn P., Lombardi R., (2012), Industrial symbiosis in European policy: Overview of recent progress, *Journal of Industrial Ecology*, **16**, 11-12.

Law 209, (2003), Implementation of Directive 2000/53/EC on end-of-life vehicles, *Official Journal*, No. 182 of the 07 August 2006 – Ordinary Supplement No. 128.

Law 133, (2005), Implementation of Directive 2000/76/EC on the incineration of waste, *Official Journal*, No. 163 of the 15 July 2005 – Ordinary Supplement No. 122.

Law 151, (2005), Implementation of Directives 2002/95/EC, 2002/96/EC and 2003/108/EC on the restriction of use of hazardous substances in electrical and electronic equipment, as well as' waste disposal, *Official Journal*, No. 171 of the 29 July 2005 – Ordinary Supplement No. 135.

Law 152 (2006), Legislative Decree No. 152 of the 03 April 2006, Environmental Regulations, *Official Journal*, No. 88 of the 14 April 2006 – Ordinary Supplement No. 96.

Law 205, (2010), Legislative Decree No.105 of the 08 July 2010, Urgent measures on energy, *Official Journal*, No. 158 of 09 July 2010.

SSS, (2014), Smart Specialisation Strategy, On line at: https://www.researchitaly.it/en/understanding/strategies-challenges/strategies-and-programs/smart-specialisation-strategy/

Procedia
Environmental Science, Engineering and Management
http://www.procedia-esem.eu

Instructions for authors

1. Introduction

Procedia Environmental Science, Engineering and Management publishes paper selected from Conference Proceedings focusing on multi-disciplinary nature of the environmental issues, and offers authors and conference organizers a rapid way to make available maximum visibility for their papers. The main responsibility for paper selection and first peer-review belongs to the Conference Organizers, who should guarantee quality control, the review process and the content of individual conference papers.

Submission of a manuscript implies that the work described has not been published before (except in the form of an abstract or as part of a published lecture, review, or thesis); that it is not under consideration for publication elsewhere; that its publication has been approved by all coauthors, if any, as well. The Conference Organizers and the Editor-in-Chief will agree and sign a bilateral agreement with technical and financial details for paper publication.

Papers, books for review, offers to review, suggestions and commercials (advertising) should be submitted to the Editor-in-Chief or Co-Editor. All papers will be published in English. Non-English speaking authors should seek the advice of a professional language expert or an English speaker to help translate the paper.

2. Legal requirements

The Conference Organizers and author(s) guarantee that the manuscript is/will not be published elsewhere in any language without the consent of the copyright holders, that the rights of third parties will not be violated, and that the publisher will not be held legally responsible should there be any claims for compensation.

Authors wishing to include figures or text passages that have already been published elsewhere are required to obtain permission from the copyright holder(s) and to include evidence that such permission has been granted when submitting their papers. Any material received without such evidence will be assumed to originate from the authors.
The author(s) are encouraged to transfer the copyright of the article to the publisher upon acceptance of an article by the journal, using the *Authors' Warranty and Assignment of Copyright agreement*. This transfer enables the Editor to protect the copyrighted material for the authors, but does not resign the authors' proprietary rights. The publication of an article is conditioned by the signature of the author to whom correspondence should be addressed on this *Authors' Warranty and Assignment of Copyright agreement* that is provided by the Editor.

Ethics in publishing

For information on ethics in publishing for journal publication please read the **Journal Ethics.**

Conflict of interest

All authors are requested to disclose any actual or potential conflict of interest such as any financial, personal or other relationships with other people or organizations concerning the submitted work that could inappropriately influence, or be perceived to influence, their work.

3. Editorial procedure

Maximum 10 pages are accepted (including Abstract, Keywords, References, Figures and Tables), processed with MS editing facilities, using the manuscript template.

Manuscripts should be written in US English and submitted electronically, in .doc format (please do not use .docx) by the Conference Organizers to the Editor-in-Chief, at procedia_esem at yahoo dot com. Please be sure to include your full affiliation address and e-mail address.

4. Manuscript preparation

Authors must follow guide for authors strictly (manuscript template), failing which the manuscripts would be rejected without review. Editors reserve the right to adjust the style to certain standards of uniformity.

Manuscripts should be concise, in 1.5 line spacing, and should have 2 cm all over margins. The font should be Times New Roman of size 12 points. The numbering of chapters should be in decimal form. Ensure that each new paragraph is clearly indicated, using TAB at 1.25 pts.

