

Transnational Learning Document #3

LCA for waste
management
and material
flows

October 2020

Improved Environmental and
Resource Efficiency through use of
Life Cycle Instruments for
implementation of regional policies
of the European Union

LCA4Regions
Interreg Europe



There are many ways of planning for **regional development**.

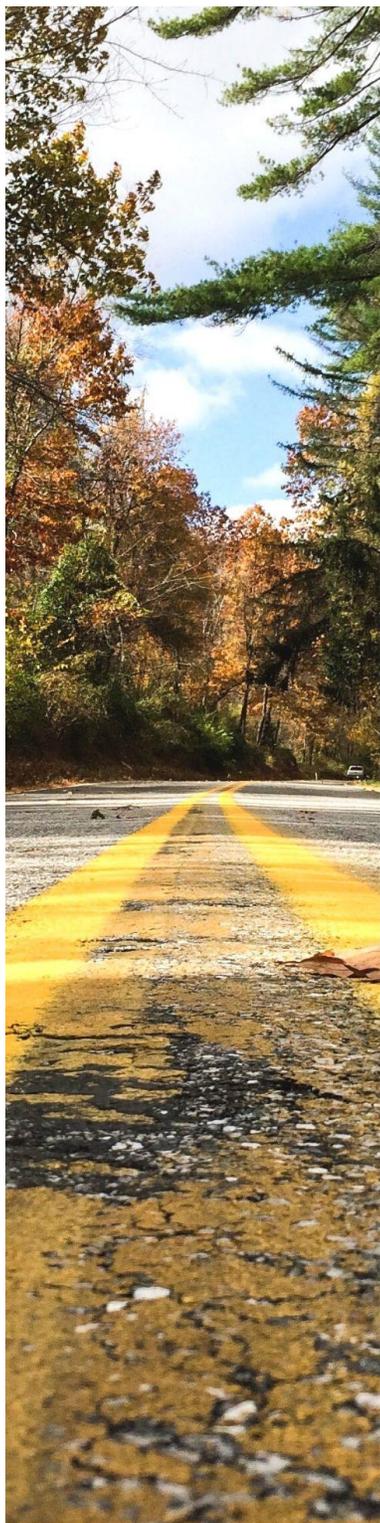
Traditional methods of 'one issue at a time' have produced some useful immediate results but have also sometimes had unfortunate side effects, as for example when infrastructure is planned without an 'end of life' component built in.



Life Cycle process

A more systematic way of thinking, taking into account the **entire life cycle of projects and products leads to more effective programmes**, and fewer unwanted secondary impacts. Citizens as well as organisations are increasingly interested in the « **world behind the product** », something that life cycle methodologies based on key SDGs can reveal. Life cycle thinking is also the basis for the LCA4Regions project where learning life cycle methods from each other improves everyone's development policies and action plans.

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Purpose of the document

The document belongs to the series of TLJ Learning Documents which aim to provide an overview of the activities carried out during the Transnational Learning Journeys. It summarizes the practices discovered during the TLJ, the discussions held, the lessons learnt, and elaborates some inputs to be further explored by the project. It proposes some elements to be considered for improving the quality and effectiveness of the next TLJ.

The present document is focused on the third Transnational Learning Journey that took place in October 2020 online (although originally planned to take place in Satakunta, FI).

What is a Transnational Learning Journey?

Transnational Learning Journeys (TLJ) represent the core of LCA4Regions, an opportunity for dialogue on a key aspect of the project.

Organised every six months by a different partner region, TLJs include thematic workshops, site visits and peer reviews and focus on one of the project's thematic pillars. **They bring together partners and stakeholders to share challenges, opportunities and good practices** to improve their regional policy instruments.

Seven TLJs will be organised during the first phase of the project, the "Interregional Learning". The first one took place in Kaunas (LT) in January 2020, tackling the implementation of Life Cycle methodologies in environmental and resource efficiency policies and focusing on tools to apply LC into practice. The second took place online in Navarre (ES) in June 2020 on life cycle methods for resource-efficiency. The following meetings will be in Western Slovenia (SI), Lodskie Region (PL) Lombardy (IT), and Baixo Alentejo (PT).

Transnational Learning Journey #3

20-21-22 October 2020, online/Satakunta (Finland)

OVERVIEW

As for the second, the third **LCA4Regions Transnational Learning Journey (TLJ)** was moved online instead of taking place in Satakunta. Still, the Pyhäjärvi Institute organised a very successful event on 20, 21, and 22 October. This time, the attention was given to the exchange of experience on LCA for waste management and material flows. Three different sessions, one on each day, delved into this topic from different angles.

The first day was dedicated to **LCA for sustainable regional development**. After a brief introduction of the project and the life cycle approaches, an overview of Satakunta region and its policy context was presented as well as some thoughts on Finnish politics and LCA. It was completed by case studies on LC tools in bioeconomy and LCA for waste management. A reminder on the **LC Toolbox and LC methodologies for regions** was also shared with participants during that session (cf. next page).

The second day focused on **LCA good practices on waste management and material flows**. LCA4regions partners presented their good practices on the use of life cycle tools and methods on waste management and material flows. It provided potential learning and inspiration for all regions with concrete ideas to be integrated into local policies and procedures. The session finished with a case presenting the circular economy of plastics.

Case studies on waste management and nutrient recycling were presented on the third and last day. A **peer review session** concluded this exchange of experiences to gather ideas to develop the future action plan in Satakunta.

The whole TLJ has been recorded and can be watched [here](#).

