

Circular Economy in Italy



Francesco Di Maria

Abstract Italy is located in the south-west part of Europe with a population of about 60.6 million of inhabitants and a gross domestic product of about 1,934,798 M US\$ in 2017. Italy operates in the wider legal framework of the European Union (EU) legislation that is internationally recognized as one of the most advanced approaches in the sectors of environmental protection, sustainable development and waste management. The broad concept of sustainability entails, among the others, also the preservation of the environment quality and of the resources of the earth for the future generations. In this context takes place the concept of circular economy (CE) based on the circular use of resources. An important sector in which circular use of resource was successfully implemented since 1991 was the waste management. The directive 91/156/EEC (CD 1991) formally introduced in the legal framework of waste management the concept of the waste management hierarchy establishing the priority goals to be pursued with a hierarchic order in waste management (Fig. 1): Prevention, Reuse, Recycling, Recovery and Disposal. From the hierarchy was also extrapolated the 3R concept based on Reuse, Recycle and Recover. The same directive introduced also the concept of extended producer responsibility (EPR) that is another fundamental pillar for enhancing the recycling of waste. These basic concepts during the years were updated and improved but never replaced or repealed by the successive directives. Legal and economic support resulted key factors for a successful implementation of CE even if it is necessary to size these activities in each specific market. Large differences were detected in the sector of the municipal solid waste compared to the ones generated by industrial and commercial sectors. Long-term efforts which aimed to the implementation of the legal framework in the sector lead in about 8 years to a reduction of the amount of waste disposed of about 33%. Furthermore, latest data available shows that this positive trend is still increasing. Socio-economic indicators showed that there is a general decrease of waste generated and that the paradigm between the increase of GDP and families' expenditures and waste generation is starting to be capsized. Different results were detected for the waste generated in industrial and commerce sectors. Even if the high level of

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recycling that in the 2014 was of about 85%, their effective prevention seems not to be successfully pursued yet.

1 Introduction

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The broad concept of sustainability entails, among the others, also the preservation of the environment quality and of the resources of the earth for the future generations. In this context takes place the concept of circular economy (CE) based on the circular use of resources. An important sector in which circular use of resource was successfully implemented since 1991 was the waste management. The directive 91/156/EEC (CD 1991) formally introduced in the legal framework of waste management the concept of the waste management hierarchy establishing the priority goals to be pursued with a hierarchic order in waste management (Fig. 1): Prevention, Reuse, Recycling, Recovery and Disposal. From the hierarchy was also extrapolated the 3R concept based on Reuse, Recycle and Recover. The same directive introduced also the concept of extended producer responsibility (EPR) that is another fundamental pillar for enhancing the recycling of waste. These basic concepts during the years were updated and improved but never replaced or repealed by the successive directives. Figures 2 and 3 reported the municipal solid waste (MSW) management for the EU member states for the years 2006 and 2014, respectively (ISRPA 2009, 2017a). These figures indicated clearly the successful implementation

Fig. 1 Waste hierarchy



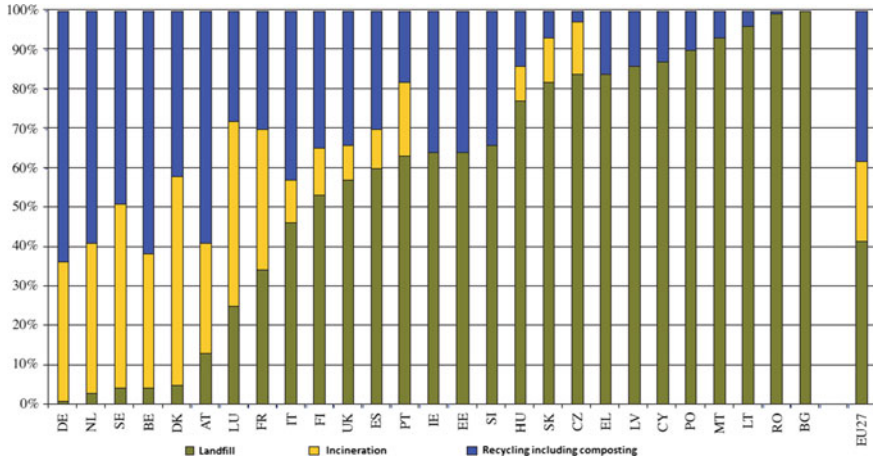


Fig. 2 Municipal solid waste management in the member states of the European Union for the year 2006

