EPA Network
Working Paper, 9.3.2018
From waste to secondary materials – Case descriptions
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1. Introduction

This document is a working paper compiled in EPA Network project on “From waste to secondary materials”. The aim of the project was to share the information in the individual countries and to analyse the cross-country experiences in order to increase the understanding of the possibilities connected to secondary raw materials. The main outcome of the project was a synthesis report on European experiences on the use of secondary raw material. This working paper serves as a background material for synthesis report. Project was run in 2017.

This report presents all case studies with details.

The focus of the case studies is on recycling the waste streams that are prioritized in EUs Circular economy package. This way the EPAs can contribute to the realization of the aims of the CE package. These waste streams are food waste, critical raw materials, plastics, bio mass and construction and demolition waste.

2. Soya meal: Waste or by-product? (NL)

Aldert Hanemaaijer, PBL Netherlands Environmental Assessment Agency, the Netherlands

2.1 Case description

In many industrial plants, in addition to the intended products, useful by-products come from the production process. Examples include beet pulp from sugar production and soybean oil from the production of soya oil. In many cases by-products are treated as waste, leading to high administrative burdens. This case is about the discussion: waste or raw material? And about the role of competent authority in the consideration of that. It outlines the dilemma between space for innovation and the utilization of raw materials on the one hand and the monitoring of waste and risk of mixing on the other as safeguarding products and production chains of contamination with waste streams and toxic or environmentally hazardous components is an ongoing concern.
When processing soya beans, approximately 20% of vegetable oil is released and 80% of protein rich soya meal. The soya meal is seen by the producer as a by-product, but in the Netherlands it is an important raw material for the animal feed industry. This case is a about Marcor, a company that stores agribulk products (like soya meal) and wants to have a license for a new storage location. Licensor DCMR initially believed that it should be treated as waste. Their assessment was primarily based on existing laws and regulations and the following possible risks to public health and the environment. However the latter was secured in the chain through feed and food regulation and the quality system used by the Dutch Food and Welfare Authority (NVWA). After intensive consultation between the company, industry organization, licensor and the Ministry of Infrastructure and Environment, it has been decided that soya meal should be considered as a product and therefore not as a waste. This has advantages for the environment, as the soya meal can be used as feed instead of being treated as waste. The economic argument includes that when a product does not have the waste status, it can be used as feed, a better image of the companies in the chain and relieves them from a lot of administrative overhead.

2.2 Operational environment

Regulatory and administration
Dutch and European legislation treat by-products like soya meal in many cases as waste. Entrepreneurs in these chains will then have to deal with the reporting, registration and certification

obligations from the waste legislation and be considered as a waste processing company. This strict waste management is of public interest. The low or negative value of waste products makes it attractive to process waste streams in a raw material chain in which this is not noticeable.
For side products with a positive market value, the situation is not very clear. EU waste legislation does not rule whether a substance is a by-product or waste. If the waste legislation in the EC circular economy package is approved, soya scrap no longer falls under the denominator of waste. Soya meal is an example. Soya meal is processed into animal feed and is a commercial product. It is sold by producers, transported and stored by stevedores, purchased and processed by animal feed companies. In Rotterdam, trade and processing of agribulk have an estimated size of 10 million tons per year.

The classification of soya scrap to waste means a heavy administrative burden for all companies in the product chain: research to determine the composition and quality of the waste, certification of the research results. Reporting of transport, (intermediate) storage and processing, assessment of the processing process by supervisors etc. In addition, the companies in this chain will be listed as a waste processing company, an appearance that not all companies want.

Drivers and barriers
Important driver is the value of the by-product and demand from the feed industry, also realized by bans on landfill and tax on incineration and landfill of waste.
As mentioned before current waste legislation and the interpretation of that by local authorities and legislators form an important barrier. A barrier at the legislator is also that they are judged by the number of permits that they produce, which is not positive when regarding more complex cases.

Markets and links to consumers
When linked as waste it is difficult to sell the by-product to companies that produce feed. This because of the image that is sticking to waste and the effect that this has on the market position of the animal feed produced. Furthermore it involves administrative costs an also causes image problems for consumers.

2.3 Success of the case

Key factors
- The case teaches that *sharing knowledge* can be an important success factor in scaling up initiatives. Knowing each other's experiences and arguments can prevent the wheel from being invented again. This is all the more important because many powers are delegated to provinces, where often less knowledge is available. Nevertheless, at the lower level of scale, the competent authority must always make its own decisions on a case-by-case basis.
- Experiment space applications will be assessed not only on the basis of potential risks to the quality of life and compliance with EU regulations. Decision making in this respect also depends on the applicant's track record.
- Another learning point emerging from the presented case is *interdisciplinary consultation*. So in this case between environment and food. The soya meal case showed that companies in the chain must comply with strict requirements of feed and food legislation. This would in itself already provide sufficient guarantees for properly complying with an environmental permit in which soya meal is no longer regarded as waste but as a raw material. However, an additional security will be included in the license to ensure the quality of the feed chain. Of the stored lots, the company must have a GMP + certificate. This proves that the party concerned meets the criteria for being used as animal fodder.
- The legislator needs to strike a balance between strictly applying existing rules and providing space for enterprise innovation. However the legislator indicates that in case of doubt, they will decide always on the safe side. So avoid risks, not only in terms of environmental quality but also

the image and position of the organization (avoid calamities). What helped in this case was a *joined decision, backed by national government.*

Impacts of the development
Considering soya meal as a product and therefore not as a waste has advantages for the environment, as the soya meal can be used as feed instead of being treated as waste. The economic argument is that soya meal as byproduct can be used as feed and be sold at a market price. Furthermore taking away the waste status leads to lower administrative costs.

Possibilities for scaling
As long as the regulations have not yet been explicitly amended, it is essential that the knowledge gained in this case be shared with others. Finally, a total of about 15 mln tons of agribulk is imported in the Netherlands annually. The Dutch Feed Industry Association intends to draw up a note setting out the arguments. This allows other agribulk streams to use the insights gained.

2.4 Lessons learned and recommendations

- Breaking barriers to licensing benefits from more self-assessment for the licensing authority. This requires formal steps on the part of the Ministry of Environment and possibly also of politics.
- The government should facilitate the exchange of interdisciplinary knowledge and experience between licensors or competent authorities, supervisors and enforcers, industry or interbranch organizations and knowledge institutions, for example through a learning environment, platform, etc..
- Organize early involvement and discussion between the involved parties, with respect for each other's role. Intensive, in-depth and equal consultation should take place between policy boards (Ministries), supervisors and licensors.
- Especially in environmental permits about food and feed, the discussion needs to be broadened from environment to institutions that have knowledge on food and feed. In this way, all relevant knowledge is put to the table and a broader and better informed decision can be made.

2.5 More information

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3 Maximising high quality food waste recycling (SC)

Andrew Sullivan, Scottish Environment Protection Agency, Scotland

3.1 Case description

Scotland has developed a package of measures to stimulate food waste recycling - making interventions across the supply chain from the point of production to the use of compost and digestate on Scottish farms.

This case study centres on the effects of driving food waste recycling through regulation with particular focus on behaviour change, supply chain impacts and the quality of final compost and digestate products. It draws lessons for other jurisdictions who may be considering this approach in light of proposed separate collection requirements in the EU Circular Economy package.

Initiation, i.e. background for the case
The five most carbon intensive waste materials make up just 6% of Scotland's waste by weight, but nearly a third of associated carbon impacts. Food waste has the greatest carbon impact in Scotland generating 15% of carbon impacts in 2014, and 17% in 2015.

In 2013, an estimated 1.35 million tonnes of food and drink was wasted in Scotland with the breakdown as follows:

- Household – 600,000 tonnes (45%)
- Commercial and Industrial – 740,000 tonnes (55%)

Led by a desire to do better with food waste, Scotland's 2010 Zero Waste Plan placed an emphasis on the expansion of food waste recycling. The renewable energy benefits of Anaerobic Digestion, the reduction of biodegradable waste to landfill and compliance with Article 22 of the Waste Framework Directive were also key considerations. Managed properly, food waste can go from being a methane generating burden in landfills to a resource for composting and digestate producers, displacing primary fertilisers.

A barrier to realising the benefits of food waste recycling was the limited ability of the industry to secure separated food waste from waste producers leading to caution around investment in systems, vehicles and treatment infrastructure.

To address this and bring more certainty to the market, SEPA, Zero Waste Scotland and the Scottish Government consulted on regulations to introduce separate collections.

The proposals had strong support from stakeholders and were passed by the Scottish Parliament in 2012, coming into effect on 01 January 2014.

The temporal development of the case
This case follows the implementation of these regulations from their coming into effect in 2014 to today, in mid-2017.

3.2 Operational environment

Regulatory links
The Waste (Scotland) Regulations 2012 were passed by the Scottish Parliament and came into effect on 01 January 2014. Amongst other things, the regulations created new duties on;

- Municipalities to provide a separate food waste collection to householders.
- Food businesses producing more than 5kg per week to separate it for recycling.

Food Waste is defined in the Waste (Scotland) Regulations 2012 as "controlled waste that was at any time food intended for human consumption (even if of no nutritional value), and includes biodegradable waste produced as consequence of the processing or preparation of food".

This is linked to Article 22 of the Waste Framework Directive which requires Member States to encourage the separate collection of biowaste with a view to composting and digestion. The Circular Economy Package is looking to strengthen these provisions so this case study is relevant to those Member States who are yet to introduce mandatory schemes.

Markets & Economic Incentives
The introduction of the regulations sought to address a perceived market failure. There are not clear cost savings to waste producers who take on a separate collection. While landfill tax is high for the disposal of mixed municipal wastes, the cost of a reconfigured service were not always so much lower as to provide an incentive on its own.

Drivers & Barriers
The main drivers of recycling food waste are;

- The legal duty to segregate food waste for recycling
- High landfill taxes associated with the disposal of mixed municipal waste
- An established composting and digestion industry with a network of facilities
- Stakeholder co-operation & buy-in from the public

The main barriers to recycling food waste are;

- Awareness of the regulations
- Lack of time amongst small food businesses to invest in developing new practices, training staff and engaging with new waste service providers
- A perception that food waste recycling will cost more than the existing service – i.e. that it is an 'upgrade'
- Some service providers facilitating non-compliance by allowing food businesses to dispose of food to mixed waste
- Limited resources to put into face to face enforcement campaigns with food businesses

Links to Consumers & Citizens
While there have been efforts to engage the public regarding the importance of food waste recycling from an environmental and economic point of view, there is still low levels of understanding.

3.3 Success of the case

Essential Key Features

- Mandatory duty to segregate food waste from food businesses
- High landfill taxes for the disposal of mixed municipal waste
- Partnership working with service providers
- Strong communication campaigns
- Proportionate enforcement tool

Impacts of the development
Since 2014, Scotland has seen a huge push on food waste recycling, both from household and commercial streams. Food waste has become part of the national conversation and food recycling is gradually becoming a 'normal' part of life.

Scotland has made a significant investment in food waste collections with over 80% of Scottish households having access to a collection service (compared with 50% in England).

Commercial food waste recycling has become common place with the collection industry expanding significantly to provide the necessary services. One particular service provider saw its customer base triple in the first 18 months of implementation helping to secure outside investment in further expansion.

The regulations have led to an increase in both the number of treatment facilities and the tonnage of food waste collected for treatment. Food waste treated in Scotland has increased by over 65% since the introduction of the regulations.