Selected Life Cycle Tools, Procedures and Concepts for efficient and effective implementation of SDGs at business or regional levels

| Life cycle systems and concepts | Life cycle assessment tools and methods | Action tools based on LCA | Life cycle Management Tools |
|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Circular economy Industrial ecology Product-service system Cradle to grave | Life cycle assessment LCA* (materials, energy) Materials flow assessment (MFA) Input-Output tables Social LCA (SLCA) Life cycle Sustainability Assessment (LCSA) Organisational LCA (O-LCA) Life cycle Costing (LCC) Chemicals assessment* Risk assessment Evolving assessment tools for biodiversity, LULUC, landscape etc. | Eco-labels* Environmental Product Declarations (EPD)* Product environmental footprint (PEF)* Eco-design | Sustainable supply-chain management (SSCM) Circular materials management Sustainable and/or circular public procurement (SSP, CPP) Green purchasing (GP) Extended Producer Responsibility (EPR) Sustainability reporting (e.g. GRI) |

* Some of the above have become standardized procedures under international agreements or practices

** Other concepts such as sustainable production, resource efficiency, sustainability footprint etc. also provide useful frameworks for implementing selected SDGs

*** Environmental Management Systems (EMS, EMAS) are useful adjuncts

AGENDA

DAY 1 - LCA4Regions - LCA for sustainable regional development

Tuesday 20 October
(09:00 - 11:30)

- 09:00 - Welcome by Pyhäjärvi Institute
- 09:20 - Satakunta policy context
- 09:45 - Politics and LCA
- 10:00 - LC tools in bioeconomy
- 10:40 - Q&A
- 10:55 - LCA for waste management
- 11:20 - Q&A

DAY 2 - LCA good practices on waste management and material flows

Wednesday 21 October
(10:00 - 13:00)

- 10:00 - LCA good practices on waste management and material flows (Part 1)
- 11:00 - Q&A
- 11:10 - LCA good practices on waste management and material flows (Part 2)
- 12:10 - Q&A
- 12:30 - Case Circular economy of plastics
- 12:55 - Q&A



DAY 3 - Case studies and peer review

Thursday 18 June
(09:00 - 11:00)

- 10:00 - Case waste management
- 10:25 - Q&A
- 10:30 - Case nutrient recycling
- 11:40 - Q&A
- 11:45 - Peer review - open discussion

SATAKUNTA



Country: Finland

Capital of the region: Pori

Population: 216,752 inhabitants (2019)

Policy instrument priority axes:

1. Competitiveness of SMEs;
2. Producing and using the latest information and knowledge;
3. Employment and labour mobility;
4. Education, skills and lifelong learning;
5. Social inclusion and combating poverty.

Economy: energy production, heavy engineering, offshore, process industry, ports and logistics and diversified food industry.

Promising pillars: resource efficiency, waste management and material flows, green public procurements.

Background: The global footprint of Finnish consumption is the biggest challenge for sustainable development. Finland is dependent on foreign raw materials. Poor sustainability indicator status is notified in dead wood in forests and high nature value farmland. Phosphorus and nitrogen loads on the Baltic Sea from Finnish rivers are high. Alarming indicator status is given for greenhouse gas emissions and removals and natural resource/raw material consumption and breakdown.

Notification of waste hierarchy is generally at the good level in Finland. However, to be notified also, is waste creation and diminished use of raw materials.

To improve:

- Regional plans and programmes

Regional Plans, such as Regional Programme of Satakunta, are a general document, and includes less concretion.

National-based licensing operations are slow, material do not meet (location/amount/quality). Notifications about waste creation and diminished use of raw materials could be better indicated at policy level.

Waste incineration operates by market-driven basis. Nine big incinerators in Finland and several smaller units operate at the moment. Capacity is not enough, and waste is transported to Sweden and Estonia, as well. No long-term environmental thinking.

Policies for subsidies utilisation (market & environmental issues - driven) should be developed.

The existing networks, such as FISU (Finnish sustainable communities) and HINKU (Towards Carbon Neutral Municipalities) should be further supported, as well as Green procurement strategies (earmarked support for green procurements) and Green urban planning (such as public transport, industrial symbioses with efficient side stream utilisations).

Difficulties in managing all the influences, LCA unclear and challenging, companies reluctant to share ideas.

- Regulatory framework

Regulatory framework is based on national legislation. LCA is more regularly taken into consideration under preparative processes of new legislation. Processes are slow.

The Pyhäjärvi Institute

Pyhäjärvi Institute



Pyhäjärvi Institute is a regional centre of research, development and education in the municipality of Eura, in Satakunta, Southwest Finland. The main activities of the Institute are planning and implementation of development projects, carrying out scientific research, organising further education especially for regional companies and producers, and providing expertise services for food economy and aquatic systems. Pyhäjärvi Institute is an important partner to create and execute the Operational Programme in Satakunta region. Institute is a member of 8 regional networks and unions that act as advisory groups for regional policy planning, contributing to the execution of Satakunta Regional Programme, for which the policy instrument acts as the guiding document.

www.pyhajarvi-instituutti.fi

The team behind the Pyhäjärvi Institute

Teija Kirkkala, is the director of the Pyhäjärvi Institute. She is an expert in environmental questions of food production, food processing and water protection.

Pekka Maijala is an expert of food production systems, especially food and bioprocessing technologies. He has specialised in sustainability and circular economy aspects.

Elisa Mikkilä is an expert in handling and analysing data of various food and environmental topics. She has specialised in GIS data and map layouts with Quantum GIS, and operates fluently with various project dissemination and executing activities.



GOOD PRACTICES ON WASTE AND MATERIAL FLOWS

An important part of the first phase of the project is to identify Good Practices, that is concrete examples that give proven successful tangible results, and have a potential for learning. Presented by partners during each TLJ, they will serve as an inspiration to prepare the Action Plans.

Among the Good Practices presented, several highlighted the positive impact made by the use of LCA on carbon footprint and greenhouse gas emissions which is indeed an important step in reaching SDG 12.

A public practice regarding the redistribution of funds from environmental pollution charges to pro-environmental investments | Lodzkie region (Poland)

2001 – Ongoing

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

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

Thanks to funds from environmental fees, RF grants subsidies and preferential loans for green investments in the areas of air protection (e.g. installation of heat pumps and PV panels, thermal

modernization), protection of water resources (modernization of sewage treatment installations), waste management, waste disposal and reclamation, green education projects. Final beneficiaries of this practice are both public and private entities and individuals.

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

- Thermomodernisation of 27,800 m²;
- PV installations - 2829 kWe;
- Reduction of waste stream for disposal by 32,500 tons;
- The amount of waste subjected to the biological treatment process 52 tons

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

Processing alternatives of biodegradable waste - anaerobic digestion, energy & biofuel | Pyhäjärvi Institute (Finland)

June 2014 – January 2016

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

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

The outcome of this practise has been utilised in Finnish waste act preparation, and has aided in launching the preparation of Finnish national biogas programme, and in the regional level the

promotion of bio and circular economy initiatives and policies. Main stakeholders include waste management companies, regional development organisations, policy makers and municipal actors.

