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Waste to Resource value chain optimisation by applying the Life Cycle Thinking approach to the regional management system of construction and demolition waste (CDW)

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Context

Construction and demolition waste (CDW)

- **30-35%** of **the total waste** yearly generated in Europe
- **70% recycling target** set by the directive 98/2008/EC
- recent programs/initiatives aiming at fostering the transition towards **circular economy** (e.g. Communication “Resource efficiency opportunities in the building sector” (2014), Circular Economy Action Plan (2015))

The government of Regione Lombardia chose the Life Cycle Thinking approach to assess and optimize its own CDW management system.

Description of the project

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Environmental sustainability of the CDW management system in Lombardy by applying the Life Cycle Assessment (**LCA**) methodology

Research project (Apr 2016 – Sept 2017) in collaboration with:

POLITECNICO MILANO 1863 · AWAR · Regione Lombardia · LEAP Laboratorio Energia e Ambiente Piacenza

Sara Pantini, Eng. Ph.D.
Lucia Rigamonti, Eng. Ph.D.

Economic sustainability of the CDW management system in Lombardy by applying the Life Cycle Costing (**LCC**) methodology

Part of a Ph.D. project (Nov 2019 – Ongoing) in collaboration with:

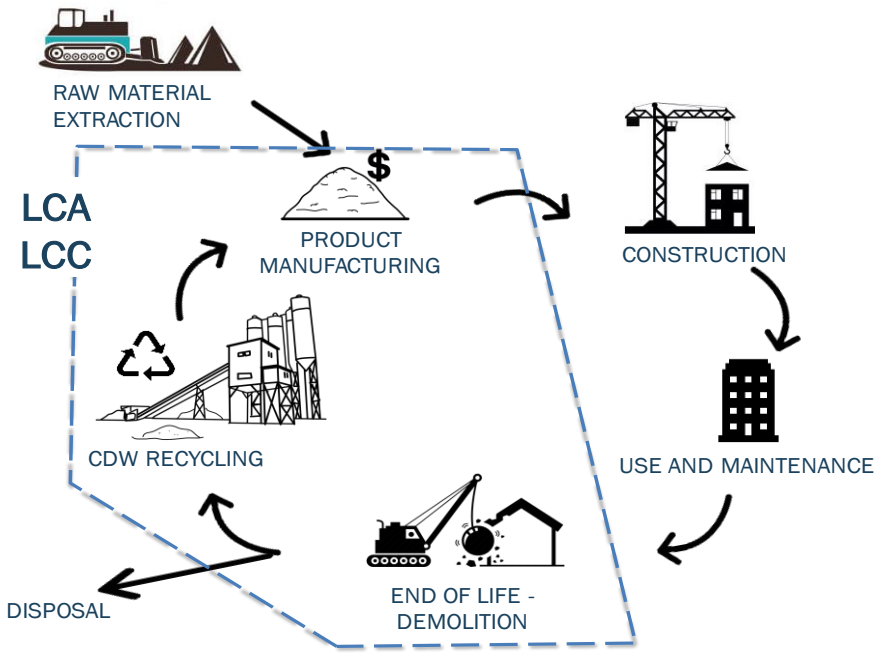
POLITECNICO MILANO 1863 · AWAR · Regione Lombardia · ENEA Agenzia nazionale per le nuove tecnologie, l'enl'energia e lo sviluppo economico sostenibile

Federica Carollo, Eng.
Lucia Rigamonti, Eng. Ph.D.

Francesca Ceruti, Ph.D.

Methodology framework and scope

The environmental (LCA) and economic (LCC) analyses encompass all the processes from the waste entering the regional management system until it leaves the system as a “secondary resource” or final emission to environment (disposal).



OBJECTIVES

- *To highlights both good aspects and critical issues along the entire value chain*
- *To identify possible improvements, based on environmental and economic considerations*
- *To give recommendations to the regional government to maximize its resource-efficiency*

Methodology: LCA

1. Goal and scope definition

Year of reference: **2014**

Type of waste analyzed: **non-hazardous CDW, excluded categories 1705 and 1706**

System boundaries: **regional plant system, import / export excluded**

2. Inventory analysis

Quantification of waste flows: **official MUD (i.e. yearly waste declaration) database**

Material/energy consumption and emissions associated with the CDW recycling: **primary data** collected through **technical visits at major CDW plants and questionnaires**

Quality and actual end-uses of recycled aggregates: **primary plant data + questionnaires + interviews with some construction companies**

3. Impact assessment

Software: **SimaPro, ecoinvent** database

Impact assessment method: **ILCD 2011**

4. Interpretation and improvement

Methodology: LCC

The LCC investigates the costs (in euros) of the whole CDW recycling chain and evaluates the most effective solutions from an economic perspective.