Key Challenge 1 – Driving Behaviour Change in the Hospitality Industry
This success has not been without challenges. Municipalities and the waste industry have risen to the task and services are now available across the majority of the country. However, participation in those services by householders and businesses could be improved. This case study focusses on the commercial side where SEPA has been most actively engaged.

The early period of implementation was focussed on communication and awareness raising. SEPA worked in partnership with Zero Waste Scotland and waste service providers to co-ordinate messages, produce leaflets, use radio, print and social media and talk directly to trade bodies and businesses. This was very successful with awareness tracking studies showing a rise from 15% business awareness to over 80% by the end of the campaign (samples of 500 random businesses).

In 2016, SEPA moved from the awareness phase to a compliance phase of implementation. SEPA carried out over 6,000 compliance assessment with partners and found that two thirds of food businesses were fully compliant and around 80% are making some efforts to separate material for recycling. There are obviously challenges and we estimated around 20% were not making any effort to comply.

Despite these issues, SEPA found that where business are committed, engage with their service provider to get the right service for them, label bins and train staff, food waste recycling quickly becomes second nature.

Larger businesses and hotel / restaurant chains tend to have good compliance with non-compliance more prevalent among small independent food businesses. These tend to be 'chancers' waiting until someone comes along to make them do it rather than acting with any criminal intent.

The only sanction available in the first two years of implementation was to pursue an offence through the criminal courts and it was clear early on this option was disproportionate to the outcome we were seeking. In 2016, SEPA was granted powers by the Scottish Parliament to use civil penalties including a Fixed Monetary Penalty (FMP) of £300. SEPA identified food waste recycling as a suitable area to utilise this new enforcement tool and designed an enforcement campaign.

In partnership with service providers, SEPA identified around 75 food businesses which had previously been unwilling to adopt a separate food waste collection. SEPA carried out inspections and found the threat of a FMP was enough to change behaviour in 88% of cases. In other cases, it was not clear if they produced more than the threshold weight of food waste. In two cases, SEPA issued FMPs and will return to those businesses in future.

In summary, there are very few, if any, technical barriers to food waste recycling. A well-run awareness campaign and consistent effort from both the waste management industry and individual food businesses achieved 80% compliance within two years. For the rest, active enforcement action including the sensitive use of a proportionate enforcing tool can change behaviour.

Key Challenge 2 – Contamination Management

The rapid expansion of businesses taking part in food waste recycling has also led to higher contaminations rates of source material. It is fair to say that before the regulations, those who wished to separate food for recycling wanted to do it, understood why it is important and took care over it. Now businesses are being made to do it, whether they want to or not, and some are taking less care.

More contamination is entering treatment facilities, particularly from plastic packaging, and, in an isolated case, polluting the final product and the receiving agricultural land. A particular incident where a farm received plastic contaminated digestate led to calls from the National Farmers Union of Scotland to improve quality – their support is vital for the development of sustainable markets for the products of food waste recycling in Scotland.

SEPA acted to develop proposals for reducing plastic contamination. The key action was to tighten the end-of-waste criteria to reduce the plastic limit in final compost and digestate. These revisions set out limits (by weight) of physical contaminants (including plastic) to 50% the previous compost standard and 8% of the previous digestate standard).

To support the industry to achieve these new limits, actions are required across the whole supply chain. SEPA consulted on and published new guidance, based on the legal duty on waste producers and managers to "promote high quality recycling", explaining what steps should be taken to reduce contamination at source.

SEPA also included new Waste Acceptance Criteria into AD and composting permits, linking to the steps set out in the guidance. The industry has also invested in more effective screening and de-packaging equipment.

It is anticipated that these actions, taken together, will work to reduce plastic contamination at source, improve product quality and maintain the confidence of agricultural end-users.

Remaining barriers / drivers
With respect to the uptake of commercial food waste recycling services, there are still some businesses with no separate collection. Continued partnership work to identify and tackle these businesses with proportionate enforcement is required. Recent publication of the FMPs already served will hopefully act as a deterrent.

There is some concern regarding the ability of the land bank to use the growing volume of compost and digestate. Some work to investigate how to make best use of these products may be required.

3.4 Summary and lessons

The drive for better food waste management in Scotland has been hugely positive. It has turned a waste into a resource and supported a renewed conversation about food waste prevention with Scotland recently setting a target of reducing food waste by 33% by 2025.

Using regulation has driven positive environmental and economic outcomes more successfully than would have been possible otherwise. Other jurisdictions should feel confident that implementing the proposed separate collection requirements for biowaste in the EU circular economy package can be done successfully. However it is important to create the right support structures to ensure awareness, service provision, participation and contamination management. In particular;

1. Many businesses will readily comply. Others, particularly small independent food businesses, need more support, engagement and regulators need a proportionate sanction such as a fixed penalty, to change behaviour.

2. Rapid expansion in food waste recycling can lead to greater input contamination. Actions across the supply chain are required and end-of-waste specifications should be reviewed to ensure tight limits on plastic contamination in final products.

3.5 More information

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4 Austrian approach to produce compost from bio-waste

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4.1 Case description

Description of the case

In Austria, a regulatory and infrastructure framework for the recycling of source separated bio-waste was established in the past years. Obligations which are stipulated in the Austrian ordinance on compost enable the status of end-of-waste for compost which has been produced from waste. The case describes the main drivers and barriers on the established system and describes the context how the taken measures contribute to the implementation of the European Commission´s Action Plan on the Circular Economy[1].

Initiation, i.e. background for the case

Bio-waste generates significantly emissions if disposed at landfills (e.g. methane). By that, Austria decided to ban waste with high organic components from landfilling by setting the legal framework in the Austrian ordinance on landfills beginning in 1996. In addition, an ordinance which stipulates the source separation of bio-waste from households has been introduced in 1992. From that time on treatment options for the environmental sound management of bio-waste have been further developed and enhanced. In general, aerobic composting and anaerobic digestion, or combinations thereof have been introduced in Austria.

The temporal (timescale) development of the case

Environmental minimum criteria and related possibilities for the application of compost which is produced out of waste have been firstly introduced in 2001 in the Austrian ordinance on compost[2]. Only defined input can be used to produce compost products from waste. Different categories of application (e.g. use in agriculture) for different compost types have been defined, according to the input used to produce the compost, e.g. if sewage sludge is used. In relation to its application, the different compost types have to fulfill specific requirements on physical properties and on limits for impurities.

4.2 Operational environment

Regulatory links

At European level the Green Paper on the management of bio-waste[3] gives guidance on the management of bio-waste. Still, there are many different approaches through European Member States concerning the level of separate collection, treatment of source separated bio-waste on its own or together with other mixed waste as well as on treatment options for bio-waste (composting/digestion/incineration).

Obligations on the separate collection of bio-waste in order to produce environmentally safe compost are stipulated in the Waste Framework Directive (2008/98/EC). The EU Landfill Directive (99/31/EC) stipulates that a national strategy for the implementation of the reduction of biodegradable waste going to landfills needs to be established to ensure that biodegradable municipal waste going to landfills must be reduced to a certain percentage of the total amount (by weight) of biodegradable

[1] COM/2015/0614 final - Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - Closing the loop - An EU action plan for the Circular Economy

[2] https://www.bmlfuw.gv.at/greentec/abfall-ressourcen/abfall-altlastenrecht/awg-verordnungen/kompostvo.html

[3] COM(2008) 811 final, Green Paper on the management of bio-waste in the European Union, European Commission, 2008

municipal waste produced in 1995 or the latest year before 1995 for which standardized Eurostat data is available.

In Austria, the different qualities of compost which ensure environmental safe application are defined in the Austrian ordinance on compost from 2001 and obligations concerning the source separation of bio-waste from households are laid down in an ordinance which came into force in 1992.

The Ordinance on compost addresses the definition of different forms of application in relation to the compost quality, recording and reporting requirements as well as labeling issues. Proofed compost according to the ordinance ceases to be waste.

The technical requirements for composting processes have been published in 2005 by the Austrian Ministry of Environment in the guidance document on the state-of-the art of composting[4].

Drivers and burdens

The main drivers for recovery of bio-waste have been:

- **Ban on landfilling** waste with high organic content
- **Composting enables treatment in a decentralized and low capacity way** by facilities with small capacities (and processes with short transport distances (compost can be used where it is produced)
- **Stakeholder cooperation** in terms of establishing minimum environmental and technical requirements

The main barriers/obstacles for recovery of bio-waste have been:

- **Quality issues** of produced compost
- **Acceptance** of consumers

Financial incentives / funding and taxation influencing the case

According to the Austrian Landfill Ordinance 2008[5] the disposal of waste, whose TOC in dry substance exceeds 5% by mass, is banned (some exemptions have been formulated, e.g. on waste pretreated in MBT processes). This ban which was firstly introduced in 2004 (with exemptions in some Austrian Federal States until end of 2008), resulting in a significantly decrease of greenhouse gas emissions from landfills in the past years.

Beginning with that ban, anaerobic digestion and aerobic composting, or combinations thereof have been established to the most important treatment options for bio-waste in Austria. Incentives for biogas treatment plants where given for produced energy from biogas if feeded to the public power supply system. No incentives were given for the producers of compost.

Markets

In 2015 about 390,000 tons of compost were produced in Austria (data according to the Austrian Waste Management Plan). The operators are able to generate benefits ranging from free delivery up to 20 EUR per ton compost product (10 to 20 EUR per ton are only reported by very few operators). Import and export of both, bio-waste as well as compost does not play an important role in Austria.[6]

Links to consumer or citizens

To foster the acceptance for compost products the quality assurance system according to the Austrian ordinance on compost has been introduced in Austria. Still, the acceptance by consumers is not very

[4] https://www.bmlfuw.gv.at/greentec/abfall-ressourcen/behandlung-verwertung/behandlung-biotechnisch/richtlinie_sdt.html
[5] https://www.bmlfuw.gv.at/greentec/abfall-ressourcen/abfall-altlastenrecht/awg-verordnungen/deponievo.html
[6] Austrian Waste Management Plan 2017 (Ministry on Environment Austria, draft version https://www.bmlfuw.gv.at/greentec/bundes-abfallwirtschaftsplan/BAWP2017.html)

good as they often argue e.g. to use primary fertilizers, not produced out of waste, more likely for growing their own vegetables.

4.3 Success of the case

Essential key factors

- **Introduction of disposal ban** for bio-waste with high organic component
- **Introduction of source-separation** on a legally binding way
- **Stakeholder cooperation** in terms of establishing minimum environmental and technical requirements
- **Quality assurance scheme** for compost products (end-of-waste status)

Impacts of the development

Looking to the environmental point of view source-separation and environmental sound management of bio-waste significantly reduces environmental impacts at landfills (see Figure 1).[7]

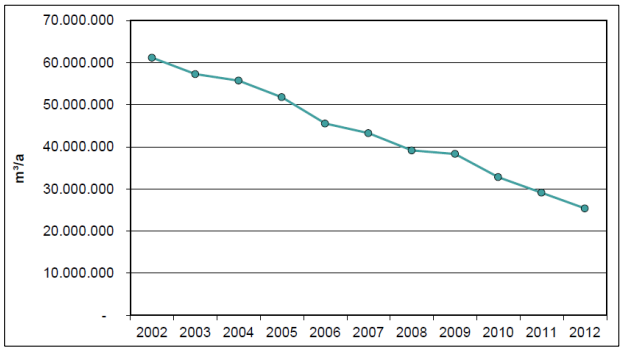

Figure 1 Collected landfill gas from 47 Austrian landfills for municipal waste

The economic impact is related to the market situation taking into consideration that the prices of primary fertilizers still are very low and it is a challenge to compete with the compost products against those low price levels. In general, primary resources are saved when recovery of bio-waste takes place and this contributes to the implementation of the EC action Plan to the Circular Economy.