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

Life cycle environmental impacts of different construction wood waste and wood packaging waste processing methods | Pyhäjärvi Institute (Finland)

December 2014 – August 2015

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

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

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

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

Application of life-cycle assessment in optimization of municipal waste management systems and presentation of the lithuanian case study | Kaunas University Of Technology (Lithuania)

2008 – 2009

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

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

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

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

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

Lithuanian’s deposit system | Kaunas University Of Technology (Lithuania)

February 2016 – Ongoing

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

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

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

Retailers apply deposit for one-way packaging when selling beverages. Consumers can redeem deposit when returning empty packages back to retailers. The approved value for the packaging deposit is EUR 0.10.

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

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

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

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

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

(Un)building for the circular economy | CIMBAL (Portugal)

2020- Ongoing

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

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

Its implementation is divided in three stages:

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

2. Regional Integrated Management System (RIMS): including the development of a materials passport and a registration system, providing information to promote the circularity of materials and for management for the reuse of materials from selective demolitions and the recovery of the inert fraction of RCD to incorporate recycled aggregates. It also includes the creation of a material bank, accessible to all, based on the passports and registration system, involving the local authorities and also the possibility of integrating social shops through Private Social Solidarity Institutions;
3. Evaluation and adjustment of the integrated system: will be developed a mathematical model that use preliminary results as distances covered by CDW, competitive factors, environmental impacts, among other, to adjust when needed the RIMS.

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

GreenEdge | CIMBAL (Portugal)

2015-Ongoing

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

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

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

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

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

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

Life Cycle Assessment of different types of graveyard candles | National Institute Of Chemistry (Slovenia)

2010

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

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

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

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

Comparative life cycle assessment of alternative packaging materials for beverage | National Institute Of Chemistry (Slovenia)

2019

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

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

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

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

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

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

would probably show lower environmental impacts, but the returnable bottle system should take into account additional bottle cleaning processes, return transport, etc.

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

The carbon footprint of the activities of the Food Bank of Navarra | Government of Navarre & AIN (Spain)

December 2019 - September 2020

Currently, roughly one-third of food produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion tons per year. This increases the release of greenhouse gases (GHG) and affects climate change due to the inefficient use of resources. Global food loss and waste generate annually 4.4 Gt CO₂e or about 8% of total anthropogenic GHG emissions.

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

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

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

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

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

The GHG emissions generated by the BAN activities were notably lower than those in a potential scenario without the existence of the BAN; 147 versus 4,715 t CO₂e in 2018, and 148 versus 4,304 t CO₂e in 2019.

The activity of the BAN prevented the emission of 4,568 tons of CO₂e in 2018 and 4,157 tons of CO₂e in 2019.

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

AGROPAPER®, a new sustainable and biodegradable solution for the agricultural mulching technique – Designing as first step to avoid waste | Government of Navarre & AIN (Spain)

January 2018 - ongoing

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

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

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

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

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

AgroPaper® has the same advantages of the plastic mulching (prevent from weeds, no use of weed-killers, water efficiency, temperature control or higher performance), but improves its disadvantages. There is no need to manage the waste due to the product is incorporated to the soil, helping to enrich and improve the quality of the land for future crops. Therefore, no cost for management is needed and environmental impacts are avoided. It has the peculiarity to withstand the sedge, a weed that plastic mulching do not control. Also, it avoids the carbon footprint of the plastic production, 1kg of plastic emit 3.5 kg CO₂, due to the paper has a negative one thanks it comes from sustainable forest. Finally, as is made of long pine fibre, is a perfect compost to improve the soil quality.

Waste separation through rewarding citizens | Government of Navarre & AIN (Spain)

April 2019 - ongoing

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

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

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

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

A preliminary carbon footprint has been made to compare the previous organic waste collecting system and the new one. At the moment, stakeholders are designing a model on which monitoring carbon emissions/blances will be used for monetizing rewards.

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

Progetto SCARTO 0: use of by-products of cutting materials from the ornamental marble quarries in carrara for the construction of the multifunctional platform in Vado Ligure | Lombardy Region (Italy)

September 2018 - June 2019

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

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

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

The project was possible thanks to several factors:

- multimodal transfer, as only 17 km were covered by road, while the remaining approx. 160 by sea from the port of Marina Carrara in Vado Ligure;
- high IT content, necessary to guarantee traceability of the material so that only the quarries and authorized transporters could carry out the operations. The software / hardware created specifically for the project made it possible to halve the delivery times, as each trip was saved approx. 3 minutes for each vehicle that accessed the port of Marina Carrara: taking into account that 200 daily passages were made, this saved 600 minutes a day.

The elimination of the phase of stopping, and restarting of the trucks at the port weigh station reduced the environmental impact in terms of CO2 and particulate emissions into the atmosphere, and eliminates possible inconveniences to traffic and the community.

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

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

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

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

This result, combined with those relating to the reduction of CO2 emissions, has made it possible to obtain the Afnor XP X30 901 (Circular Economy) certification, first issued in Europe by Bureau Veritas.

Life cycle costing on construction and demolition waste management system | Lombardy Region (Italy)

November 2019 - Ongoing

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

Construction and demolition (C&D) activities generate every year a great volume of waste. Although most of this (especially in Italy) is already sent for recovery), some obstacles prevent the usage of the recovered materials. Among them, the mistrusting of the sector operators is the most impactful. Preferring natural cave-generated aggregates in place of the recovered ones means

large amounts of recycled materials that remain unsold, other than the reduction of natural goods, of which availability can be more and more limited by time. An E-LCC (Environmental life cycle costing) will be carried on to investigate the costs of the entire chain. As a strategic decision tool, the economic evaluation of the advantages of using recycled aggregates compared to natural ones can be crucial to push the construction industry in using these. The project is on-going, and the inventory phase is almost completed. The data collected concerned with the first phase of demolition. The costs considered to build up the inventory can be divided into three main categories, and these are:

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

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

Waste to resource value chain optimization through the application of the life cycle assessment methodology to the regional management system of construction and demolition waste (CDW) | Lombardy Region (Italy)

April 2016 – September 2017

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

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

closing materials loop [e.g. limited use of RAs in high-grade application] and to investigate possible solutions to foster the whole CDW value chain. This may give indirect benefits to all the stakeholders involved as constructors, recyclers, citizens and public administrations.