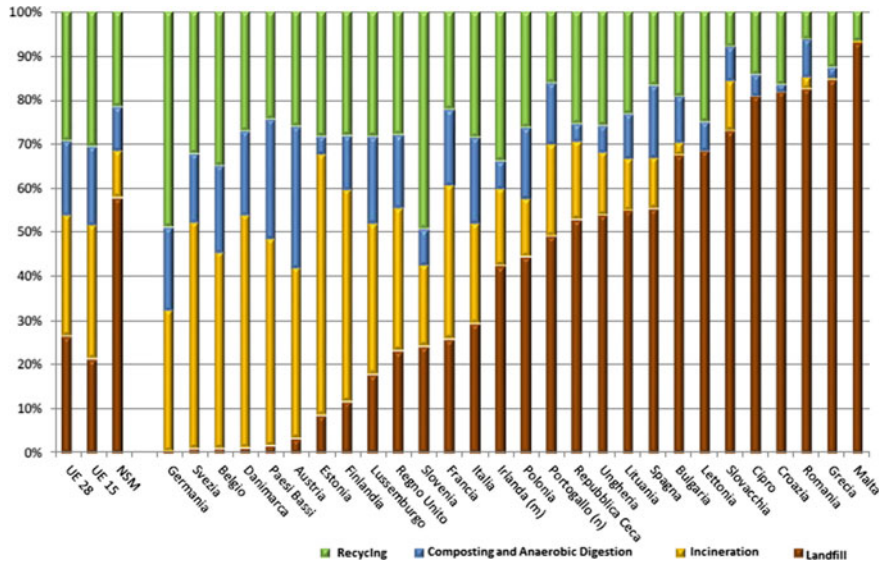


Fig. 3 Municipal solid waste management in the member states of the European Union 28 for the year 2014 (NSM = New State Members)

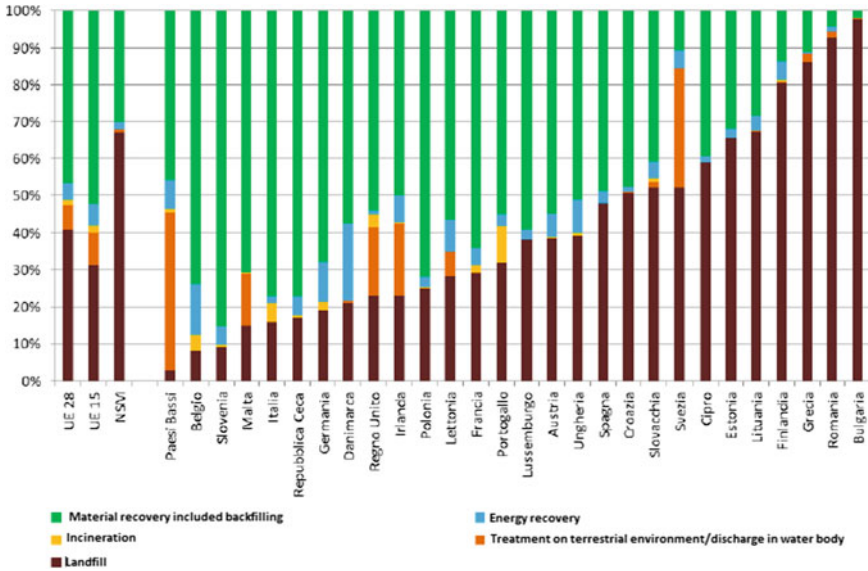


Fig. 4 Special waste management in the member states of the European Union 28 for the year 2014 (NSM = New State Members)

of the legal goals with a significant decrease of the MSW disposed of and a corresponded increase of those recycled including the composting and the anaerobic digestion of the organic fraction. By the way, according to legal definition, MSW are those generated strictly by households and similar activities and represent only a limited amount (i.e. 250 Mtonne for EU and about 29 Mtonnes for Italy) of the whole waste generated (i.e. about 15%). In fact, waste generated by other activities (e.g. industry, agriculture and commerce) legally defined as special waste by the EU legislation (ISRPA, 2017b) in the EU were about 2,502 Mtonnes (2014), whereas in Italy, this figure was of about 160 Mtonnes (2014). Figure 4 reports the management of these special wastes in the different member states of the EU.

Of course the waste management sector is relevant in the implementation of circular economy as it determines the put in practice of the waste hierarchy (Fig. 1). By the way, other actions need to be taken for a full implementation of CE involving different actors and activities necessary and strategic for the achievement of this goal.

Key drivers for CE are represented by economic actors as business and consumers, local, regional and national authorities and also over national authorities as EU. All these actors have to operate for the implementation of the right regulatory framework related to each single market and indicate to all the actor which is the way forward. Above these, other relevant activities are necessary to be pursued as the implementation and promotion of the United Nations Agenda for Sustainable Development (UNRIC 2018) and the G7 alliance for resource efficiency (EC 2015b). International cooperation is also another key factor for CE implementation.