Contribution to the overall situation in the country

In 2015 more than 580,000 tons of bio-waste were treated anaerobically in digestion plants. About 1.14 Mio tons of bio-waste were treated aerobically in composting plants producing good quality compost which can be used as fertilizer or in terms of re-cultivation issues.[8]

Losers and winners of the development

Not discussed in detail.

Remaining barriers / drivers to be introduced

The acceptance of compost products which are produced out of waste still is an issue to be tackled in the relationship between producers/consumers. Therefore the promotion and application of quality

[7] Austrian National Inventory Report on Greenhouse Gases, Environmental Agency Austria, 2016
[8] Austrian Waste Management Plan 2017 (Ministry on Environment Austria, draft version https://www.bmlfuw.gv.at/greentec/bundes-abfallwirtschaftsplan/BAWP2017.html)

assurance to ensure technical and environmental requirements may help to take decision on the approach of circularity.

Monitoring

In Austria, waste transfers are recorded continuously and reported at a yearly basis. Collection and treatment operators have to report their waste transfers and waste balances by amount and type. These data provides the basis for inspections activities carried out by the responsible authorities. In addition, the data on amount and type are used to calculate the regional and national waste situation as well as the quotas and numbers needed for reporting under European and national legislation.

4.4 More information

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5 Study on amounts and reasons for food waste from food industry (SW)

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5.1 Case description

The generation of food waste is problematic from an ethical, ecological and socio-economic point of view and is diametrically opposed to any sustainability considerations. In Switzerland around 2.3 million tonnes impeccable food products are discarded or get lost each year. Food waste leads to a high waste of resources, because water, energy, fertilizers and land are used along the value chain for the food production. Preventing food waste has been a priority for the Swiss Federal Office of Environment (FOEN) for over a decade. Monitoring and reporting of food waste streams is one main objective, which has been put in place by FOEN to deliver sustainable food waste reduction along the food value chain.

This paper contains a case study on food waste streams analysis in the Swiss food processing industry. The document has been prepared by the Swiss Federal Office of Environment as a contribution to the IG Green and Circular Economy of the European Network of Heads of Environment Protection Agencies (EPA Network).

A short general description of the case

The FOEN, in cooperation with the Federation of Swiss Food Industries (FIAL), carried out an analysis on the food waste streams in the Swiss food processing industry. The aim of the study was to i) analyse amount of the food waste streams and the primary reasons for wasting food and ii) to highlight the factors that are important for successfully reducing food waste in the food industry. The data were collected through anonymous online survey, which was prepared by the FOEN and coordinated by the FIAL.

Food Waste streams

The FOEN study was carried out between 2015 and 2017 and estimated annual food waste arising within the Swiss food processing sector to be around 508`000 t dry matter (DM), 68% of which could have been avoided. In terms of sector-specific production quantities, the greatest losses are incurred in the tuber processing industry (190,519 t DM/a or 41% of the sector-specific total production in dry matter), followed by the oilseed/coffee/cocoa processing industry (107,140 t DM/a or 27%). The lowest losses (21,000 t DM/a or 3%), are incurred in the cereals and bakeries sector (exclusive of mills). The proportion of inedible unavoidable food waste is greatest in the processing of tubers (potatoes and sugar beet), at just under 70% (of the total sector-specific losses). Figure 1 shows a flow analysis of the Swiss food industry.

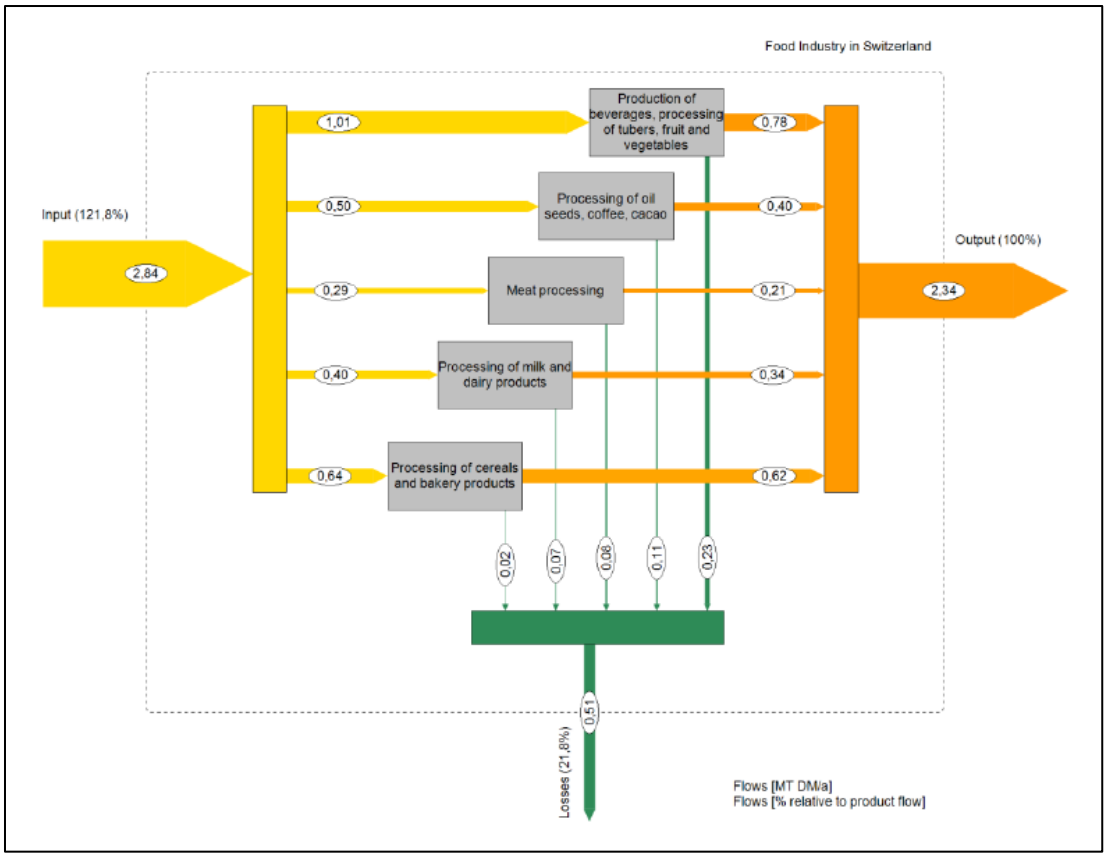

Figure 1. Mass flow analysis of the Swiss food industry (source: FOEN 2017).

Reasons for Food Waste

The primary reasons for the occurrence of food losses across all sectors were**:**

- The losses consist of parts that are not fit to be consumed (26% of total losses in terms of dry matter)
- The losses consist of parts that are fit to be consumed, but which are not put to further use by the food industry (e.g. whey) (20%)
- The losses are unavoidable based on the current state of technology (20%)
- Other reasons (sub-optimal technology, additional expense not warranted...) (34%).
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Disposal of Food Waste

Across all sectors, the largest part of the total waste is fed to animals (74.9% of total losses in terms of dry matter), followed by energy and material recovery (biogas 11.4%, composting 9.3%). Only a small proportion, i.e. 3.1%, is incinerated (municipal waste incinerators). Food that is donated, given away or downgraded accounts for 0.6%. For 0.7% of the food waste, recovery pathways could not be specified.

Measures to reduce Food Waste

A reduction in food losses primarily requires technical measures. In addition, for products that are not currently recovered within the food industry but which are, in principle, fit for consumption, further recovery pathways need to be defined. Especially in the dairy industry, alternative uses for whey offer a great reduction potential.

Food waste streams from the following industrial sectors have been considered in detail (s. above Figure 1):

- production of beverages, processing of tubers, fruits and vegetables
- processing of oil, seeds, coffee, cacao
- meat processing
- processing of milk and dairy products
- processing of cereals and bakery products

Initiation, i.e. background for the case

The case study was initiated as part of the implementation of the Swiss biomass strategy, which has been adopted by four federal agencies in 2008 (ARE, FOEN, FOAG and SFOE). (http://www.sib.admin.ch/en/documentation/publications-addressing-biodiversity/2009/switzerlands-biomass-strategy/index.html). The core elements of the Swiss biomass strategy, include sustainable biomass production and use along the value chain and the return of the nutrients contained in the biomass into the cycle.

The initiative for the particular study was started by the FOEN as part of the implementation of the Swiss biomass strategy (s. link above).

Preventing food waste has been a priority for the Swiss Federal Office of Environment for over a decade. Monitoring and reporting of the food waste streams in order to assess progress against targets and to recognise achievements and benefits of taking action belongs to the range of mechanisms, which have been put in place by FOEN to deliver sustainable food waste reduction along the whole food value chain.

The present case study exemplifies the food waste analysis in the Swiss food industry and was carried out in co-operation with the FIAL. The FIAL have been involved in the data collection, data analysis and communication of the results to the public via media release.

The temporal (timescale) development of the case

Estimate of the duration from initiation to implementation was 24 – 30 months, including the media release.

Any specific aspects connected to the process concerning use of time

There were good communication and willingness to co-operate.

5.2 Operational environment

Regulatory links

The new Ordinance on the Avoidance and Recycling of Waste (Waste Ordinance, ADWO) of 4 December 2015 enshrines the principle that biodegradable waste, including food waste, should be avoided and - if not possible - recycled as raw material (in that order), as long as (i) its properties make it suitable for a treatment as raw material, (ii) it is collected separately and (iii) the recycling is not forbidden by another Federal law e.g. as is the case with food waste from transboundary movements that needs to be disposed of thermally in accordance with the Ordinance on Animal By-products (VTNP).

Food waste prevention is substantial towards a circular economy and Switzerland is committed to meeting the Sustainable Development Goals (SDG), adopted in September 2015, including a target to halve per capita food waste at the retail and consumer level by 2030, and reduce food losses along the food production and supply chains.

On 8th March 2013, the Swiss Federal Council, at the request of the Department of the Environment, Transport, Energy and Communications, approved measures under the title Green Economy Action Plan. This contains 27 measures within four implementation domains. The reduction of food waste is a measure from the domain of consumption and production. A project group from different sections of the federal administration was set up with a mandate to initiate a stakeholder dialogue and to identify causes of food waste at the individual value creation levels. In addition, the legal framework was examined and courses of action were identified which would help to permanently reduce food waste along the value creation chain and protect natural resources.

Possible financial incentives / funding and taxation influencing the case

The Swiss food processing industry is already sensitized to reduce the food waste due to the fact that the disposal of eatable and therefore avoidable food waste costs the food processing industry an estimated 35 million Swiss francs per year disposal costs (fermentation and composting). This estimation does not consider the cost of the goods.

Markets

- Further pathways to the market need to be defined for products that are, in principle, fit for consumption but end up in the waste bin. Especially in the dairy industry and for whey alternative uses offer a great reduction potential.
- There are indications that industrial quality standards affect the level of food waste.
- Packaging in transit and storage of the food and the later products can play a key role in food waste avoidance.
- Missing/inadequate communication about the difference between “best before” and” use by” date labels.

Role of the industry

Increasing collaboration between food industry and farmers/retailers to identify where food waste is occurring and direct actions towards prevention.