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

Admixtures for bituminous conglomerates | Lombardy Region (Italy)

June 2019 - ongoing

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

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

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

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

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

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

Environmental passport for the agricultural and food products of the montagna vicentina | Lombardy Region (Italy)

September 2018-August 2020

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

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

The main steps were:

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

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

Cantiere green | Lombardy Region (Italy)

September 2019 - ongoing

The Cantiere green protocol is a Save the Planet Onlus project which aims to reduce greenhouse gases (GHG) deriving from the use of electrical equipment on site. How can I check and calculate the CO₂eq production on the site deriving from electrical machines?

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

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

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

The accuracy of the on-site measurement is indicative of real-time CO₂ production and savings. The CO₂eq saved is calculated, knowing the emission factor of the kW of absorbed energy, belonging to the national energy mix.

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

Through this protocol, carbon credits can be generated, which can be resold on the voluntary carbon credit market, creating a virtuous circuit. Each carbon credit is in fact equivalent to one ton of CO₂eq saved. This mechanism for saving CO₂ emissions can be perfectly integrated with the current protocols used in construction to build (Leed, GBC, etc.).

The success that emerges from the "Cantiere green" protocol is highlighted in various aspects and results achieved. As a first goal, having reached about 50 construction sites in 11 months of the project with the first Italian protocol for the reduction of CO₂ on site; consequently, after 11 months from the start of the project, with the application of the protocol, being able to obtain a significant saving of CO₂ in the atmosphere equal to 308 Ton CO₂eq.

LCA for Municipal Solid Waste Management | Lombardy Region (Italy)

November 2010 – July 2012

In the GERLA project, the LCA methodology was applied to analyse the environmental performance of the current MSW management system implemented in Lombardy region as of 2009. The focus was on MSW, in particular six packaging materials separated at the source (glass, aluminium, steel, paper, plastic and wood), organic waste separated at the source (food and green waste) and residual waste (RW). Based on the interpretation of the results of the current situation, four alternative management scenarios were proposed for the year 2020. These future scenarios were subsequently evaluated with the LCA methodology to verify and quantify the improvements associated with the various actions implemented. This has provided Regione Lombardia with useful indications for the drafting of the new Regional Waste Management Program. For the first time in Italy the outcomes of a detailed LCA of a current waste management system implemented in an extended area such as that of Lombardy region were utilised to address future policies pursuing the improvement of the environmental performances of the system itself.

The system boundaries included all treatment processes, from the moment the waste is collected to when it leaves the system as an emission (solid, liquid or gas) or as a secondary raw material, following the 'zero burden assumption'. Cases of multi-functionality were solved by expanding the system boundaries to include avoided primary productions due to material and energy recovery from waste.

In the inventory analysis, all the flows of waste were characterised in terms of quantity, composition and destination. Moreover, the most important treatment plants (i.e. for organic waste and residual waste those treating more than 70% of the respective waste stream, and for packaging those receiving the majority of each type of material collected in Lombardy) were analysed in terms of their capacity, energy and materials consumption, emissions in the environment, energy and materials recovery. Most of the data used to model each unit (e.g. paper recycling, food waste composting, energy recovery from residual waste) are primary, i.e. acquired directly from the plant operators. For each unit, a new dataset was designed in SimaPro software, including the avoided material and energy production.

CML 2001 was adopted as characterisation method to evaluate the environmental impacts (global warming, acidification, human toxicity, and photochemical ozone creation), whereas the Cumulative Energy Demand method was chosen to evaluate the energy consumption of the system.

The LCA of the integrated MSW in Lombardy showed that for all the examined scenarios all the analysed impact indicators (global warming, acidification, human toxicity, photochemical ozone creation and cumulative energy demand) are negative in sign, which means that the benefits arising from material and energy recovery from waste are offsetting the impacts added in the environment due to the processing of the waste itself. The integrated MSW of Lombardia Region was, therefore, already characterised by good energy and environmental performances. However, there was still room for further improvement: actions based, on the one hand, on a further increase in recycling rates and, on the other, on a series of technological improvements, especially in food waste and residual waste management, could be undertaken to improve the overall system. These actions were analysed in four future scenarios, which actually resulted with better performance than the current one. The actions that have shown greater influence in improving the overall performance of the system are as follows:

- increase of energy production in waste-to-energy (WTE) plants, with particular reference to thermal energy;
- increase of packaging materials sent to recycling (especially paper, glass, aluminium and homogeneous polymers such as polyethylene terephthalate and high-density polyethylene);
- treatment of organic waste by anaerobic digestion + post-composting rather than by traditional aerobic composting;

- refuse derived fuel (RDF) co-combustion in cement kiln where local conditions allow this practice;
- recovery of non-ferrous metals from bottom ashes produced by WTE plants, in addition to ferrous ones;
- phasing out of landfill as the destination of the residual waste and of bio-dried material produced by mechanical-biological treatment facilities;
- preference for mono-material separate collection with respect to multi-material.

A review of TLJ3 Good Practices from a life cycle perspective by F. Balkau



Most regions submitted two or more Good Practice (GP) waste management examples. All were focussed on local priority waste types and it can be seen that there is a common concern over, for example, GHG from energy use, demolition and construction waste, biomass waste of several types (agricultural and forest residues, food waste), and recycling of packaging and other materials (including food). Several GPs addressed waste policy directly, while two focused also on financing mechanisms for waste management.

Among the SDGs being addressed, there was a particularly strong emphasis on climate change via reduced carbon footprint, with rather lower emphasis on other issues, although several LCA examples did take into account eutrophication, freshwater acidification and land contamination. Several GPs were aimed at facilitating waste handling directly, while others promoted lower-impact products for use within the region. Waste recovery and recycling were prominent among the GPs that, together, show a range of waste management initiatives in regions that can serve as inspiration to other partners in their future action plans. Most GPs have incorporated extensive stakeholder participation in their execution, a welcome feature that has not always been seen in past waste policy practices.

The GPs highlighted some common challenges that need to be addressed by regional governments. In particular, all face data shortages, whether for LCA or for decision-making generally. The lack of suitable local data to underpin life cycle evaluations needs to be urgently addressed by regions. Regional data systems include the use of materials and waste flow mapping (e.g. through MFA), and use of secondary materials and biomass atlases to identify opportunities for resource recovery rather than simple disposal. LCA procedures would be much improved through the establishment of such regional data systems as this would reduce the reliance on global databases that do not always reflect the situation locally.