2 Legislation

Currently, in EU and Italy, it is possible to find several legislations related to the implementation of CE concept in specific sectors since more than 20 years. By the way, the first coordinated and specifically dedicated document for the implementation of CE in the EU is represented by the communication of the EC COM(2015) 614 final (EC 2015a). By this communication, the EC launches an EU action plan for the implementation of CE.

This action plan is an integrated approach involving legislative, economic and research aspects supporting the CE implementation in each step of the value chain starting from production to consumption, repair, remanufacturing, waste management and secondary raw materials feed back into the economy. Action will be also taken on fertilizers and water reuse.

Implementation of CE starts from the first phase of the value chain that is the design and production of goods. Design is the first step for promoting repair, reuse, upgrade and recycling of products. Increasing the lifespan of goods is another important aspect of CE. More incentives for eco-design will be hence implemented. By the way, even if efficient eco-design is performed, no adequately efficient production systems can lead to the generation of a high amount of waste. Production system and waste generated differ a lot by industrial sectors. The European Commission will elaborate specific best reference documents (BREFs) for supporting legal authorities in releasing permission for industrial installation for promoting innovative and best practice which able to increase the production efficiency including the remanufacturing of secondary raw materials and recycling. Concept based on industrial symbiosis will be also promoted. Reject of materials and energy from one production process can be used as inputs from another production process minimizing the waste of materials and energy. For the implementation of this concept, an improvement of the extended producer responsibility will be also pursued.

Consumers play a crucial role in successful implementation of CE, but there is a need of correct information, affordable prices and regulatory framework. Information about the eco-friendly level of products is fundamental for driving the consumers in the choice of more sustainable products. Eco-label, energy performances and similar labelling systems are already put in practice but not always so clear or useful for the goal. National and local authorities will also promote economic supporting schemes for more eco-friendly products by different supporting scheme as tax reduction or similar. Guidance for product repair and availability of spare parts is also another important aspect to be promoted for increasing the lifespan of products. Green public procurements represent also another important aspect for driving purchase towards CE implementation.

As already stated, waste management plays a central role in the implementation of CE since it determines how the hierarchy is put into or practice. All wastes have to be considered from household to industrial, including mining and construction and demolition. The European Commission is committed to establish long-term recycling targets and to reduce landfilling. Particular care will be also focused on

how the wastes are managed that is an essential point for returning high valuable and recyclable materials.

Waste management is also crucial for secondary raw materials' reuse. Secondary raw materials replace raw materials pursuing two objectives—prevention of resource depletion and security of supply. Two main obstacles, nowadays, hamper the secondary raw materials' exploitation—uncertainty about their quality and market demand. About the first aspect, the European Commission will elaborate common quality standards in particular for organic fertilizer generable from organic waste. In the second case, appositely legislation will be implemented together with adequate economic support. Another import issue is also represented by wastewater reuse. About this aspect, the European Commission will implement legislation together with minimum quality standards. Furthermore, the COM(2015) also targeted five priority areas characterized by specificities of their products or value chain, their environmental footprint or dependency of material from outside. These areas are represented by:

- (1) **Plastics.** Plastic materials are widely used in different products from packaging to vehicles. Currently in the EU, about 25% is recycled and about 50% is landfilled. Improper plastic management causes also ocean pollution with very high environmental burden. The European Commission will implement more ambitious targets for plastic recycling, reduce marine litter and avoid hazardous substances in plastics production.
- (2) **Food waste.** Food production, distribution storage and use generate high impact. This resulted in increase of edible food disposal. Furthermore, food waste takes place at all the level of the value chain from production, to final users (e.g. restaurants, canteen, home) making very difficult its quantification. The European Commission will elaborate uniform calculation methodologies for addressing these amounts. Data marking is also another issue to be addressed as the 'best before' that usually did not indicated the expiry date. Wrong interpretation of this also causes a large generation of food waste.
- (3) **Critical raw materials.** These are represented by high value and vulnerable supply distribution materials. These are often present in electronic waste. Recycling rate will be hence improved, and the commission will promote this activity.
- (4) **Construction and demolition waste.** This represents one of the largest amounts of waste generated in the EU. A lot of recyclables in such waste still continue to be disposed. Quality standard and selective demolition procedures are among main criticisms for their recycling. Green public procurement is also another important aspect to implement for increasing construction and demolition waste.
- (5) **Biomass and bio-based products.** Biomass can play an important role in replacing fossil and mineral resources for the production of fuels, energy and chemicals. It is in any case mandatory to analyse with attention the sustainability of the supply chain with particular attention to the environmental impact. Wood packaging recycling will be also increased. Research funding for supporting EU bio-based economy is also a fundamental factor for a full implementation of CE.