Links to consumers or citizens

- Missing perception related to wasted food.
- Acceptance of products with low “optical quality standards” relating to appearance, weight, size, and shape may be rejected by the consumers and utilized as animal feed.
- Missing knowledge about the difference between “best before” and” use by” date labels.

5.3 Success of the case

Essential key factors which enabled the progress

- perception related to wasted food
- spirit of cooperation
- good communication

Impacts of the development

Environmental impact

Food waste entails a high degree of resource wastage, since water, energy and fertiliser and land are consumed along the value creation chain as the food is produced. Land, that is required to produce food, is so to say “thrown away by Swiss households”.

Economic impacts

- The costs for food losses accumulat along the value chain and are reflected in the consumer prices of the food products coming from the food processing industry, so these cost are paid by the consumers**.**
- For the food processing industry, reducing food waste helps to reduce costs associated with waste disposal (35 Mio CHF/year) and support a sustainable, competitive sector.

Social impacts

Food waste reinforces problems and a fair distribution of food and lead to a widening of the gap between surplus food production and malnutrition.

Contribution to the overall situation in the country

The Swiss food industry produces approximately 2.3 million tons of food and semi-finished products annually. Across all sectors there is a loss of approximately 0.5 million tons. This amounts to 14% of the total food production or 22% of the total food waste amount in Switzerland.

Across the study, more than 300 companies with >50 employees have been considered. For the survey, a pool of selected companies, representing the different industry branches, have been created. The survey was confidential and company names cannot be communicated.

Possibilities for scaling

The case study could be repeated in another country in co-operation with local industry associations and organizations. Indicators can be used to benchmark similar economies.

Losers and winners of the development

Reducing food waste provides both economic and environmental benefits. It is a win-win situation.

Remaining barriers / drivers to be introduced

There is an economic, social and environmental rationale to reduce food waste in the Swiss food processing industry. However, there are barriers that have prevented the food processing industry to address and take action in the past, such as lack of platforms to share best practice, as well as lack of awareness and information.

Monitoring

Monitoring and reporting of the food waste streams in order to assess progress against targets, is part of the range of mechanisms, which have been put in place by FOEN to deliver sustainable food waste reduction along the whole food value chain.

Monitoring and reporting is performed on regular basis by FOEN.

Other lessons

Reviewing the entire food chain, a close cooperation with relevant stakeholders at each stage of the food value chain is necessary in order to define a shared vision of the future, to create goals, and develop action plans to achieve results. For example, in an ongoing analysis of the food waste streams from the agriculture, FOEN co-operates closely with the Swiss Farmers Union.

5.4 More information

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6 Autoclaving mixed MSW to produce feedstock for biocoal and ABE production; optimisation with CVORR framework (UK)

Mike Tregent, Environment Agency UK, United Kingdom

6.1 Case description

This case focuses on the use of a steam rotating autoclave, Mechanical Heat Treatment system (MHT) to process mixed municipal (or similar) waste. This methodology is being used to optimise the capture of recyclable materials from a mixed waste stream with the biogenic fraction of the waste converted into sanitised fibre to be used in a variety of technologies including approved combustion, gasification, and pyrolysis, conversion into bio-char, bio-chemicals, bio-fuels and anaerobic digestion. This can be considered as a global solution to the growing waste problem throughout the world. Production of Bio-Coal from Wilson Fibre® has been granted an End of Waste status[9] supported by legal opinion of a Queens Council and therefore can be defined as a commodity product.

Resource Recovery from Waste (an environmental research programme funded by NERC, ESRC and Defra) initiated a project that aimed to develop the Complex Value Optimisation for Resource Recovery (CVORR) framework (funded by NERC and ESRC). The framework is designed to enable a holistic and consistent evaluation of social, environmental, technical and economic values to assess the sustainability of various supply chains, such as those that can be formed around the treatment process developed by Wilson Biochemical registered as the Wilson System®.

Whilst recycling sits in the middle of the waste hierarchy, once waste has been produced, optimization within the hierarchy becomes the next priority for dealing with that waste. There has been much research and investment into engineered solutions for sorting mixed wastes and capturing as much recyclable material as possible. Within this tier of the hierarchy, there are now numerous technologies and systems in use, all of which claim to deliver good results in terms of capture rates and efficiency of operation. It has been however, difficult to differentiate between these methodologies to establish which has the best sustainability/resource efficiency credentials.

With the development of CVORR, this differentiation will become possible as a more sophisticated method for assessing waste management systems for the recovery of waste would be available, purposed to assess how different processes, technologies and interventions could affect the capture and/or dissipation of value. The CVORR approach and framework examines both up- and downstream parts of the system within which waste production and management processes interact, and evaluates the system based on measureable environmental, economic, social and technical benefits and impacts.

The project is collaboration between Resource Recovery from Waste (RRfW)[10] and the CVORR project[11] at the University of Leeds, Wilson Bio-chemical, and the Bio renewables Development Centre; it is currently being undertaken in the Yorkshire and Humber Region of the UK and is due for completion in autumn 2017.

6.2 Operational environment

Regulatory links

[9] This company have self-assessed end of waste status. The Environment Agency (England) has not reviewed any data or evidence nor endorses the status of the material as having achieved end of waste status.
[10] https://rrfw.org.uk/
[11] https://leedsplus.wpengine.com/cvorr/

The process is designed to treat and sort waste in accordance with the waste hierarchy and within the recycling and reuse tiers. The intention is to meet these objectives through the optimisation of recovery of materials for recycling and to produce a clean and stable biomass product derived from residual waste.

The circular economy is being met through the improved recovery of recyclable materials, reducing the burden on use of virgin raw materials, and reducing energy demand in conversion.

The application of the CVORR framework has the potential to deliver a more sophisticated comparison of the systems and technologies available to treat and recover a number of waste streams. Being able to determine and measure consistently how resource efficiency is being delivered, will help in the delivery of a more circular economy and will help put Waste to Resources at the center of the UK Industrial Strategy.

Administrative drivers and barriers

Steam autoclaving of waste is currently operational commercially in the UK with full regulatory permits and local planning permissions. As this is an emerging and more advanced technology, it has already benefitted from innovation funding at the feasibility stage and as such is a good candidate for further collaboration.

Funding and financial incentives

The fibrous product of autoclaving as a preparatory process enables the production of bio-coal.

Gate fees are available on the incoming waste and the bio-coal product has a value within the commodities market. Sorting and treatment facilities generally charge a gate fee for accepting residual or unsorted wastes.

Similarly, the production of bio-fuels and high value chemicals will be valued by the current commodity price on the open market as a non-waste product. High value chemical production plants will also benefit from a gate fee being paid for the receipt of waste.

Further to this clean and sanitized materials are recovered for resale such as ferrous metals, aluminium and any other recovered waste which has a value.

The production of bio-fuel and bio-chemical from a sustainable source as opposed to from field crop and fossil fuel sources will contribute to achieving the EU requirements of 10% biofuel by 2020.

Markets

This is a commercial operation, however being able to measure a range of criteria that include technical, economic, social and environmental impacts gives a very useful insight as to how such opportunities and efficiencies are perceived. The project intends to highlight areas where purely market driven options and the selection of systems that do not perform as well, may need changes to policies or incentives to reflect this.

The recyclable outputs from the plant, recovered glass, plastics, ferrous and non-ferrous metals, are sold as commodities and traded here in the UK, European and global markets. As such there are vulnerabilities to volatility in such markets; hence it is important to realize the true value and efficiency of a process. Wilson Fibre® will be an essential product in the renewable energy and bio-chemicals market and will be a replacement for fossil fuels and first generation bio-fuels. Through a torrefaction process, Wilson Fibre® can be turned into a bio-char material for co-mingling with coal in coal fired power stations. The fibre can also be used as a feedstock for ABE production (Acetone, Butanol and Ethanol) to enter into the transport fuel market and even further into the high value chemicals market.

The waste industry is very keen to be seen as a part of the overall industrial model, providing resources and feedstock directly into manufacturing and remanufacturing. This project helps to evaluate this and can provide input into reporting under Corporate Social Responsibility (CSR).

Links to consumers and citizens

UK citizens participate widely in recycling schemes and would like to know that their efforts are being rewarded through improved resource efficiency and ultimately reduced costs. There are also more altruistic aspirations in knowing that recycling effort translates in a cleaner and better society.

There is still work to be done in terms of total acceptability of recycled materials and products being the same as those produced from virgin material. This can be helped by the ability to improve the overall quality of recovered materials and also by being able to evidence links to green growth and jobs.

6.3 Success of the case

Key factors to progress

Wilson Bio-Chemical is privately funded company and has also successfully received grant funding for research and development projects from Innovate UK and European Funding through BESFT2, Bioenergy Sustaining the Future. Overall the company has been awarded close to £2M in grants towards these projects with a value of up to £6M. As a result a bio refinery demonstrator plant will be installed at the Bio renewables Development Centre (BDC) at the University of York; with technology support from the BDC.

Impacts of the development

Impacts of developing the autoclaving system for treatment of waste are improvements to the waste and recycling industries and the introduction of a sustainable feedstock for renewable energy and bio-chemical production. There have been major problems converting heterogeneous feedstock's such as waste, however using the Wilson System® as a preparatory process; a homogenous feedstock with high surface area to volume ratio is created.

Using Wilson Fibre® as a feedstock reduces carbon and greenhouse gas emissions that are typically emitted with fossil fuels. It contributes to solving the issue of feedstock availability and security; as the World Bank suggests, urban waste feedstock is abundant and expected to rise from 1.3 billion tpa in 2012 to 2.2 billion tpa by 2025[12]. Unlike first generation biofuels, using waste as a feedstock is not associated with adverse environmental impacts such as deforestation, indirect land use effect and it will not detract from food production.

[12] http://www.worldbank.org/en/topic/urbandevelopment/brief/solid-waste-management

Overall contribution to national picture

A complete Wilson System® consists of two autoclave vessels for treating 150,000 tonnes of waste per annum, diverting up to 90% of waste from landfill. Given its modular flexibility, increases to expand capacity are available and at 150,000 tonne increments.[13]

If Wilson Fibre® is used as a feedstock for bio-coal production for co-mingling with coal in coal fired power stations, one Wilson System has the capabilities to produce up to 76,000 tpa bio-coal, displacing up to 78,000 of lignite. If focusing on transport fuel market, one system can produce up to 6,000 tonnes of bio-Butanol.

Winners and losers from the development

Winners will include the environment, municipalities, global population and labour market, sustainable fuel and chemical suppliers and distributors, and manufacturing industry. The main losers shall be alternative methodologies and technologies such as Mass Burn Incineration.

Monitoring & Reporting

- A full Life Cycle Analysis has been carried out on bio-coal and will be carried out on the production of Butanol and hydrogen.
- All plants will be under the command of a Central Control System designed to control and report on all the variables.
- All environmental systems will be part of the same control system and will monitor for malfunction and include alarm situation.
- All emissions are monitored continuously by the system and includes all historical data.

6.4 More information

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Resource Recovery from Waste: https://rrfw.org.uk/
Complex Value Optimisation for Resource Recovery: https://leedsplus.wpengine.com/cvorr/

[13] England produces around 20M tonnes of MDW per annum and around 24M tonnes of commercial waste (that is deemed to be similar in nature). Of this, around 44% is currently recycled and other fractions may be reused or recovered. This treatment methodology can operate to deliver material to recycling or recovery, but may also offer a pre-treatment function.