While the GPs addressed a broad range of wastes and sustainability issues, their use of LC methods is often limited, being largely restricted to LCA, LCC and GHG calculations. Certainly, several GPs have already obtained good results in using LCA to define waste options and policy directions. LCA was helpful in comparing technical alternatives for waste handling, or for identifying products that had fewer waste implications. Systematic calculation of carbon footprints was popular, and helped to quantify the benefits of actions being carried out. Nevertheless an enlarged vision of LC tools (refer to the LCM toolbox) would bring additional

benefits. LCC was the least used of the methods observed, a pity in view of its universal utility in costing out the various options in the waste sector. The GPs could benefit from using MFA given its ability to track materials flows, thus assisting development of policies that address future waste streams. Further, in view of the emphasis that all partners are now giving to increased stakeholder involvement it would have been encouraging to see also some examples of social LCA techniques that can give early warning of disruption to the region's social fabric due to controversial waste issues (and not only wastes). Systematic stakeholder mapping through sLCA can also identify partners who can assist in building effective waste management systems. It is also recommended that future LCAs give increased visibility to biodiversity, water resources, land-use and toxic substances.

What should be the next steps in bringing LCA more deeply into GPs? While a good number of GPs used a formal quantitative LCA approach, others refer to LCA only in a very general way, without defining the scope of the thinking behind it, nor describing how it was used. Even the LCA-based GPs could still be enhanced by enlarging their scope i.e. by taking upstream/downstream factors more systematically into account. At present they tend to take the waste flow as a given, without exploring reduction measures (as required by the waste policy pyramid). No GP has gone so far as to question the consumption patterns that have contributed to regional waste challenges – i.e. minimising waste generation at the source (recall SDG #12 on Responsible Consumption Patterns). Some have indirectly dealt with the avoidance route by assessing alternative products, but this is not the same as questioning the generation pattern of waste in the first place. As well, end of life issues have also not so far been prominently incorporated into the GPs, as for example in the fact that recycling nearly always results in further secondary waste streams that still contain most of the pollutants. To be rigorously addressing a 'life cycle' way of thinking, all the GPs could still go further, certain among them further than others.

To conclude, with this TLJ we saw a useful and interesting set of methods and initiatives, a good number of which used an LCA approach in building up their waste management experience. But not all are yet fully lifecycle focused, and some have not yet attempted a quantitative assessment. With some notable exceptions, most could consider to incorporate a broader set SDG issues than only 'waste' and 'GHG'. Finally, the content of the GPs are for the most part still descriptive rather than analytical. More emphasis is needed on actual results achieved, working methods used, difficulties and challenges. Important also is a description of the 'lessons learned' that would greatly assist in the exchange of experiences that is the core business of the LCA4Regions project.

PEER REVIEW

Focus on Satakunta's policy instrument

The peer review is an essential part of the exchange of experience process. Each Transnational Learning Journey foresees a peer review session focused on the local policy instruments. During the third TLJ, participants provided feedback on the environmental policies implemented in Satakunta and in Finland in general.

In order to make the session as much interactive as possible, the following methodology was implemented:

- the project regions discussed the local policy context in three separate virtual rooms;
- in each virtual room, 2 regions were dialoguing, moderated by a Satakunta's representative;
- the stakeholders were split in the different virtual rooms, in order to make them actively contribute to the discussion;
- at the end of the session, all the attendees convened back in plenary with rapporteurs presenting the main outcomes.

The project partners had analysed in advance the local policy context, going through a review document that outlined the key points of the local policy context. The partners were asked to elaborate their analysis through three observation points:

1. Use of policy instruments to address the waste management and material flow issues;
2. Use of life cycle tools to improve the designing and implementation of policy actions;
3. Opportunity of experience replication.

Overall, all agreed that the country has launched an impressive set of policies laying down ambitious targets in several areas: climate change (mitigation and adaptation, decarbonization, carbon neutrality), circular economy. The

way these strategies will be rolled out, harmonizing targets and finding synergies, will be a source of inspiration for the other regions. While reflecting on how to enrich the Finnish policies, partners pointed out that social life cycle analysis could be an efficient tool to put inclusiveness, resiliency, and local communities' development in the focus.

On the question of how LCA results are incorporated into policy, one response is that comparative LCA studies of several alternative technical or procedural options allow the administrators to choose the one that best meets their broad SDG objectives. This is especially true for waste management that has numerous alternative options.

Replication of Satakunta experiences includes themes such as collection and sorting, bio-waste for energy. Replicating the building of local or even national databases eg a biomass atlas, is more long-term, but can eventually be guided by Finland's experience too.

In addition to the emphasis on GHG and carbon footprints, a policy strand in Satakunta also concerns nutrient cycles and eutrophication. This has not been identified in other regions.

There was interest to put greater emphasis on Social LCA and MFA, two applications neglected so far in LCA4Regions. (Note that Satakunta does not yet have experience to share here)

There was a slight contradiction detected as far as the important (and rather neglected) issue of waste reduction through stronger demand-side policies was concerned. Waste generation is mentioned in the Finnish national plan, but greater visibility of this would be helpful in the Satakunta policies under review. In general, the talk is still dominated by "disposal" rather than "prevention", and this is also reflected in all partners' regional policies. The practices identified elsewhere, e.g. the Navarra Food Bank, could be given more prominence as examples of waste reduction measures, and encourage regions to look more deeply into their regional programmes.

CASE STUDIES

For this TLJ study visits took the shape of case studies. Four organisations and companies – Fortum Waste Solutions Ltd., Natural Resources Institute Finland, LUT University and Loimi-Häme Waste Management Ltd will – gave overviews on their work with sustainability issues, research and development work towards improved governance and decision-making.

FORTUM WASTE SOLUTIONS LTD

[Fortum](#) is a European energy company providing our customers with electricity, gas, heating and cooling as well as smart solutions to improve resource efficiency. Together with the subsidiary Uniper, Fortum is the third largest producer of CO₂-free electricity in Europe. With around 19,000 professionals and activities in more than 40 countries, the company has the competence and resources to grow and to drive the energy transition forward. Fortum Recycling & Waste provides recycling and material efficiency services, environmental management and hazardous waste treatment in the Nordics. The goal is to support customers' business by conserving natural resources and promoting circular economy. Fortum works together with the customers to build smart and sustainable solutions for ensuring the circulation of valuable materials and the removal of harmful substances from the material cycle.

[Plastics hold value – views about circular economy of plastics | Auli Westerholm. Manager in Public affairs, Fortum Waste Solutions Ltd](#)

The presentation described as a case study the value chain of post-consumer plastic packaging waste recycling in Finland and views of an industrial operator.