Finally, the COM(2015) 614 (EC 2015a) indicates also a timetable for the planning of the actions to be taken forward per each main from 2015 to 2018.

Furthermore, the European Commission proposed other two documents related also to emending the 2020 targets reported in the WFD (2008). They consist in an overall recycling of waste within 2030 of 65% (EC 2015c) and in an increase of recycling rates of specific waste materials (EC 2015d): plastics up to 65%; metals up to 85%; wood up to 75%; glass up to 85%; paper and cardboard up to 85% EC (2018) (Table 1).

3 Research Models

In the following are reported some of the most meaningful recent research projects involving different aspects related to the implementation of circular economy.

Of particular interest are those concerning the production and the consumption aspects.

For the production aspect:

LIFE M3P—Material Match Making Platform for promoting the use of industrial waste in local networks

The Life M3P project will study and implement an online platform to promote exchanging of industrial waste among the companies of manufacturing districts. The Life M3P project will last three years (October 2016–September 2019), and it runs in Italy—Lombardy, Belgium—Flanders, Greece—Western Macedonia, Spain—Asturias.

The final objective is to demonstrate and apply experimentally a model of territorial management of industrial waste in order to promote the Industrial Symbiosis. Through the proposed model, the project wants to boost the overall efficiency of industrial processes in the target areas by increasing the use of industrial waste and reducing landfill, storage and transport.

Implementing and using the online platform will allow to address the lack of information about the industrial waste produced in a local area, through a systematic approach oriented to the life cycle of products and to the material chain needed to make them.

In particular, the partnership—coming from Italy, Belgium, Spain and Greece—aims to strengthen local networks for the improvement of the industrial waste, fostering their use in other local businesses and reducing the needs for treatment, storage, transport and the consequent environmental impact.

The M3P project wants to support industrial companies in their continuous improvement in order to reduce processing waste and to replace raw materials with others resources less critical for environment and supply.

In fact, the study of a model of local collaboration on materials will allow companies to act consciously as ‘geographical area’, and it will provide to small- and medium-sized companies useful operational tools for the materials efficiency. The

Table 1 List of regulation in the sector of waste management in the EU and in Italy

Year	Number	Title	Main targets
<i>European</i>			
1975	75/442/EEC	Council directive on waste	Definition of waste and of disposal Promotion of recycling, reuse and energy recovery
1991	91/153/EEC	Council Directive 18 March 1991 amending Directive 75/442/EEC on waste	Introduction of the waste hierarchy
1994	94/62/EC	European Parliament and Council Directive of 20 December 1994 on packaging and packaging waste	Recycling target from 50–65%
2008	2008/98/EC	Directive of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives	Recycling target 2020: 50% of waste and 70% of construction and demolition waste
2015	COM(2015) 614 final	Closing the loop—An EU action plan for the Circular Economy	Priority areas for CE implementation. Timetable of action to be taken
2015	COM(2015) 595 final	Proposal for a Directive of the European Parliament and of the Council amending Directive 2008/98/EC on waste	Waste recycling target 2030 65%
2015	COM(2015) 596 final	Proposal for a Directive of the European Parliament and of the Council amending Directive 94/62/EC on packaging and packaging waste	Specific waste materials recycling targets 2030: plastics 65%; metals 85%; wood 75%; glass, paper and cardboard 85%
2018	COM(2018) 28 final	Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Regions A European Strategy for Plastics in a Circular Economy	List of EU action for implementing the strategy

(continued)

Table 1 (continued)

Year	Number	Title	Main targets
<i>Italian</i>			
1982	DPR n.915	Implementation of EU directives 75/442/EEC, 76/403/EEC, 78/3149/EEC on different waste	Waste classification
1997	D.Lgs. n. 22	Implementation of EU directives 91/156/EEC, 91/689/EEC, 94/62/EC on different waste	Target on separated collection; 15% 1999; 25% 2001; 35% 2003
2004	L. n. 308/2004	Delega al Governo per il riordino, il coordinamento e l'integrazione della legislazione in materia ambientale e misure di diretta applicazione	Ferrous by-products from steel industry not a waste
2006	D.Lgs. n. 152/2006	Norme in materia ambientale	Target on separated collection: 35% 2006; 45% 2008; 65% 2012
2010	D.Lgs. n.205/2010	Disposizioni di attuazione della Direttiva 2008/98/CE del Parlamento europeo e del Consiglio del 19 novembre 2008 relativa ai rifiuti e che abroga alcune direttive—Implementation of Directive 2008/98/EC	Target on reuse and recycling: MSW and packaging 50% 2020; C&D 70% 2020
2015	L. n.221/2015	Disposizioni in materia ambientale per promuovere misure di green economy e per il contenimento dell'uso eccessivo di risorse naturali.—Green economy and prevention of natural resource depletion	Economic support for separated collection
2016	L. n.166/2016	Disposizioni concernenti la donazione e la distribuzione di prodotti alimentari e farmaceutici a fini di solidarietà sociale e per la limitazione degli sprechi.—Food waste prevention	Economic incentives for retailers; Social cooperation