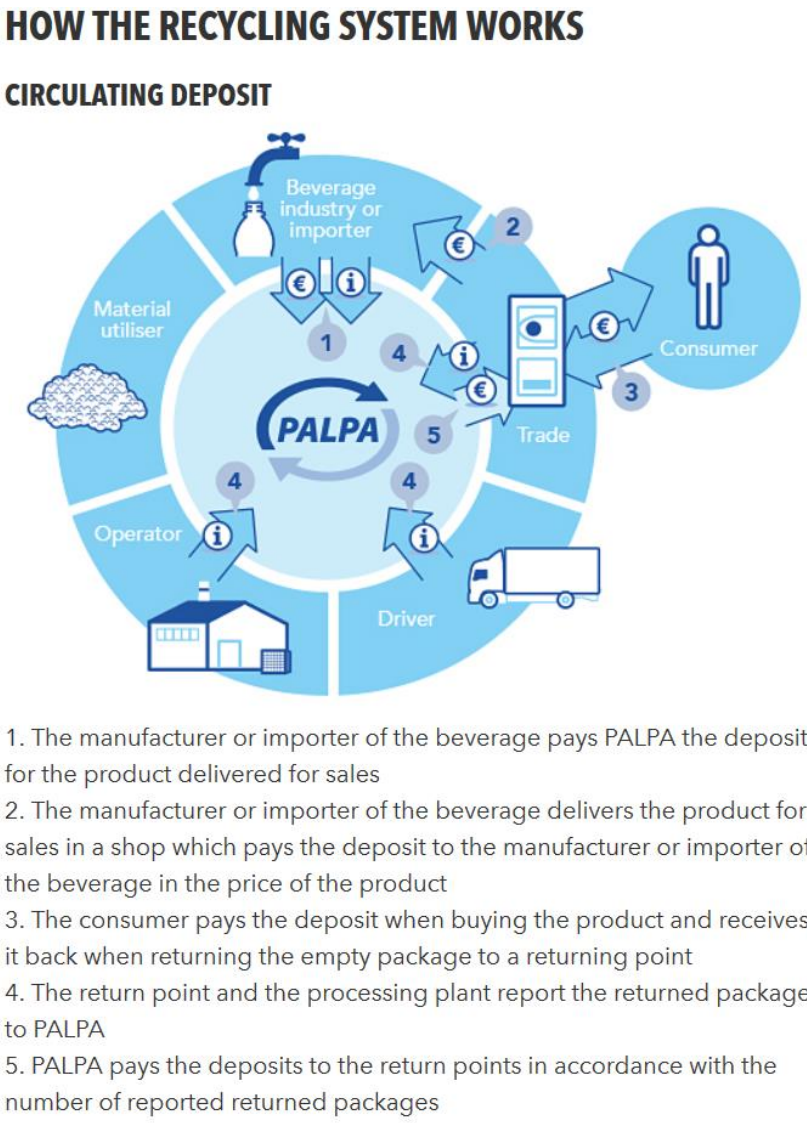
7 Finland's returnable deposit system for PET-bottles (FI)

Hanna Salmenperä, Finnish Environment Institute SYKE, Finland

7.1 Case description

The case is about a deposit return system and recycling of PET beverage packaging. Recycling of packaging is required by EU legislation. Finland has organized a deposit based return system for beverage packages of different materials. The system is based on the Finnish Waste Law and the Act on Excise Duty on Beverage Containers. Due to the joint effect of the deposit-refund system and beverage packaging tax, 93% of the yearly sold PET bottles in Finland are returned and directed for recycling.

Consumers return the bottles to reverse vending machines. PET-bottles are baled and transported to recycling in Finland, and utilised either in Finland or exported.



(Source of the Picture PALPA Oy, https://www.palpa.fi/beverage-container-recycling/deposit-refund-system/)

Initiation, i.e. background for the case and temporal development

There is a long tradition with return system of beverage bottles in Finland. Deposit return system has begun since 1950 with reusable glass bottles. Ever since the range of beverage packaging types and materials in the system have been extended.

As of beginning of 2008, the range of returnable bottles in Finland was expanded with recyclable plastic deposit bottles. The recyclable plastic deposit bottle has been included in the current recycling system for beverage containers alongside refillable glass and plastic bottles and beverage cans. However, as explained above, returned recyclable plastic bottles are not be reused as such – their plastic is utilised as a raw material for new bottles or other products.

7.2 Operational environment

Regulatory links

In EU level recycling of packaging is required by Directive 94/62/EC on packaging and packaging waste and Finland's returnable deposit system is defined in special legislation on the taxation of the manufacture of certain types of drinks packaging (1037/2004) as well as statutes in the Waste Act (646/2011) and a related decree on collection systems for returnable drinks packaging (526/2013).

A beverage packaging tax of EUR 0.51 per litre is collected for the packages of certain alcoholic beverages and soft drinks, but becoming a member of an approved and operational return system or organizing a new return system **provides an exemption from the tax**. Economical saving encourages packaging manufacturers to join the return system. In practice, most of beverage manufacturers and importers are members of return system managed by Suomen Palautuspakkaus Oy PALPA.

In addition Finnish Government has issued a decree on the recycling objectives of return systems and the minimum values of different beverage package deposits.

Aim is that 80% of recyclable beverage packaging is returned to the deposit system. The amount of deposit for plastic bottles must be at least

- 0,20 euros for plastic bottles over 0,35 litres but under 1 litres
- 0,40 euros for plastic bottles over 1 litres

Finland's returnable deposit system is promoting the principals of EUs action plan for the circular economy and its focus areas on development of the plastic recycling and enhancing the recycling of packages.

Drivers and burdens

The main drivers for recycling the PET bottles

- Packaging and packaging waste directive and national legislation

The main burdens for recycling system the PET bottles

- Bottle and packaging types outside the system
- Aims have been reached and there are not enough incentives to expand the system

- Cost-effectivity may suffer if different plastic materials than PET or different packaging types (with a risk of dirty materials) are introduced to the system

Financial incentives / funding and taxation influencing the case

The expenses of the deposit-refund system are covered by the fees paid by manufacturers or importers of beverages. PALPA pays processing fees to the return points accepting packages from consumers. PALPA pays transport compensations to the drivers and the expenses of the processing of beverage packages in processing plants. The reprocessor pays the price of the material to PALPA.

In accordance with a government decision in Finland, the drinks packaging tax on beverage packaging reutilized as raw material was abolished on 1 January 2008. The decision aims to ensure open competition and free entry onto the market.

Drinks packaging taxes are currently paid on packaging for alcoholic beverages, beer and soft drinks. Bottled water and certain other drinks packages are also subject to the tax. This form of taxation aims to further encourage the re-use of drinks packages, to reduce the quantities of such materials ending up in landfill, and to prevent litter.

Administration

Suomen Palautuspakkaus Oy (PALPA) manages the return systems of beverage packages. The duties of the administrator include the collection, recycling and/or reuse of the packages belonging to their systems. In addition, PALPA manages the administration of the deposits in their return systems, the development of their systems and the communications concerning their operations.

PALPA is owned by franchising groups and breweries. The operations are monitored by the Pirkanmaa Centre for Economic Development, Transport and the Environment. Other beverage package return system administrators also operate in Finland, but PALPA is clearly the largest.

PALPA administers three different return systems intended for different package types: there are return systems for aluminium cans, PET plastic bottles and glass bottles recycled as materials.

Markets

The ownership of PALPA is divided between retail and breweries. In addition, PALPA has several partners that operate on the different phases of the recycling process. Owners of PALPA are companies from brewery and beverage industry and retail trade (Alko Oy, Inex Partners Oy, Ruokakesko Oy, Tuko Logistics Oy, Oy Hartwall Ab, Olvi Oyj and Oy Sinebrychoff Ab.)

Majority of Finnish PET Bottles are recycled in Pramia Plastic Oy facility in Finland. In Pramia Plastic Oy facility, 100% of all collected PET bottles will be recycled. New preforms for brewery industry are manufactured from the recycled bottles.

Raw material for different types of plastic products is made from the clear bottles, while fleece fabric, backbags, shoes, umbrellas and mobile phone parts are made from the coloured bottles. 70-80% of the recycled PET is exported for raw material in e.g. textile industry. The PET-bottle capsules, made of PE and PP, are recycled into fenders, composters and plastic blanks.

Markets for recycled good quality PET are well functioning.

Links to consumers or citizens

Returnable beverage packaging has long traditions. Habits and attitudes also have an effect: In Finland, returning bottles and cans is learned in childhood, and it is considered important. Therefore, the recycling rates of beverage packages in Finland are among the best in the world.

7.3 Success of the case

Key factors which enabled the progress

The deposit is a good incentive for recycling. Other aspects, such as the location of the nearest return point and the functionality of the reverse vending machines, affect the will to recycle.

Impacts of the development

Due to the deposit based return system 93% of the yearly sold PET bottles (350 million pieces) are returned and directed for recycling. The total amount of plastic packaging is 86 000 – 117 000 tonnes from which the recycling of PET bottles is 10 – 14 %.

The deposits of the packages encourage consumers to return empty beverage packages for recycling. This prevents the packages from ending up in nature or in mixed waste. Littering and plastic waste in the environment and especially in the sea environment is considered to be one of the greatest environmental challenges.

When the materials of beverage packages are efficiently recycled, natural resources are conserved and environment is cleaner. The recycling materials acquired from PET plastic bottles and glass bottles are used for the manufacturing of new bottles and other products in many different sectors of industry.

Contribution to the overall situation in the country

System is introduced all over Finland.

Losers and winners of the development

Winners are the manufacturers who get the exemption from the packaging tax. Losers are the manufacturers and importers whose products are still outside the deposit-refund system.

Remaining barriers / drivers to be introduced

A big question is still the expanding of the system to new packaging types and maybe new materials as well. It has been noted that increase in the markets of recycled plastics of different plastic types, would be a possible driver to expand the system.

Possibilities for scaling

There still exists some beverage or other packaging types that is at the moment outside the deposit-refund system. The system could be scaled to other beverage packaging types and plastic types. However it has been identified that the biggest potential is in beverage packaging made from PET. That is how to clean and homogenous materials

In other Nordic Countries, beverage packages are recycled with the help of a national and general deposit-refund system. However, other countries do not have similar beverage packaging tax enhancing the effectiveness of the system. However, the recycling rates, i.e. the share of returned packages in relation to the number of sold packages, are very high in all Nordic Countries.

Monitoring

As the national authority for producer responsibility, the Pirkanmaa ELY Centre supervises the compliance with provisions concerning producer responsibility, with the exception of Åland. The Centre also approves the return systems for beverage containers in Finland, with the exception of Åland.

7.4 More information

https://www.palpa.fi/english/

8 Austrian approach to recirculate mineral construction and demolition waste in the construction sector (AT)

Christian Neubauer, Environment Agency Austria, Austria

8.1 Case description

Description of the case

In Austria a regulatory and infrastructure framework for the recycling of mineral construction and demolition waste was established in the past years. High recycling rates are achieved and materials are recirculated to the construction industry enhancing the issue of circularity. The case describes the main drivers and barriers on the established system and describes the context how the taken measures contribute to the implementation of the European Commission´s Action Plan on the Circular Economy[14].

Initiation, i.e. background for the case

In Austria, since 2009 the annually generation of mineral construction and demolition waste (concrete, asphalt, tiles, bricks, stones, ceramic) increased by 46% to approximately 10 Mio tons in 2015[15]. The high volumes of the waste stream and established fees to landfill them, in combination with the existing demand on primary construction materials in the construction industry resulted in the definition of national quality criteria for the recycling of this waste streams on both, technical and environmental level.