LOIMI-HÄME WASTE MANAGEMENT LTD

Loimi-Häme Waste Management Ltd (Loimi-Hämeen Jätehuolto Oy, LHJ) was founded in 1995. The company is 100% owned by the 16 municipalities covering regions in Southern Finland. In total, 135,000 inhabitants live in the operating area. LHJ's main purpose is to provide the waste management services of its owner municipalities. The company has processing centres in two locations, Forssa and Säskylä. In addition to the basic task, LHJ Group, formed by five companies, operates in connection with LHJ group, offering services to industry, public administrations and producer organizations in the areas of electronic waste, contaminated land and special waste, as well as safe disposal of data protection materials.

[Separate collection and recycling of waste – A company view | Pasi Kaskinen, Marketing Manager, Loimi-Häme Waste Management Ltd](#)

The presentation, made from a company perspective, offered an insight on various aspects of separate collection and recycling of waste. Life cycle assessment has been used to obtain information applied in the decision-making of waste collection systems. Views of the use and potential of the database of waste, Material market, was also given.

NATURAL RESOURCES INSTITUTE FINLAND

Natural Resources Institute Finland (Luke) promotes bioeconomy and sustainable use of natural resources. Luke's research is divided into four research programmes: Boreal Green Bioeconomy, Innovative Food System, Blue Bioeconomy and BioSociety. In addition, Luke has many authority and expert services. The research programmes aim to create new bio-based products and business opportunities, increase productivity by digitalization, support regional vitality by circular economy, create well-being from immaterial values, and support the profitability of healthy food production. Luke monitors the developments in the Finnish bioeconomy using indicators that are based on the national accounts, compiled by Statistics Finland. The indicators are also used to assess the attainment of the goals set up in the Finnish Bioeconomy Strategy. Luke brings together experts in natural resources and sustainable food production, and is one of the most multi-disciplinary research institutes in the area worldwide. Luke also carries out statutory government work by monitoring natural resources, certifying plant production, inspecting control agents, storing genetic resources, producing data on greenhouse gases, supporting natural resource policies and producing Finland's official food and natural resource statistics.

[Nutrient calculator – tools for planning regional nutrient recycling in Finland | Sari Luostarinen, Senior Scientist \(PhD\), Natural Resources institute](#)

[Biomass Atlas | Eeva Lehtonen, Research Scientist \(MSc\), Natural Resources Institute](#)

The presentations illustrated the collection and utilisation of biomass data for the creation of tools for nutrient availabilities and potentially to be used as a basis for life cycle assessments.

LUT UNIVERSITY

LUT University (Lappeenranta-Lahti University of Technology LUT) is a pioneering science university in Finland, bringing together the fields of science and business since 1969. LUT has about 6,500 students and experts engaged in scientific research and academic education. Clean energy, water and air are resources for which LUT University seeks new solutions with the expertise in technology and business. University helps society and businesses in their sustainable renewal. LUT has a tradition of strong links with the business community. The Finnish business journal "Talouselämä" has ranked LUT as the best university in business technology cooperation in Finland. LUT promotes business generated by scientific research. This is demonstrated by the university's own investment company Green Campus Innovations, which supports LUT's research-

based start-up companies. LUT aims to be a forerunner in education by securing international quality labels for degree programmes as a sign of excellence in the teaching.

Environmental impact assessment of biodegradable waste treatment | Jouni Havukainen, Associate Professor (PhD), Lappeenranta University of Technology

The presentation dealt with using life cycle assessment in environmental impact assessment of biodegradable waste management. Examples include facility scale study (carbon footprint calculation conducted for recycled nutrients from a biodegradable treatment facility) and estimates of the environmental impacts of different manure treatment chains on a more wider system level.

A review of TLJ3 case studies from a life cycle perspective by F. Balkau



This TLJ took us to fascinating case studies, backed up by extensive waste and environmental profiling. Options for confronting waste issues reflect among other things the socio-demographic politics in Finland, the complexities of a contemporary waste stream, waste producer habits and cooperation, and the technological options for dealing with the sustainability objectives the country has set itself. It will not be possible

to simply transpose these regional solutions to other countries, but we can learn from the way they have handles certain opportunities and constraints.

Some key points can be highlighted:

- Finland has put great emphasis on separation at source and separate collection, followed by recycling into new products. Landfill has been greatly reduced;
- With efficient resource recovery and recycling, bio-waste assumes the biggest volume in cities, requiring a new set of policy options to deal with it;
- Sorting efficiency is still the biggest challenge for recovery of all waste streams;
- It is not clear whether separate collection or single-stream sorting and treatment is more effective, determined in part by the “system” built up for waste management;
- There is a policy contradiction between recycling and incineration (with energy recovery), each depending on a different policy “system” to increase efficiency;
- Policy frameworks depend greatly on which SDG objectives are adopted;
- It is necessary to provide adaptability towards the constantly changing waste stream;
- Additional factors such as management of the nutrient stream need to be confronted as sustainability objectives broaden;
- Data initiatives include a biomass atlas and a materials market to allow waste generators and waste recyclers to come closer together;
- In rural areas waste systems inevitably involve a high level of transport, itself a significant source of GHG;

- In a complex and dynamic system, the use of LCA techniques helps to throw light on the various policy options and technologies, nevertheless the results of such studies depend greatly on their scope and the sustainability parameters taken into account. Waste policy therefore is closely integrated into sustainability and economic policies generally;
- As in other countries, carbon footprint reductions often dominate policies, although in Finland land and agricultural issues are also important.

The case studies integrate life cycle approaches in different ways and to different degrees. Thus the transport component of waste options cannot be ignored, nor the fate of secondary wastes from recycling facilities. Waste reduction at source becomes a factor to consider once operational costs are integrated. Several of the case studies used formal LCA, others a more qualitative approach than nevertheless gave good consideration to upstream/downstream factors. Formal extended LCC was not observed, nor was there an attempt at social LCA. Waste and materials flows had obviously been studied in developing the operational systems, however there was no mention of a formal MFA.

TLJ #3 Lessons learnt

The TLJ showed that LCA can be applied in many areas and that it is important to have a comprehensive approach and understanding in this matter. Specifically regarding waste and material flows, more focus should be given to upstream events in waste management.

Another learning is that changes do not happen quickly and that it is necessary to act systematically. A key point is to secure the support of the government in these approach and regulations that set the goal and give the green light to change.