Data collection: Survey

Demolition companies
Year of reference: 2019

The survey requests data about preliminary costs (e.g. preparation of the demolition site), machinery acquisition costs, management costs (labor costs, diesel and water consumption costs, etc.), and transportation and delivery costs/profits.

The result of the survey is the sum of the total cost of demolition including the end-of-life of the output flows, thus getting the total cost per m^3 demolished.

CDW recycling plants
Year of reference: 2019

The survey requests data about preliminary costs (e.g. land purchase), machinery acquisition costs, management costs (labor costs, diesel and water consumption costs etc.), and transportation and delivery costs/profits (both input and output flows).

The survey aims to separate the costs from the profit of the plant to verify the consistency with the gate fees declared by the demolition companies.

Issues addressed

Life Cycle Assessment (LCA)

- *13 environmental impact categories*

Climate change	Cancer and non cancer effects	Terrestrial eutrophication	Freshwater ecotoxicity
Ozone depletion	Particulate matter	Freshwater eutrophication	Water resource depletion
Human toxicity	Photochemical ozone formation	Marine eutrophication	Mineral and fossil resource depletion
Acidification			

- *Energetic indicator (i.e. Cumulative Energy Demand)*
- *"Ad-hoc built" indicator (for natural resource consumption/saving)*

Life Cycle Costing (LCC)

- *costs*

Preliminary costs
Machinery acquisition costs
Management costs
Transportation and delivery costs/profits

Evidence of success

The LCA allowed to identify hotspots of the CDW value chain in Lombardy Region:

- Deficiencies in the treatment of some specific waste streams (e.g. gypsum-based waste)
- Unstable market of recycled aggregates (on average, 70% RAs sold)
- Poor competitiveness of RAs due to large availability and low prices of natural aggregates
- Low-grade applications of RAs due to quality issues (presence of unwanted materials as soil or gypsum)
- Absence of EoW criteria, low-knowledge and diffidence on RAs technical properties among the main reasons preventing widespread RAs uses

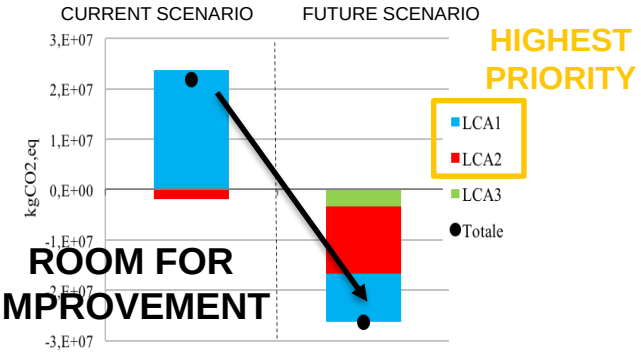
How to improve the sustainability of the system

How to measure its effectiveness

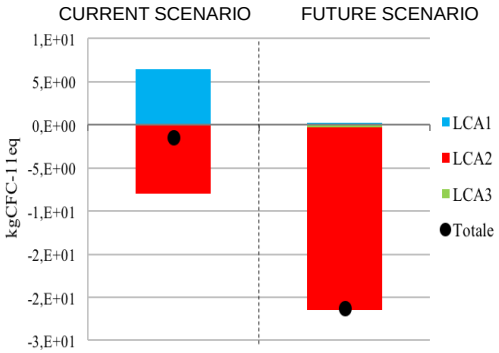
Evidence of success

Quantification of the environmental benefits potentially achievable with the proposed solutions by comparing current vs future scenarios