The temporal (timescale) development of the case

Environmental minimum criteria and related possibilities for the application of the recycled materials have been firstly introduced into the Austrian Waste Management Plan 2006[16]. Different categories of application of recycled materials have been defined, according to their use in bounded or unbounded form, with or without layer and according to their use in hydrogeological high or low sensible areas. In relation to its application, the recycled materials have to fulfill specific requirements on physical properties and on limits for impurities.

The Austrian Ministry on Environment[17] together with the Environmental Agency Austria[18] developed and introduced the environmental minimum requirements into the Austrian Waste Management Plan. Therefore several studies were conducted to analyse and assess the quality of construction and demolition waste.

In addition, the development of technical minimum requirements has been done by the Austrian Construction Materials Recycling Association[19], going back to and issued for the first time in the year 1996.

[14] COM/2015/0614 final - Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - Closing the loop - An EU action plan for the Circular Economy

[15] Austrian Waste Management Plan 2017 (Ministry on Environment Austria, draft version https://www.bmlfuw.gv.at/greentec/bundes-abfallwirtschaftsplan/BAWP2017.html)

[16] Austrian Waste Management Plan 2006 (Ministry on Environment Austria)

[17] http://www.bmlfuw.gv.at

[18] http://www.umweltbundesamt.at

[19] http://www.brv.or.at

8.2 Operational environment

Regulatory links

At European level the EU Construction and Demolition Waste Protocol[20] gives qualitative guidance on the management of construction and demolition waste. It covers issues on waste identification, source separation/collection, waste logistics, waste processing, quality management as well as appropriate policy and framework conditions to foster recycling of construction and demolition waste at national level. In addition, quantitative recycling targets for construction and demolition waste are stipulated in the Waste Framework Directive (2008/98/EC).

In Austria, the framework on environmental minimum requirements for the recycling of construction and demolition waste has been established over years in the Austrian Waste Management Plan and guidelines on recycling materials. In 2015, the Austrian ordinance on building materials[21] came into force and firstly stipulates a binding regulative framework on recycling activities for construction and demolition waste in Austria. It lays down specific requirements that need to be met during the construction or demolition such as the execution of a pollutant investigation, an organized and recycling-oriented demolition of structures and a duty to separate the waste generated. Furthermore, (quality) requirements for the manufacture and use of recycled construction materials are formulated.[22]

The enforcement of recycling of construction and demolition waste in Austria has been significantly pushed by the introduction on disposal fees, which gives the main incentive for recyclers to go for other options than disposal.

In addition, several standards on recycled aggregates have been published in the past years to establish the technical minimum requirements on both, European level[23] and national level[24].

Drivers and burdens

The main drivers for recycling of construction and demolition waste have been:

- **Introduction of disposal fees** for construction and demolition waste to be disposed of at landfills
- **High volumes** of construction and demolition waste are generated yearly and the waste stream is still increasing
- **Ongoing demand** on primary mineral construction materials
- **Stakeholder cooperation** in terms of establishing minimum environmental and technical requirements via establishing standardization and guidance
- **Established infrastructure** on waste separation, waste collection and waste handling carried out by several waste treatment operators

The main barriers/obstacles for recycling of construction and demolition waste have been:

- **Hazardous impurities** of construction and demolition waste which hampers recycling and generates burdens in competing with primary construction materials
- **Low prices** for primary construction materials
- Over years **requirements and conditions for recycling were stipulated only on the basis of a non-binding regulation** within the Federal Waste Management Plan (this has been solved by the new regulation which came into force in 2015)
- **Black sheep's** which sometimes contradict the regulatory framework

[20] EU Construction and Demolition Waste Protocol, European Commission, September 2016
[21] https://www.bmlfuw.gv.at/greentec/abfall-ressourcen/abfall-altlastenrecht/awg-verordnungen/recyclingbaustoffvo.html
[22] Construction and Demolition Waste management in Austria, Factsheet. European Commission, September 2015
[23] https://www.cen.eu/Pages/default.aspx
[24] https://www.austrian-standards.at/home

Financial incentives / funding and taxation influencing the case

According to the Austrian Law for Remediation of Contaminated Sites[25] (Altlastensanierungsgesetz, ALSAG) the disposal and the management of construction and demolition waste in a non proper and structurally engineered way is charged with 9.20 EUR for every ton that is not recovered.

This is the main economically driver for recycling activities.

Markets

In 2014 about 6.5 Mio tons of recycled materials were produced in Austria (data according to the Austrian Construction Materials Recycling Association; 1 Mio tons asphalt granulate, 2.5 Mio tons concrete granulate and 3 Mio tons of mineral granulate from buildings). The recycling companies are able to generate benefits ranging from 2 to 14 EUR per ton recycled bricks, asphalt or concrete depending on quality and mixture. Import and export of both, construction and demolition waste as well as recycled materials does not play an important role in Austria.[26]

Links to consumer or citizens

To foster the acceptance for recycled construction materials by consumers and industry a quality assurance system has been introduced in Austria by the Austrian Construction Materials Recycling Association[27], establishing labeling for both, processes and recycled materials.

8.3 Success of the case

Essential key factors

- **Introduction of disposal fees** for construction and demolition waste to be disposed of at landfills
- **Stakeholder cooperation** in terms of establishing minimum environmental and technical requirements
- **Quality assurance scheme** for both, the recycling process and the recycled materials

Impacts of the development

Looking to the environmental point of view recycling of construction and demolition waste significantly reduces environmental impacts at the stage of construction, re-construction and demolition as well as at stage of final disposal:

- By removing hazardous impurities (WEEE, lamps, asbestos etc.) prior to demolition of a building, the hazardous components are removed and treated in an environmental sound way. The dispersion of hazardous components is minimized.
- If recycled, mineral construction and demolition waste saves a significant amount of landfill volumes.

The economic impact is related to the market situation taking into consideration that the prices of primary aggregates still are very low and it is a challenge to compete with the recycled materials against those low price levels. In general, primary resources are saved when recycling of mineral construction and demolition waste takes place and this contributes to the implementation of the EC action Plan to the Circular Economy.

Economic impacts also has been assessed in a study conducted by the Austrian Ministry on Environment, but as mineral construction and demolition waste represents a waste stream with very

[25] https://www.bmlfuw.gv.at/greentec/abfall-ressourcen/abfall-altlastenrecht/altlastenrecht/alsag.html
[26] Study on economic effects of recycling of selected waste streams, background information and fact sheet on construction and demolition waste (WIFO, Umweltbundesamt https://www.bmlfuw.gv.at/umwelt/nachhaltigkeit/ressourceneffizienz/ressourcen_aktivitaeten/WIFO-Recycling.html)
[27] http://www.brv.or.at

high volumes and the gap between the prices of recycled and primary materials is that low, no significant results could be gained on that waste stream.

Contribution to the overall situation in the country

Construction and demolition waste covers about 16% of the total waste generated in Austria. The mineral part comprises fractions such as building debris (no construction site waste); road rubble/bitumen and asphalt; concrete demolition waste; track ballast; bitumen; asphalt; construction site waste (no building debris) and accounts for approximately 10 Mio tons in 2015, or 1,16 kg per inhabitant in Austria. More than 90% of this waste stream has been directed to recycling activities in 2015. In Austria 420 facilities were in operation in 2015, carrying out activities on the recycling of construction and demolition waste for about 8.2 Mio tons of waste (see Figure 1). About half of the facilities are operated as mobile installations. In addition, and if specific conditions are met, construction and demolition waste can also be used as filling material. Approximately 640.000 tons were disposed of at landfills in 2015 (see Figure 2). [28]

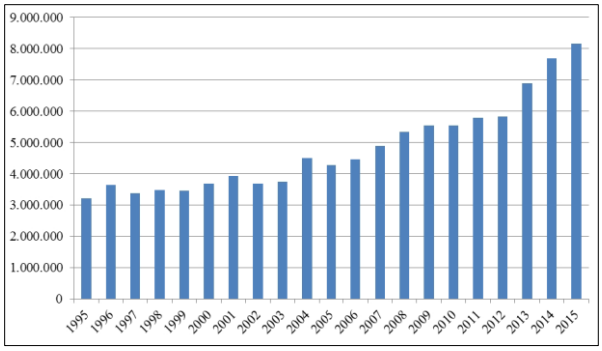


Figure 2 Treatment of construction and demolition waste in recycling facilities

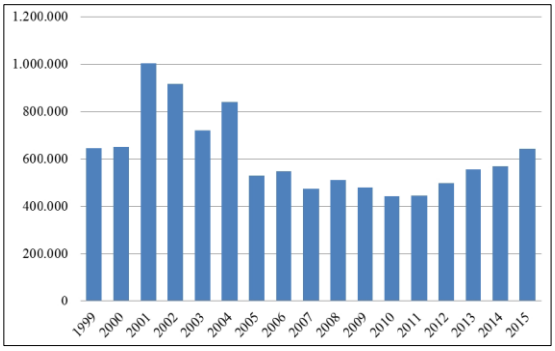


Figure 3 Disposal of construction and demolition waste

Losers and winners of the development

Not discussed in detail yet.

Remaining barriers / drivers to be introduced

The acceptance of recycled aggregates still is an issue to be tackled in the construction industry. If primary aggregates are available at same price levels as recycled aggregates obstacles to choose the recycled ones still are visible. Therefore the promotion and application of quality assurance to ensure technical and environmental requirements may help to take decision on the approach of circularity.

Monitoring

In Austria, waste transfers are recorded continuously and reported at a yearly basis. Collection and treatment operators have to report their waste transfers and waste balances by amount and type. These data provides the basis for inspections activities carried out by the responsible authorities. In addition, the data on amount and type are used to calculate the regional and national waste situation as well as the quotas and numbers needed for reporting under European and national legislation. With the new Austrian ordinance on building materials the data quality on the output of recycling facilities will be improved by reporting of different types/qualities of output separately. This provides more information and enables an assessment on qualitative aspects of the recycling activities in Austria in the future.

[28] Austrian Waste Management Plan 2017 (Ministry on Environment Austria, draft version https://www.bmlfuw.gv.at/greentec/bundes-abfallwirtschaftsplan/BAWP2017.html)

8.4 More information

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9 Roofing felt recycling in Finland (FI)

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9.1 Case description

Roofing felt is used as roofing material especially in small houses. Roofing felt contains high amounts of bitumen and mineral fillers. Discarded roofing felt has previously been landfilled, but since landfilling of organic waste was banned in Finland from the beginning of 2016 roofing felt should have been combusted if no recycling option were available. The bitumen in roofing felt makes it a good fuel, but on the other hand, the mineral fillers increase the generation of ash in combustion, hence combustion of high amounts of roofing felt is not recommended. Additionally, in combustion process, the material is lost from the cycle.

At the same time, due to the high content of bitumen and mineral fillers, roofing felt has a high recycling potential as a raw material for asphalt. Recycling of roofing felt gives a solution for one of the several waste flows included in construction and demolition waste (C&DW) and promotes reaching the 70% recycling target for C&D waste by 2020. In Finland the recycling rate was 58% in 2014. An estimated 13 000 – 15 000 tons of roofing felt waste is produced annually in Finland (estimation based on the amount of roofing felt produced in Denmark per inhabitant). The overall annual amount of C&DW in Finland in 2014 was 1.4 million tons, hence roofing felt represents 1% of the Finnish C&DW.