Life M3P project will also allow to search for new applications of waste, based on creative features and useful to product managers, process engineers, designers, looking for innovative solutions or replacements for their products.

The expected result is twofold:

- Create awareness of locally available resources (waste or by-products), in order to reduce the need for handling, as well as the treatment and final disposal;
- Strengthen the synergies with the other European industrial areas in order to get a better overall waste recovery.

LIFE ECO-PULPLAST—Local circular ECOnomy by an innovative approach for recycling paper industry PULper waste into new PLASTic pallets

The overall objective of the LIFE ECO-PULPLAST project is to progressively reduce to zero the amount of paper mills' pulper waste sent to landfill and incinerators. In order to reach this goal, the technical and economic feasibility of an innovative technology to recycle pulper waste into new plastic compounds and products will be demonstrated during the project lifetime, with the realization and testing of a demonstration production line especially designed for the characteristics and peculiarities of pulper waste. The main idea behind this project is to realize plastic euro-pallets to be reused by the same paper district that generates the material waste in the first place and creating local circular economy, which is one main goals of the European environmental strategy for the next decades. Thanks to the local products manufacturing and reuse, the project also aims at reducing the environmental impact due to the current transportation of pulper waste to incinerators and landfills and the related disposal's impacts.

In addition, by replacing common wooden euro-pallets, that require a high consumption of raw natural materials, with reusable plastic pallets from recovered waste materials, the project addresses the European strategy towards an efficient use of resources. More specifically, the project aims at demonstrating that pulper waste can be used as main input material in the new compounds, by using a simple and low energy consuming mechanical process that does not require a washing phase or the removal of the residual fibres from the plastic materials and not even a selection phase of the different polymers composing the pulper waste-mixed plastics. A further objective of the LIFE ECO-PULPLAST project concerns the working method. The project, in fact, is promoted in synergy by different entities: industrial and technological partners working side by side with environmental organizations, all aiming at a common goal (Fig. 5).

For the consumption aspects:

LIFE PROMISE Product Main Impacts Sustainability through Eco-communication

The main objective of the PROMISE project was to reduce the negative environmental impact of products in Italy, particularly household products and agri-food products. A communication strategy would be designed and implemented covering information campaigns that target producers, retailers, consumers and public authorities. Communication actions would be tested to assess their effectiveness in achieving lifestyle or behaviour changes that help create environmental benefits. Different

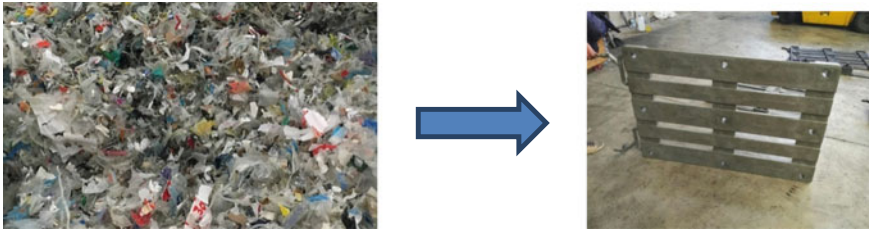


Fig. 5 Pallet produced from pulp waste plastic by the LIFE ECO-PULPLAST project

approaches to disseminating information would be piloted and evaluated in terms of the reduction of environmental impact throughout product lifecycles. Results from local level actions would help develop a communication model at national level that supports the EU's SCP/SIP Action Plan. The communication strategy represents a 'means' to achieve a variety of tangible results, including green public procurement in public authorities and wider uptake of initiatives such as eco-branding and EMAS.

The PROMISE project targeted the environmental impacts of products (EIPRO) that represent a problem across all EU member states and are strictly related to the lifestyles of EU citizens. The project implemented four communication campaigns to increase the awareness of the different actors that can reduce the environmental impacts associated with the products, their production, distribution, use and end of life.