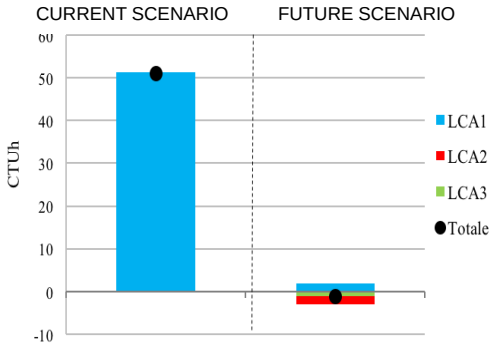
Climate Change



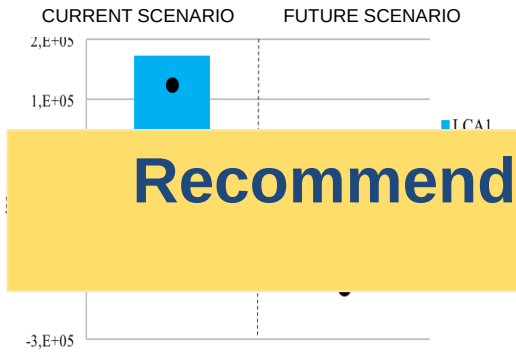
Ozone Depletion



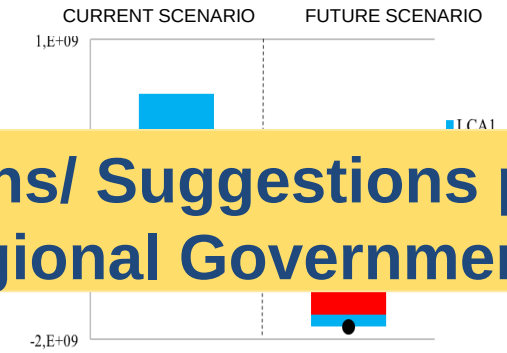
Human Toxicity, no canc.



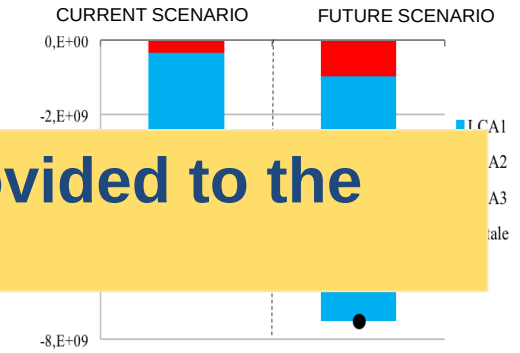
Acidification



Energetic Indicator - CED



Sand & Gravel consumption



Recommendations/ Suggestions provided to the Regional Government

Total CDW managed in Lombardy in 2014: 7.38 Mt (EER 1701,170302,170802,170904)

Evidence of success

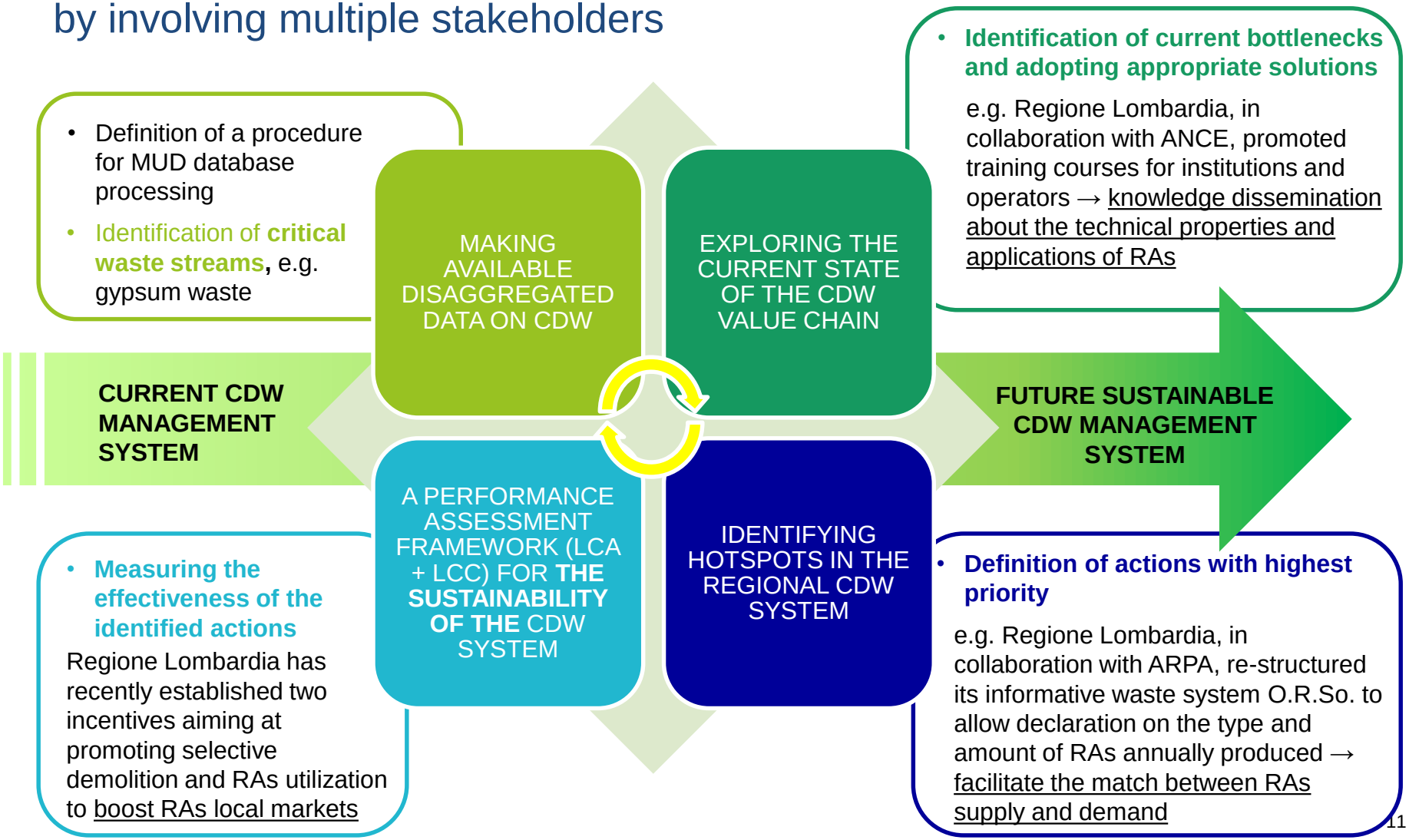
High-priority objectives and suggested actions:

SHORT-TERM ACTIONS ARE HIGHLIGHTED WITH YELLOW COLOUR

TO FOSTER THE MARKET OF RECYCLED AGGREGATES - RAs	
Effective implementation of existing regulatory tools aimed at favouring the use of RAs	• Make the DM 203/2003 and CAM for construction fully operational • Introduce incentives on construction works that use RAs
A more sustainable planning of the mining activities of natural resources (NA)	• Increase taxes on mineral extraction • Authorisation of excavated volumes should take into consideration for the local availability of recycled aggregates
Avoid unfair competition between RAs and NA	Update the sector's technical instruments to the European standards (e.g. Call for Tenders, price lists of construction works)
TO PROMOTE THE PRODUCTION OF HIGH-QUALITY RAs	
Widespread application of selective demolition, so that highly homogeneous CDW streams are generated	• On—site multi-streams waste separation should be awarded • Creation of new chains/ Enforcement of existing chains for those materials currently mixed in CDW e.g. gypsum
Upgrading existing CDW recycling plants	• Favour the operation of recycling plants powered with electricity (in the authorisation process) • And, more advanced technology for separation of light-impurities • Avoid the mixing of different waste streams in the CDW plants (e.g. reclaimed asphalt, gypsum)
TO OPTIMIZE THE WASTE MANAGEMENT SYSTEM	
Minimization of waste transportation and limitation of intermediate waste management steps	• Platforms facilitating the match between RAs demand and supply • Definition of location criteria for new CDW plants taking into account for local «deficiency of treatment»

Potential for learning

Implementation of concrete actions for optimizing CDW management by involving multiple stakeholders



Potential for transfer

The Good Practice implementing the combined *Life Cycle Assessment* and *Life Cycle Costing* approach:

- can be extended to other regional contexts
- can be used to evaluate other waste management systems e.g. steel slags or bottom ash from municipal waste incineration
- provides guidance for other regional governments interested in improving the sustainability of their own waste management system
- assists policy makers in monitoring and refining waste management plans in relation to sustainability goals
- improves regional competitiveness in successfull economic and policy development

Challenges

- Processing official MUD database (ARPA) requires a complex procedure to extract disaggregated data at waste code level, with **long processing time** (punctual mass balances were applied to find out data discrepancies) (e.g. 7 waste codes, >300 plants in Lombardy → 2-3 months)

- **Data collection is a challenging step**, but fundamental for generating an accurate inventory (collecting data about the amount, types and sold volumes of recycled aggregates can be difficult and **time-consuming**; economic data are rarely provided, due to **confidentiality**)

- The proposed combined approach LCA + LCC requires time, resources (to obtain data and information) as well as **expert knowledge on the life cycle methodologies** (for a fair modelling)

Publications

- Borghi G., Pantini S., Rigamonti L. (2018). “Life cycle assessment of non-hazardous construction and demolition waste (CDW) management in Lombardy region (Italy)”. Journal of Cleaner Production, 184, 815-825.
- Borghi G., Pantini S., Rigamonti L. (2017). “Analisi LCA a supporto della pianificazione della gestione dei rifiuti da costruzione e demolizione non pericolosi in Lombardia”. Ingegneria dell'Ambiente, Vol. 4 n. 4/2017, 313-328.
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- Rigamonti L., Pantini S., Borghi G. (2017). "Valutazione con metodologia LCA (Life Cycle Assessment) dei flussi e del destino dei rifiuti da costruzione e demolizione". Reports and annexes available at: https://www.regione.lombardia.it/wps/portal/istituzionale/HP/DettaglioRedazionale/servizi-e-informazioni/Enti-e-Operatori/ambiente-ed-energia/Rifiuti/valutazione-con-metoldologia-lca-flussi-rifiuti-da-costruzione-demolizione

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Thank you!

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Questions welcome

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