Title page will contain

A concise and informative title (Times New Roman bold, all caps of size 13points); the maximum length of the title should be maximum 150 letters and spaces; The full name(s) of the author(s) (first name, then last name, with Times New Roman bold 11 points) should be written below the title. The affiliation(s) and complete postal address (es) of the author(s) will be provided immediately after the full name of the authors and will be written with Times New Roman italic 9 points. When the paper has more than one author, their name will be followed by a mark (Arabic numeral) as superscript; for the corresponding author, two asterisks will be added using *Word_Insert_Reference_Footnote_Symbol* sequence.

Also, the full and e-mail addresses, telephone and fax numbers of the corresponding author will be provided in the footer of the first page, as: *Corresponding author*: email..., Only one corresponding author has to be provided.

A bstract: each manuscript must be preceded by an abstract presenting the most important results and conclusions in no more than 300 words, written with Times New Roman 9 points.

Ke y words: three to five key words should be supplied after the Abstract for indexing purposes, **ordered alphabetically**, using American spelling and avoiding general and plural terms and multiple concepts (avoid, for example, "and", "of"). Be sparing with abbreviations: only abbreviations firmly established in the field may be eligible. These keywords will be used for indexing purposes.

The text of the paper should be divided into Introduction, Experimental, Results and Discussion, Conclusions, References (or Case-studies presentation instead ofexperimenta).

The text layout must be on a single column.

Introduction

State the objectives of the work and provide an adequate background, avoiding a detailed literature survey or a summary of the results.

Material and methods

Provide sufficient detail to allow the work to be reproduced. Methods already published should be indicated by a reference: only relevant modifications should be described.

Experimental

Provide sufficient detail to allow the work to be reproduced. Methods already published should be indicated by a reference: only relevant modifications should be described.

Results and Discussion

Results should be clear and concise. Discussion should explore the significance of the results of the work, not repeat them. Avoid extensive citations and discussion of published literature.

Conclusions
The main conclusions drawn from results should be presented in a short Conclusions section (maximum 100 words).

Formulae, symbols and abbreviations Formulae will be typeset in Italics (preferable with the Equation Editor) and should be written or marked for such in the manuscript, unless they require a different styling. The formulae should be quoted on the right side, between brackets:

$$(x_1+x_2)^2 = x_1^2 + x_2^2 + 2x_1x_2 \qquad (1)$$

Abbreviations should be defined when first mentioned in the abstract and again in the main body of the text and used consistently thereafter.
SI units must be used throughout.
Footnotes should be avoided.

References The list of References should only include works that are cited in the text and that have been published. References should be cited in the text in brackets (Harvard style) as in the following example: (Schmidt, 1989), (Schmidt and Walter, 1996), (Walter et al., 1999).

References should be alphabetically listed at the end of paper, with complete details, as follows:

Books:

Book chapter: Names and initials of authors; year, article title; editors; title of the book (italic); edition; volume number; publisher; place; page number:

Cutaia L., Morabito R., Barberio G., Mancuso E., Brunori C., Spezzano P., Mione A., Mungiguerra C., Li Rosi O., Cappello F., (2014*), The Project for the Implementation of the Industrial Symbiosis Platform in Sicily: The Progress After the First Year of Operation*, In: *Pathways to Environmental Sustainability,* Salmone R., Saija G. (Eds), Springer Science & Business Media, Cham Heidelberg New York Dordrecht London, 205-214.

Books:
Faber K., (2000), *Biotransformations in Organic Chemistry - A Textbook*, vol.VIII, 4th Edition, Springer, Berlin-Heidelberg-New York.

Handbook, (1951), *Handbook of Chemical Engineer*, vol. II, (in Romanian), Technical Press, Bucharest, Romania.

Symposia volumes: Names and initials of authors; year; article title; full title; symposium abbreviated; volume number; place; date; page number:
Masutti D.C., Borgognoni A., Scardovi F., Vaccari C., Setti L., (2014), *Production of Lignocellulosic Enzymes from Different Agro-Food Wastes by Solid State Fermentation*, Proc. of 5th International Conference on Engineering for Waste and Biomass Valorisation - Rio de Janeiro, September 6th-8th, Brazil.

Journal papers: Names and initials of authors; year (between brackets); full title of the paper; full name of the journal (italic); volume number (bold); first and last page numbers:

Setti L., Giuliani S., Spinozzi G., Pifferi P.G., (1999), Laccase-catalyzed oxidative coupling of 3-methyl 2-benzothiazolinone hydrazone and methoxyphenols, *Enzyme Microbial Technology*, **25**, 285-289.

Patents: Names and initials of authors; year; patent title; country; patent number:
Grant P., (1989), Device for Elementary Analyses. USA Patent, No. *123456*.

Dissertations: Names and initials of authors; year; title; specification (Ph. D. Diss.); institution; place:

Guikema J.W., (2004), *scanning hall probe microscopy of magnetic vortices in very underdoped yttrium-barium-copper-oxide*, PhD Thesis, Stanford University, Stanford, USA.