The objective of increasing awareness on sustainability was met by disseminating good practice in sustainable production and consumption. The project involved all those who have a strategic role to play in this process: consumers, retailers, companies and public sector.

In line with the European and national policies, PROMISE carried out a measure to improve the understanding of all policy-makers on consumer choices and sustainability.

Specifically, it increased awareness of green choices among:

- Producers that can use clean technologies and introduce certification of process and products;
- Local authorities, which have a didactic role to play, and are themselves final consumers;
- Citizens, particularly those multipliers of information and knowledge, such as young people, educators and representatives' cultural and environmental associations;
- Retailers, who are able to influence consumers' choices through the provision of products and the distribution of information.

The project also helped locate information gaps on green products by producers, distributors, consumers and local authorities, as well as identify and recognize a 'green product' without ambiguity, through the dissemination of knowledge of the EU labels. Through the use of different media, it promoted the professional growth

of manufacturers, retailers and local authorities. Moreover, it applied plans of communication aimed at promoting changes of behaviours of all actors of the lifecycle of the product manufacturers, distributors, consumers and local authorities. This foresaw the overcoming of information barriers, the need to incentivize dialogue and understanding among the various actors in the market and the promotion of clear and easy to understand information for all the subjects involved.

At a low estimate, the project involved:

- 600,000 consumers through the dedicate awareness campaign (conferences, forum, web site, brochures, boards, media news/reportage, video). The beneficiary estimates that some 2,500,000 of consumers have been reached;
- 300 local bodies through the awareness campaign (seminars, brochures, conferences and web site). At the end of the project, all the local bodies (provinces, municipalities, national and regional parks) of the three regions had been involved;
- 200 companies through the awareness campaign; and
- 300 dealers through the awareness campaign. Some 8,000 Coop retailers nationwide have been reached by the campaign.

A report on the efficiency of the communication showed that:

- GPP increased by 15.8% in those public authorities involved in the awareness campaign;
- Green products increased by 19.5% in Coop stores;
- Sales figures of green products increased by 21.1% in the Coop stores;
- Four eco-design initiatives were adopted by producers; and
- Three companies adopted cleaner techniques, including the installation of photovoltaic panels in their production sites.

Finally, the project provided the Commission's consultation 'Stakeholders Consultation on Delivering more Sustainable Consumption and Production' of March 2012 with a position paper. It was presented by the Liguria region and included the guiding principles on how communication on SCP should be implemented in an effective way. It featured the requisites and rules based on ISO 14020 standards, to be provided to the national authority for the drawing up of the Italian National Communication Plan on SCP.

LIFE12 ENV/IT/000393 PREFER PProduct Environmental Footprint Enhanced by Regions

The LIFE PREFER project aims to demonstrate the effectiveness of the European methodology for environmental footprint in different sectors using the cluster approach, in order to overcome the typical drawbacks affecting SMEs (lack of human and financial resources). It will develop and strengthen this approach based on shared resources. The project will provide an opportunity for innovative environmental governance on the possibility to facilitate knowledge-sharing and experience exchange among participants and encourage the application of the PEF methodology. At the cluster level, a set of instruments, tools and resources will be shared with local SMEs in order to support them in the application of the PEF methodology and to achieve

improvements in environmental performance. The effectiveness and uniqueness of the project lie in using the clustering methodology in an innovative way—i.e. to define and implement a policy and governance approach aimed at increasing the uptake PEF among SMEs.

PRoduct Environmental Footprint Enhanced by Regions is a project co-financed by the European Commission's LIFE Plus Programme. PREFER (LIFE12 ENV/IT/000393) started in October 2013 and finished in December 2016. The project coordinator was the Institute of Management of Sant'Anna School cooperating with five partners: CENTROCOT, Consorzio dell'Asti, ERVET, Patto dell'Agro and Lombardy Region. PREFER project aimed at fully implementing the European Product Environmental Footprint (PEF) methodology on eight different products. The European Commission adopted the PEF by the Recommendations 2013/179/EU. The project involved eight Italian clusters placed in Campania, Emilia Romagna, Lombardy, Piedmont and Tuscany. The project budget is 1.541.845 € with a Life Plus contribution of 50%. The project results concern the PEF implementation. The partners tested the methodology on 13 products representing 8 Italian clusters (Paper district of Lucca, Tuscany fashion district, Lombardy textile district, Wine district of Asti, Agricultural and Food District of Nocera Gragnano, Northern Italy industrial tomato cluster, Shoes district of San Mauro Pascoli, Lombardy wood district). The pilot companies attending the project were 38, 32 SMEs and 6 large enterprises. Eight PEFCRs were developed and shared with three European cluster organizations in Spain and Romania. A project survey (94 respondents) identified the main needs and barriers to PEF adoption. Based on survey results, partners designed five technical tools to support SMEs in the PEF implementation. The PREFER training initiatives involved 350 organizations.