Tarpaper Recycling Finland is a Danish-Finnish owned company providing method and services for recycling roofing felt into asphalt. The company started operating in Finland in 2013, but has been operating in Denmark from 2006. The method for recycling roofing felt has been developed by Tarpaper Recycling together with development partners with grants from EU Life+ program for 2009-2010.

Initiation, i.e. background for the case and temporal development

Recycling of roofing felt in Finland started from a demonstration project KIHU, funded from European regional development funds (ERDF), where the collection, treatment and recovery of roofing felt and gypsum waste were studied and piloted. This project was initiated in the situation where the primary treatment for these waste fractions was landfilling. The KIHU-project was performed by two municipal waste management companies, Päijät-Hämeen Jätehuolto Ltd and Helsingin seudun ympäristöpalvelut – federation of municipalities, and the Lahti Region Development LADEC Ltd (municipally financed). The potential for recycling of roofing felt was discovered in a preceding project by LADEC Ltd. Two Danish companies (Tarpaper recycling roofing felt, the other recycling gypsum) participated in the steering group of the project and provided their know-how to it.

The KIHU project was executed in 16 month from 2014 to 2015. During 2014 Tarpaper Recycling Finland Ltd had managed to expand the separate collection of roofing felt to cover 35–50% of the overall roofing felt waste generated in Finland. Currently the collected amounts are over 10 000 tons annually.

9.2 Operational environment

Regulatory links

The 70% recycling target by 2020 for C&DW is a driver for this case. Another important driver is the national ban on landfilling of organic waste.

Administration

Source separated roofing felt waste is treated in Päijät-Häme Jätehuolto Kujala waste treatment center in Lahti, southern Finland. There are several companies included in the recycling chain. Päijät-Hämeen Jätehuolto Ltd (PHJ), Maansiirto Morri Ltd and Lahden Siniset Ltd all have their role in collecting and treating the raw material Tarpaper needs. Roofing material producer Icopal Ltd and Icopal Katto Ltd have been co-operating from the beginning in developing the recycling concept in Finland and other countries.

Tarpaper Finland takes in bituminous demolition waste and roofing felt left overs and processes them into quality assured roofing felt crush, which is directed to asphalt industry to be used in asphalt to compensate a share of virgin bitumen. In addition, Tarpaper Finland uses numerous local subcontractors for the maintenance, and contractors in waste sorting and lifting operations.

Acceptance from the clients (road constructors, such as municipalities) was important for the market creation. Acceptance was obtained by testing the material in pilot road constructions using the recycled material and by applying and receiving end-of-waste status for the roofing felt crush to be used in asphalt or new roofing felt.

Financial incentives / funding and taxation influencing the case

Funding for the KIHU-demonstration project from European regional development funds (ERDF) was crucial for starting the recycling in Finland. Funding from EU Life+ programme was essential for developing the recycling method by the Danish company.

In Finland the ELY Centre (Centre for Economic Development, Transport and the Environment) and Tekes (the Finnish Funding Agency for Innovation) have had significant roles in the development process. The ELY Centre has granted funding for Finnish investments and for development of the recycling and service concept. Tekes has provided funding for the product and technique development (e.g. the feeder needed to feed the bitumen crush in the asphalt process) and enabled verification of quality benefits from the use of recycled roofing felt crush (such as increasing the deformation resistance of asphalt).

Markets

Main customer for the recycled roofing felt is asphalt industry that is interested in the recycled bitumen since it is cheaper than virgin bitumen. The recycled material had demand from the beginning. Roofing felt is used in Northern and Central Europe, asphalt is produced and used everywhere, so markets for bitumen exist at least on the European level. However, as roofing felt is not used for roofs everywhere in the world, global markets are more restricted.

Links to consumers

Consumers do not have a relationship with asphalt, so the acceptability is more connected to the properties of the asphalt produced.

9.3 Success of the case

Key factors which enabled the process

The method for recycling had been developed previously and demand for the recycled material exists continuously. The municipal waste management company Päijät-Hämeen Jätehuolto Ltd was willing to give space for the recycling operation. The waste management company even built and rented a building for the operator. Delivering roofing felt to material recovery was cheaper than landfilling. Co-operation between companies was achieved.

Markets require acceptance and trust in the quality of recycled materials. Acceptance from the clients was obtained by testing the material in pilot road constructions using the recycled material and by applying and receiving end of waste –status for the roofing felt crush to be used in asphalt or new roofing felt.

Impacts of the development

Reduction of greenhouse gas emissions have been verified in an environmental product declaration by Bionova Ltd. Comparison was performed on a Finnish asphalt producers product according to EN 15804 standard. The comparison showed a reduction of 11% in greenhouse gas emissions when comparing AB16 asphalt (including 50% recycled asphalt) with AB16 asphalt (including 50% recycled asphalt and BitumenMix crush compensating 2% of the weight of asphalt). The calculation included emissions from raw material acquisition, transports and production of asphalt mass.

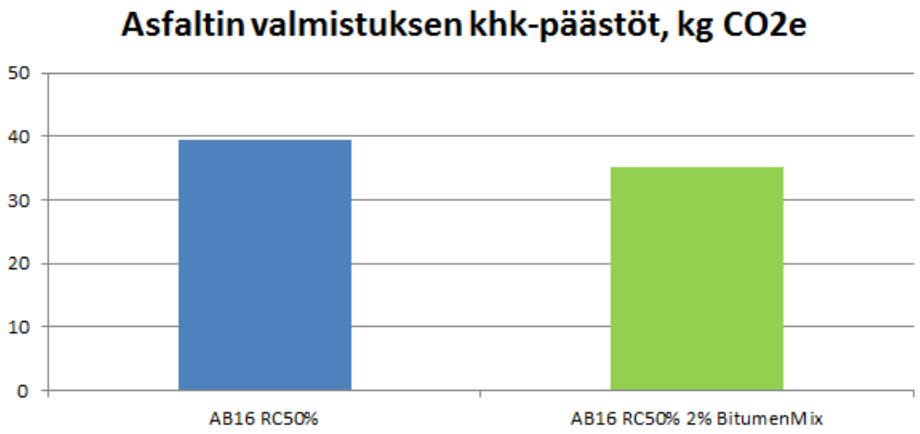

Figure 1. Greenhouse gas benefits of using recycled bitumen from roofing felt in asphalt production. On the left: Emissions from raw material acquisition, transports and production of AB16 asphalt (including 50% recycled asphalt), on the right the corresponding for AB16 asphalt (including 50% recycled asphalt and BitumenMix crush compensating 2% of the weight of asphalt).

Using the bitumen from roofing felt for asphalt instead of virgin bitumen is economically interesting to asphalt industry due to its lower price. The price of bitumen more or less determines the price of asphalt. In addition to bitumen, roofing felt also includes mineral substances and sand which are applicable for the base material in asphalt. Delivering roofing felt to recycling is cheaper for the waste producer than landfilling it. Sorting of roofing felt was not considered laborious at the demolition site.

Logistics play an important role; Lahti is situated in the southern Finland, where most of the Finnish population lives, distances are not too long, and the cost level is lower than in Helsinki metropolitan area. Roofing felt waste from nearby locations are collected, combined and transported to Lahti as full truckloads of 45 tons. Future plans include developing logistics so that delivering crushed roofing felt waste to asphalt stations would be combined to a return load of collected roofing felt waste.

Possibilities for scaling

Scaling is possible, but for the business operator, information is needed on the amounts of roofing felt generated and the co-operation possibilities with various companies.

Monitoring

Quality monitoring begins at the renovation and demolition sites. Sorting at site ensures that the roofing felt fraction is as clean as possible and contains no contaminants. If contamination is suspected, a sample is delivered to the laboratory for analysis. Tests are performed during the whole production process. Parameters such as hazardous substances, hardness and amount of bitumen, particle size and water content are monitored during the production.

9.4 More information

EN 15804—2012 Sustainability of construction works, Environmental product declarations, Core rules for the product category of construction products.

Leiskallio, A., Ekholm, E., Vehviläinen, J., Mäntynen, M. & Makkonen, O. Askel kohti kiertotaloutta - Kipsi- ja kattohuopajätteiden keräys kierrätykseen. KIHU-hankkeen loppuraportti.

https://www.phj.fi/ajankohtaista/462-kihu-hanke-onnistuneesti-paatoksessaan-loppuraportti-on-valmistunut
https://www.ladec.fi/tarpaper
http://www.tarpaper.fi/

10 Closing Critical Materials Loop in Basque Iron and Steel Industry (Basque country)

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10.1 Case description

Driven initially by economic and environmental criteria, Sidenor, one leading special steel factory, launched a "Refractory Close Loop Project" to reduce a relevant part of its 5,000 tons/year refractory waste and save money maintaining or even increasing steel quality. Although most steel producers considered not possible to perform better, this internal team, followed by public authorities, reached after 2 years hard work, were:

- Increase high quality magnesite recycling rates from 8% to 75%
- Still low quality non yet recyclable magnesite refractories accounts for 40% of the initially generated wastes (today 73% of wastes)
- Reduce magnesite refractories consumption in 10% by in factory reuse and smart management, taking in account a high material cost over 1,000 €/ton
- Increasing refractory lifetime by 38%
- Save 0.8 million €/year of materials due to reuse without accounting high additional productivity savings
- Finalist Company in European Environmental Awards 2015-2016 based on the refractory reuse and recycling success story of Sidenor

The key for success have been:

- A new business model for refractories, going to a pay for use model where suppliers necessary commit for improvement, getting 50% of the reached results (benefits or even losses)
- Optimization of furnace ovens control parameters make possible to monitor in depth process parameters.
- Availability of highly skilled and experienced refractory experts in manufacturers and users
- Interdisciplinary team members commitment, led by R&D Department and awarded as "Best Project" by Gerdau Steel Multinational
- A follow up of IPPC implementing regional authority (and BREF sectorial team member)

This project was also supported by the "Circular Economy Demostration Projects Programme" of Ihobe (Basque Government). The economic support of 25,000 € facilitated a continuous public-private dialogue with the Steel Factory and has contribute decisively to:

- A transfer of the practical experience and innovative knowledge to the other 8 Basque Steel Factories that accounts for 100% of production and refractory wastes. The presence of multinationals factories in this transfer (Arcelor Mittal, Celsa Group, Gerdau,..) will suppose an international impact
- A preparation of a regional landfill ban of recyclable magnesite refractories, in discussion. (ongoing)
- A preparation of specific new requirements to Steel Factories about refractory recycling to be integrated in the recently renewed permits (ongoing)
- A first draft of Circular Economy Refractory Criteria for the new Steel Furnace BREF revision (to be initiated)
- A RTD support to develop new technical alternatives for low quality refractory wastes (to be initiated)

Fig 1: Periodically oven reconditioning exchanging high quality magnesite refractories (Sidenor Basauri)

Initiation, i.e. background for the case and temporal development

The Basque Country consumes near 216,000 ton/year of critical materials of the EU List of 2014 with a global value of more than 415 million €, as reported in 2016 in "Green Manufacturing: Critical Materials in the Basque Country" The reality shows that 88% of this materials and 97% of the economic value is consumed by the iron and steel industry, mainly by Steel Electric Arc Furnaces (EAF) and, in a smaller amount, by foundries. The explanation is that EAF furnaces produce up to 5 million tons/year of steel products, being more than 20% special steel semi-elaborated products and 5% stainless steel products.