Star K., (2008), *Environmental risk assessment generated by natural hazards*, MSc Thesis, Institute of Hazard Research, Town, Country.

Legal regulations and laws, organizations: Abbreviated name; year (between round brackets); full name of the referred text; document type; author; URL address:

JRC European Commission, (2011), *Supporting Environmentally Sound Decisions for Construction and Demolition (C&D) Waste Management*, A practical guide to Life Cycle Thinking (LCT) and Life Cycle Assessment (LCA), On line at: http://lct.jrc.ec.europa.eu/pdf-directory/ReqNo-JRC65850-LB-NA-24916-EN-N.pdf.

EC Directive, (2010), Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (Integrated Pollution Prevention and Control), *Official Journal of the European Union*, **L334**, 17-119.

EC, (2014), Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions Towards a Circular Economy: A zero waste programme for Europe, European Commission, On line at: http://ec.europa.eu/environment/circular-economy/

Law 152 (2006), Legislative Decree No. 152 of the 03 April 2006, Environmental Regulations, *Official Journal*, No. 88 of the 14 April 2006 – Ordinary Supplement No. 96.

GD, (2004), Governmental Decision no. 1076/2004 surnamed SEA Governmental Decision, regarding the procedure for strategic environmental impact assessment for plans or programs, published in Romanian Official Monitor, part I, no. 707 from 5th of August, 2004.

Web references: The full URL should be given in text as a citation, if no other data are known. If the authors, year, title of the documents are known and the reference is taken from a website, the URL address has to be mentioned after these data.

Web references must not be listed separately, after the reference list.
All references must be provided in English with a specification of original language in round brackets.

Lorint C., (2012), *Natural Protected Areas and Biodiversity Preservation* (in Romanian), Universitas Press, Petroşani, Romania.

Citation in text Please ensure that every reference cited in the text is also present in the reference list (and vice versa). Do **not cite references in Abstract and Conclusions**

Unpublished results, personal communications as well as URL addresses are not recommended in the reference list, but may be mentioned in the text.
Citation of a reference as "in press" implies that the item has been accepted for publication. Papers which have been accepted for publication should be included in the list of references with the name of the journal and the specification "in press".

Abbreviations
Define all abbreviations at their first mention in the text. Ensure consistency of abbreviations throughout the article.

Acknowledgements
Include acknowledgements in a separate section at the end of the article before the references and do not, therefore, include them on the title page, as a footnote to the title or otherwise. List here those individuals who provided help during the research (e.g., providing language help, writing assistance or proof reading the article, funding supports etc.).

Footnotes
Footnotes must be avoided. Do not include footnotes in the Reference list.

Table footnotes
Indicate each footnote in a table with a superscript lowercase letter.

Tables
Draw the tables in grid format using a basic, solid line style without shadows. Ensure that the data presented in Tables do not duplicate results described in Figures or elsewhere in the article.

Figures
Number Figures consecutively in accordance with their appearance in the text. All illustrations should be provided in camera-ready form, suitable for reproduction, which may include reduction without retouching.
Photographs, charts and diagrams are all to be referred to as Figure(s) and should be numbered consecutively, in the order to which they are referred.
Figures may be inserted as black line drawings. They should be pasted on, rather than taped, since the latter results in unclear edges upon reproduction.
Ensure that each illustration has a caption, placed below the Figure. A caption should comprise a brief title (not on the Figure itself) and a description of the illustration. Keep text in the illustrations themselves to a minimum but explain all symbols and abbreviations used. Multiple Figures can be expressed as one Figure (for e.g. 1a, 1b, 1c etc...), while retaining the maximum limit of 6.

ALL Figures must be submitted in either .jpg or .tiff format with a very good resolution (but do not submit graphics that are disproportionately large for the content).

Figures and Tables must be embedded in the text.

Proofs
Proofs will be sent to the corresponding author (mainly by e-mail) and should be returned within 48 hours of receipt. Corrections should be restricted to typesetting errors; any other changes may be charged to the author.

Article in electronic format
Authors are asked to submit their final and accepted manuscript as an attachment as .doc or .rtf document to the e-mail.

Authors are provided with the electronic format of the article as .pdf, free of charge. Further supplies in hard copy may be ordered on a reprint order form, which will be sent to the author from the Editor's office. This request will be formulated when the final form of the manuscript (the electronic one) is provided by the author.

P - ESEM

Edited by the ***National Society of Environmental Science and Engineering*** (SNSIM) as Publisher
(http://snsim.ro/)
within the SNSIM Publishing House, Cluj-Napoca, Romania