LIFE PRISCA Pilot project for scale reuse starting from bulky waste stream

The main objective of the PRISCA project was to reduce the flow of bulky waste sent to landfill. The project also aimed to increase the recovery and reuse of bulky waste. Its specific aims were to contribute to the effective implementation of the EU Thematic Strategy on waste and natural resources, focusing its efforts on the national priorities; to set up two demonstration reuse centres, in Vicenza (northern Italy) and San Benedetto del Tronto (central Italy); and to reduce the flow of bulky waste going to landfill, with a target of reusing 60% of that waste.

PRISCA—Pilot project for scale reuse starting from bulky waste stream—is a project financed by the European Commission through the Life Plus Environment 2011 programme, that aims to demonstrate the feasibility of two reuse centres, one in Vicenza and one in San Benedetto del Tronto, where reusable goods from solid urban waste flows are sent for preparation for reuse operations to enter a second life, instead of being disposed to landfill.

The PRISCA project contributed to improvements in waste management generally and, in particular, to the implementation of the waste prevention objectives of the EU Waste Framework Directive (2008/98/EC). The project established two waste reuse centres, in Vicenza and San Benedetto del Tronto, which reduced the flow of waste

and goods going to landfill by reusing more than 60% of the incoming material at both sites.

In both the demonstration sites, performance monitoring systems were implemented. These consisted of traceability tools that provide useful information and verified the project's target in terms of intercepted waste flows and management efficiency of the overall process from interception to marketing. Dedicated software was used for the optical reading of characters on labels, to replace the manual input of codes, which made the process of traceability for intercepted goods both easier and faster. The project team created a testing and repair laboratory and published a technical manual.

The project's dissemination activities, aiming to replicate the model in other areas, included 20 regional seminars, targeted at local operators and public administrations, 2 national workshops, 3 national conferences and a final International event. Intensive networking activities were also organized with other LIFE projects. Awareness-raising activities were aimed at citizens living near the two waste reuse sites, focusing on citizen involvement in waste management and sustainable consumption behaviour.

The environmental impacts of the PRISCA model were evaluated with Life Cycle Assessment (LCA) tools. Environmental benefits were generated by the reduction of quantities of waste and goods destined for disposal by landfill or incineration, through their diversion into reuse activities that extended their life cycle as second-hand goods. This life cycle extension brings relative saving in resources, and subsequent savings in greenhouse gas (GHG) emissions. During the start-up phase in Vicenza, a total of 244 tonnes (2014), and in San Benedetto del Tronto a total of 5 tonnes (during 5 months in 2015), were diverted from the waste flows. LCA evaluations of the global GHG savings connected to the activity of the reuse centres during this start-up phase were for 236 tonnes CO₂ eq. in Vicenza and 36 tonnes CO₂ eq. in San Benedetto del Tronto.

In addition to helping implement the Waste Framework Directive, the PRISCA project also contributes to the implementation of the Thematic Strategy on the sustainable use of natural resources COM (2005) 670 final (EC 2005a); COM(2003) 302 (EC 2003) on Integrated Product Policy; the Sustainable Consumption and Production (SCP) and Sustainable Industrial Policy (SIP) Action Plan COM(2008) 397 final (EC 2008); and the Thematic Strategy on the Prevention and Recycling of Waste COM(2005) 666 final (EC 2005b) and its follow-up Report on the Strategy COM(2011) 13 final (EC 2011), which stressed that waste prevention was a priority to be urgently implemented. Waste production prevention is also an important objective in the Communication Towards a circular economy: a zero waste programme for Europe COM (2014) 398 final (EC 2014).

The PRISCA model developed an economically sustainable supply chain that supports waste prevention activities in the long term. The project integrated the second-hand product sector and the reuse supply chain through its solid urban waste management system, to increase the interception of reusable items. PRISCA introduced an 'industrial approach', to promote standardization of manufacturing processes, in a field not always well-organized as far as supply, workflow management and final retail are concerned.

Management tools that enable optimal traceability and the logistic organization of the reuse centres allow reuse operators to increase and widen their market and to better cope with market demand. The demonstration activities in the two project areas, involving a multi-disciplinary team of coordinating and five associate beneficiaries, showed the importance of cooperation among stakeholders at waste reuse centres.