The main long term challenge in the Iron and Steel industry is to reduce the losses of critical materials by an advanced scrap procurement and management fully coordinated with the production processes that ensures that relevant alloys as Molybdenum, Nickel or Chrome are not supply to low quality steels or lost in slags, as UNEPs "Metal Recycling: Opportunities, Limits, Infrastructure" study shows. A recent experience developed by the Ihobe supported "Kriteus" project showed relevant savings (over 2 million €/year) by optimizing internal scrap management in stainless steel EAF. There are some other additional actions that should be faced in short or middle term to build up on successful experiences and create awareness in this sector. Closing the loop of an auxiliary critical material, as high quality magnesite used for furnace refractory purposes is a best practice to start.

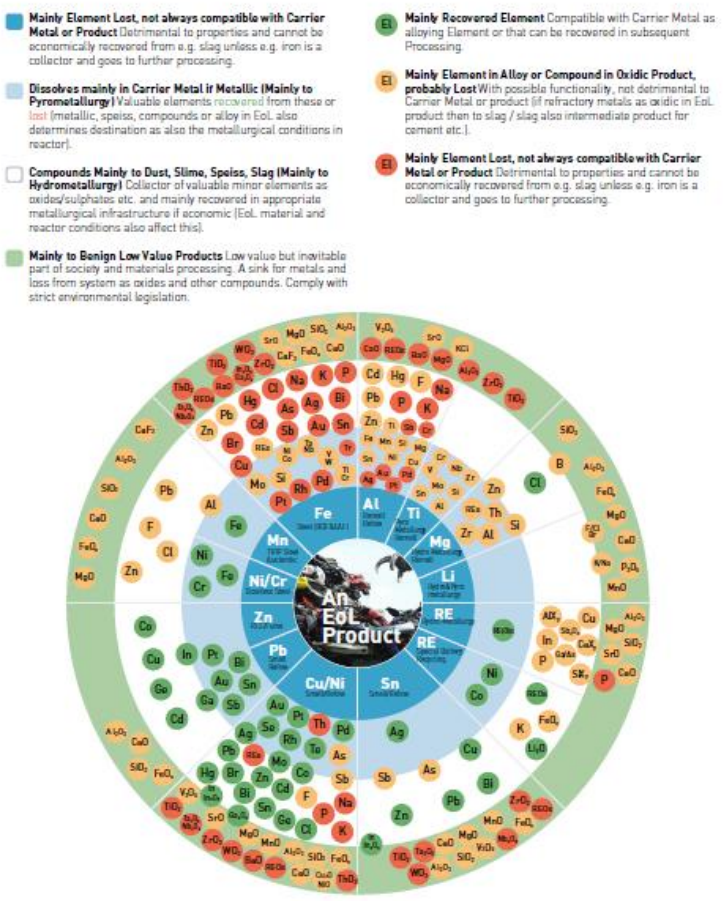

Fig 2: Overview of usual Material losses of Critical Materials in Metal Industry (Source “Metal Recycling: Opportunities, Limits, Infrastructure”, UNEP, 2013)

Magnesite refractories flows in the Basque Country have been recently analyzed. It has been confirmed that the refractory value chain is almost full represented in the Basque region, except the extraction of high quality magnesite imported from China. Relevant refractories manufacturers, steel furnaces and recyclers are available. Chinese export restrictions led in 2011 to serious supply problems in European refractory manufacturers. Curiously, low landfill costs and market incoherence makes that relevant amounts of high quality magnesite wastes (6,000 tons/year) are exported after pre-treatment mainly to Germany and high & lower quality magnesite containing waste is landfilled massively (>15,000 tons/year).

Steel industries don´t prioritize auxiliary materials and their wastes because they are not critical to the core business of this IPPC EU Directive affected industries, who prioritizes market share and customer satisfaction on their high quality alloyed steels. Public Authorities are dealing more on slag and dangerous steel dust wastes and are less aware of a minor amounts of non-dangerous wastes like magnesites refractories are.

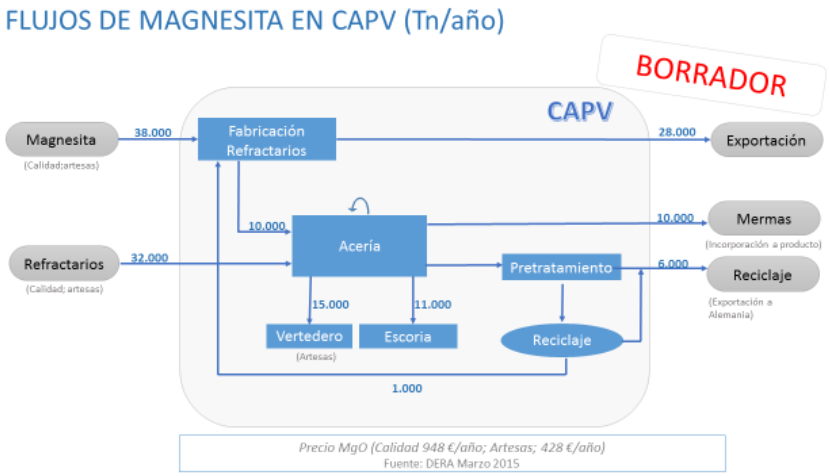

Fig 3. Magnesite Flow in the Basque Countries Steel and Iron Industry. (Source:Ihobe, 2015)

Public Authorities IPPC responsible Basque officers are in constant exchange with Steel and Iron industry to require and renew licences and anticipate different challenges via a public-private dialogue, faced usually in an individual way. They are also participating in the Sevilla IPTS-JRC led process of renewing the different BREF documents, being especially active in Iron and Steel Industries related ones. Although Steel Furnaces have been just adopted to new BREF and few debate is previewed in the next five years, the previewed guidance of Circular Economy criteria into new European Commissions BREF documents, as established in the Circular Economy Action Plan COM(2017) 33 final, will accelerate critical material cycle closure.

10.2 Operational environment

Regulatory links
Today, Basque regulation requires that, before landfilled, industrial waste producers have to confirm by three external recycling firms that their waste is not technically able to be recycled and possible economic overcost are assumible.
Public Environmental Authority has the power to ban landfilling for waste flows that are recyclable, establishing for it an official announcement.

Possible financial incentives / funding and taxation influencing the case
The best financial incentives to increase circularity in refractories would be:

- Increase of the actually low Landfill tax (bellow 20 €/ton for this refractories), at this moment in policy debate, would accelerate definitively solutions.
- Subsidies to Research and Development Projects (RTD) in close collaboration with suppliers and other users are key to confirm seriously new circular economy alternatives.
- Support to refractory suppliers to rethink their business models towards an service based Product Service System

Administration
IPPC management is not only about requirements. A honest public-private dialogue make possible to anticipate new rules and synchronize public actions with the factory schedules to minimize negative business impacts and risks, offering certainty. This make possible to transfer knowledge to other Steel Factories and even to push high value refractory recycling initiatives at local level, avoiding transportation of more of 2.000 km to be recycled. During the second semester 2017 a closed one day seminar between Ihobe, environmental authorities and EAF factories will be held to share best practices not only on circular refractory management, but also on improvement of high alloyed internal scrap management and more efficient in factory EAF dust recycling techniques.

Markets
The public-private open dialogue has induced that regional refractory manufacturers are analyzing to participate in new recycling infrastructures, to introduce higher recyclates contents in new refractories (several RTD projects going on) and to move to a “pay for use” business model, that ensure a strong customer (EAF Steel Factory) loyalty.

Links to consumers or citizens
No links previewed except a clear publication of a Case Study to facilitate circular economy thinking.

10.3 Success of the case

Essential key factors which enabled the progress

The key factors are:

- A new recycling alternative for low quality magnesite and dolomite refractories (and also low quantities produced isostatic ones) is a key issue to avoid any steel refractory landfill.
- Give a timeframe of 2-3 years to applicate the Sidenor experience in other Steel factories. It implies structural changes of the relationship with refractory suppliers
- Co-design and announce a landfill ban for steel refractories
- Support the take up of waste refractories in local refractory manufacturers subsiding RTD projects with a clear business focus
- Require in IPPC permits the recycling of refractories and recommend good practice for an optimal furnace oven control

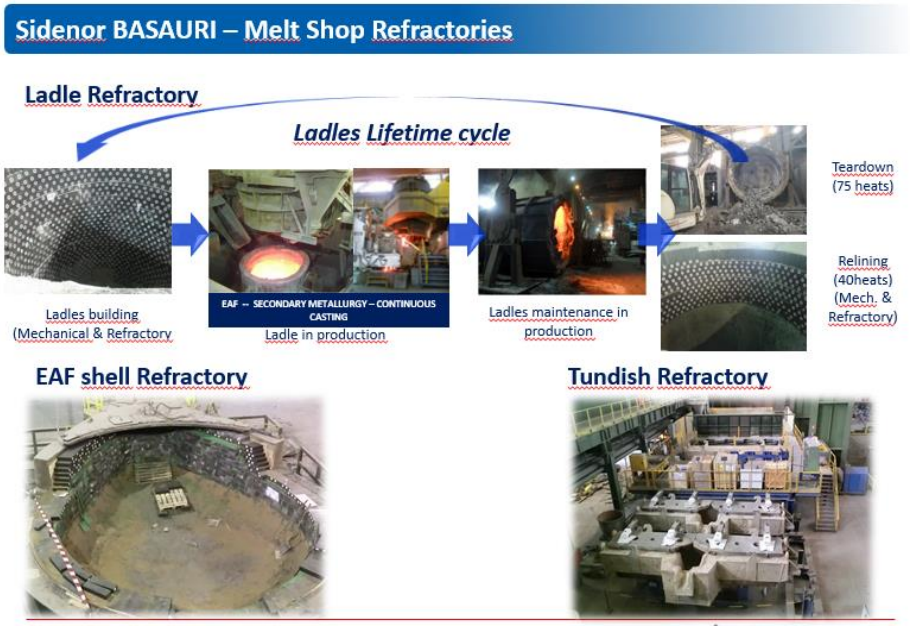

Fig 4: Main reuse and recycling actions done internally in Sidenor best practice

Impacts of the development
In a first phase high grade magnesite refractories have to be addressed, focusing first in reuse and only afterwards on upcycling. In a second phase low grade refractories should be addressed. Only in the Basque Country it would led to >15.000 tons/year to be recycled and 6.000 ton/year to be upcycled to high value products.

Possibilities for scaling

Scaling at regional level is guaranteed by a close public-private dialogue with the steel business association. Transfer at international level can be done introducing results at new Steel BREF discussions and via steel multinationals present in the Basque Country (f. ex. Arcelor Mittal,…)

A second scaling up is directed to introduce Critical Material Early Management in Steel Factories, focusing mainly on an advanced scrap management in the whole supply chain of alloys containing steels.

Monitoring
IPPC permit requirements design has to clearly define the way for measuring and monitoring an integrated Life Cycle Analysis based environmental performance in steel furnaces. European Commission is proposed to develop an TOP-DOWN approach for IPPC sectors, applicating a Life Cycle Thinking based simplified Organizational Environmental Footprint (OEF) using European Commissions pilot project methodology. Initially to be developed in collaboration with agencies, should be voluntary for few IPPC sectors like EAF to be piloted in some regions. If succeeded, transfer of this monitoring system should be supported to facilitate some other countries and regions to progressively require the OEF in the annual report IPPC companies have to deliver periodically to their environmental authorities.

10.4 More information

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An overview in
"36 Circular economy demonstration projects in the Basque Country" (2016)
"Two Decades of Refractory Improvements in Nippon Steel Corporation" (2008)
"REFRASORT: Raw Material challenges in refractory application" (2016)