An interesting pool of practices...

Partners expressed their interest in the different good practices presented. As a follow-up, they will discuss them with their stakeholders – with the help of a written summary for some, periodic meetings for others, get in touch with experts in the field that interest them (i.e. public procurement), and conduct a more thorough analysis to determine which ones could be applied to their territory. The practices that partners found the most interesting are:

LCA applications in construction, waste management and eco-design

Biomass atlas

Green Procurement

Processing alternatives of biodegradable waste (anaerobic digestion, energy and biofuel)

Redistribution of charges for environmental pollution into proenvironmental investments

The carbon footprint of the activities of the Food Bank of Navarra

...to feed the Action Plans

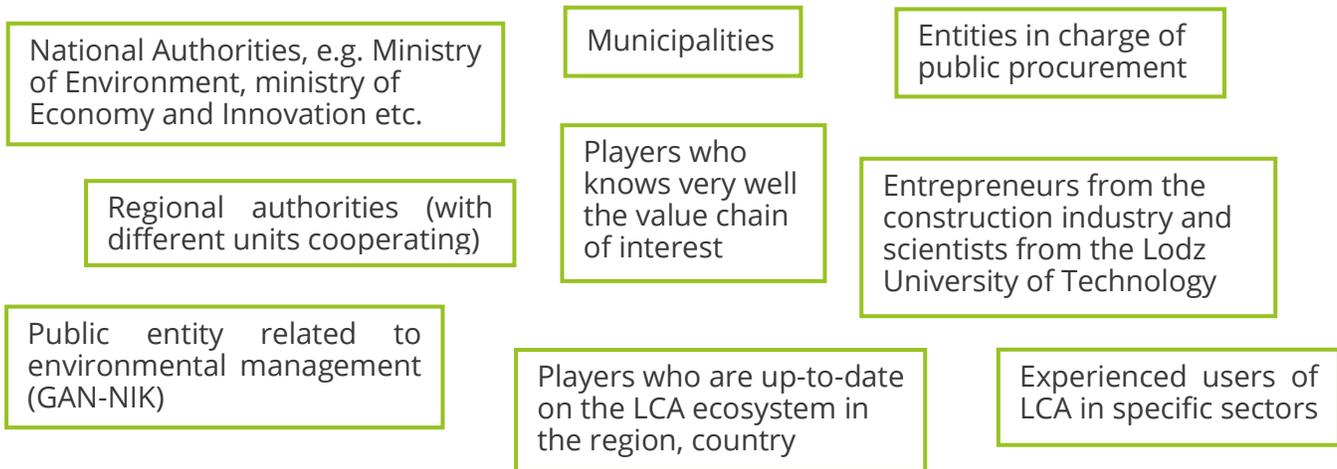
Both the study visits and the Good Practices presented contribute to generate ideas to build up the future Action Plans. Together with the discussions held afterwards, they help clarifying the topics and widen the perspectives on tools and their use. A next step will be to start processing all the information and knowledge received to determine what

should be included in the plans, how this could be done, and at which scale to fully benefit the improved policy instruments.

This specific TLJ helped some partners to already get better ideas for actions such as introducing LCA methodologies in the educational system; stimulating local demand for recycled products so that the local resource of raw materials stays in the production cycle as long as possible and to minimize transport and environmental costs.

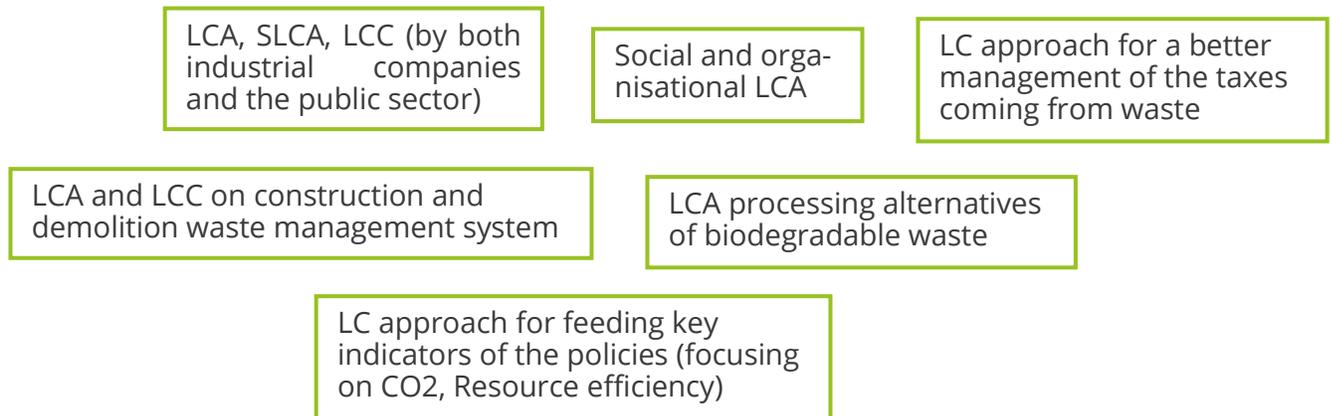
One partner also found most useful and inspiring the comprehensive set of Finnish regulations on waste management, bioeconomy and the circular economy. The regulations are the beginning of changes and the consent to them. They also show how important government support is.

To prepare and implement their future Action Plans, partners are already mapping the relevant players and contributors. Expectations of the society and business will also need to be taken into account, as they will be the beneficiaries of the project. One partner noted the impact of national law and the possibilities it offers, as the scope of possible changes to be introduced depends on them. In general, those key players are:

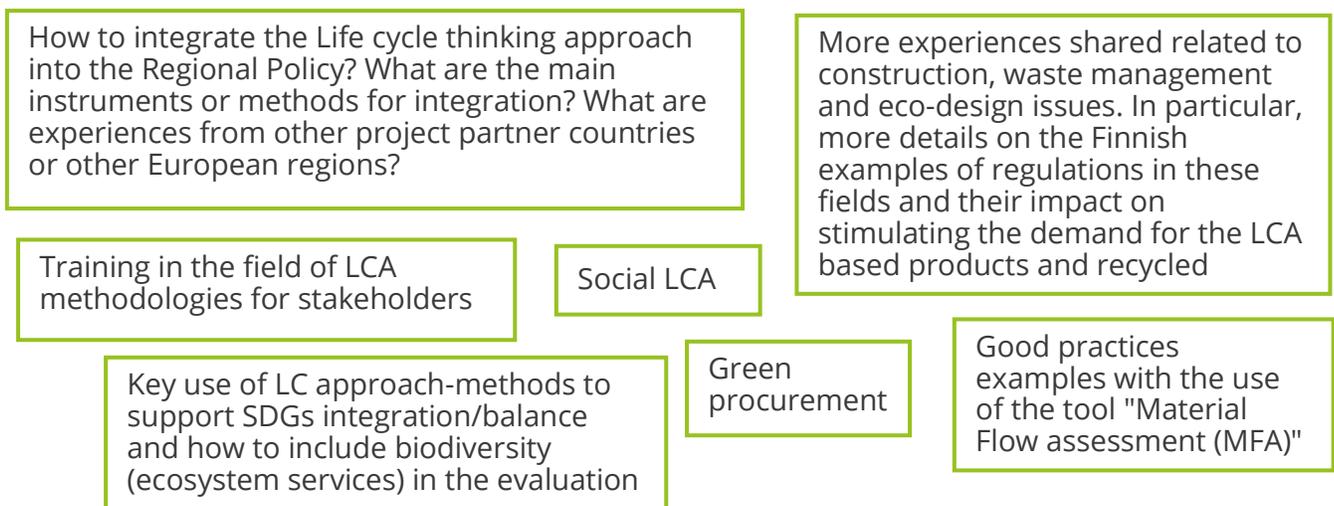


The start of a long process to insert life cycle methods in regional policies

Replicating life cycle methods in their region makes no doubt for partners, but for most of them this process is still in an early stage. Despite the interest mentioned above, solutions to implement are yet to be defined. In one case, much depends on national regulations that are still developing. In another case, most of the methods presented could be replicated, but in a first place by researchers leaving the question of how to transfer it for policy makers still wide open. Otherwise, the life cycle methods that caught partners' interest are:



Some ideas for the future

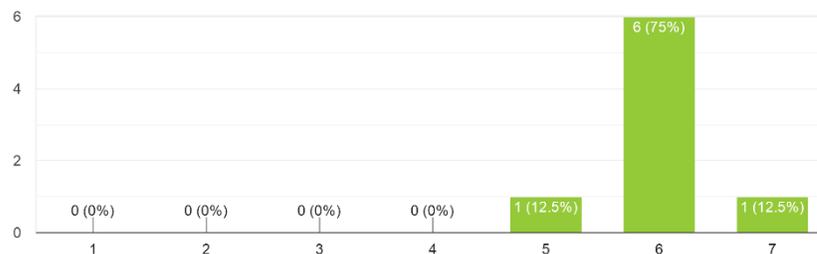


Participants' feedback

This TLJ was once again a successful event and a positive learning experience for participants, as suggested by the feedback received.

How satisfied are you with the TLJ?

8 responses



General evaluation of TLJ#3 with 7 being the highest and 1 the lowest

Opportunity Fruitful
Excellent!!
Great!
Perfect Inspiring
Striking!
triggering

With each TLJ, partners keep improving in the practical organisation, knowing that this is not always facilitated by circumstances. The key learning for this TLJ when it comes to organisation is that enough time should be dedicated to each session while at the same time the programme should not be too heavy (i.e. number of days, breaks, etc.).

The importance of P2P

P2P exchange is an important part of a TLJ and adequate time should be dedicated to it, both during the TLJ itself but also before, during the preparation phase. This might be one of the sessions which has the biggest margin for improvement.

To give the best results and make the analysis deeper, the method adopted for the P2P session must include a thorough preparation and briefing ahead of the session, even more under a very compressed time schedule, so that no time is lost and that subjects can be discussed efficiently. The moderators also have a very important role to frame the discussion. It might be useful for the host partner to run a preparatory session with them a few days before the event to ensure that everything is well on track.

Another possible approach to ensure deeper discussion is on the one hand to make partners more active and on the other hand to polish the document presenting the policy context. A

very close attention has to be given to this document to make sure that it includes all the key information, concrete details and can provide partners with in-depth insight on the topic while keeping a reasonable length. The host partner could also pinpoint the key issues where a specific help could be given or around which the discussion could be focused.

Regarding partners' involvement, it would be beneficial to find ways to collect effective hints for the host. This can be by asking to work on a first analysis with stakeholders or by giving them more time to get familiar with the policy paper and asking them to submit before the TLJ a written review on this paper. Another idea is to set a so-called leading group (gathering experts suggested by the host, stakeholders, staff members, partners, etc.) who could prepare in advance a first analysis of the policy instrument that will then be used as a starting point of the discussion.

The role of stakeholders

Because of their knowledge and experience but also their role in implementing new practices in the regions, it is important to involve the stakeholders in the discussion and making sure that they have enough space to share their insights, often enriching. Suggested approaches for that are:

Encourage a direct participation through specific questions, polls, etc.

Give more time for discussions with stakeholders, for instance in breakout rooms

Let the stakeholder owning the good practice present it

Identify main topics or subjects for a common brainstorming

Conclusion

This third TLJ is a new milestone in the project's search of powerful tools that will help regions to increase sustainability in their policies.

After three intense days, project partners left digital Satakunta convinced that **for a greener future it will be crucial to understand how to incorporate life cycle tools findings in policy actions**. The 12th Sustainable Development Goal (SDG) "Responsible consumption and production" is one of the challenges to be overcome, not only for Satakunta but also for other regions. There is a need for waste policies to take into account "upstream" opportunities for reducing waste generation at the source. Thus, **LCA studies should explore further this direction to enable a reflection on how to introduce the idea of demand-side management alongside recycling and improved handling of the waste finally produced**.

The TLJ proved that this is not a utopia: some examples are already proving successful and demonstrate that **comparative life cycle analysis can support decision making**. **Material flow analysis and social life cycle assessment** have been identified as **relevant tools with a high potential, yet not sufficiently deployed**. Regions have a key role to push for their use and support their implementation on their territories.

There is a lot of questioning about how LCA leads to better policies. To complement the first answers profiled during the TLJ, [recent work from the European Commission's Joint Research Centre](#) shows the extent to which LCA already underpins EU policies on sustainability, including resource efficiency, climate, the Green Deal etc.

The next TLJ, scheduled in spring 2021, will take us to Slovenia, hosted by the National Institute of Chemistry. The TLJ#4 will focus on the **exchange of experience on LCA in public procurement**.