In terms of social benefits, the PRISCA model helped create new jobs at the two reuse centres and, as the activity is likely to become a structural support to local waste management systems, this result can be acknowledged as a long-term benefit. During the project, all the job positions created in Vicenza for implementing the Prisca model were made permanent, increasing the staff of Cooperativa Insieme. Furthermore, in San Benedetto del Tronto, which was a greenfield, implementation generated four permanent part-time positions and the opportunity to hire four disadvantaged people via the municipal administration. In addition, the introduction of standardized procedures and equipment, along with workers' training activities, enabled improvements to be noted in conditions, as well as in health and safety, in the workplace.

4 Case Studies

In Italy, the implementation of circular use of resource is monitored also by a public web site www.economicircolare.com CDCA, ECODOM (2018). In this web site, there is reported an atlas (Fig. 6) indicating the geographical position of the companies and the short description of the circular use of resources implemented in their production cycle. The industrial sectors involved are very broad ranging from the

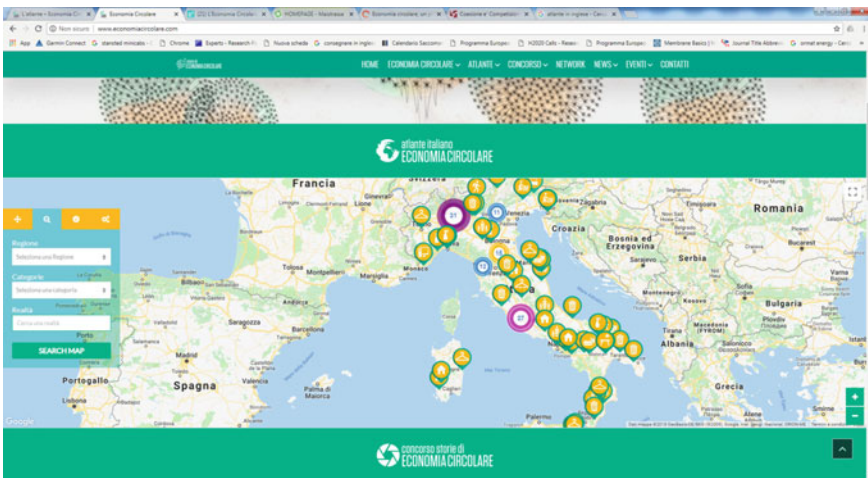


Fig. 6 Atlas of circular economy implementation

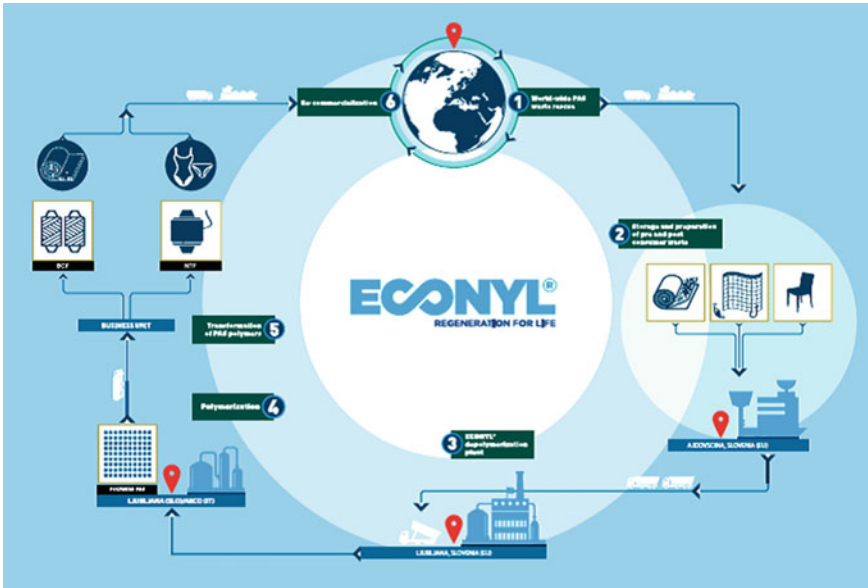


Fig. 7 Econyl project scheme

agriculture, the textile, the building, the ICT, the waste management, furniture and others.

Among these of interest are the best practices introduced by the following two companies.

Acquafil

Acquafil is a company operating in the textile sector producing a wire for carpet and for dresses. Starting from this business, they implemented the Econyl project (Fig. 7) aimed to generate an high-quality nylon wire from waste containing nylon.

This activity consists of three main steps:

- (1) Nylon waste collection including residues from production, industrial plastics components, moquette, carpet and fish nets;
- (2) Waste pre-treatment for removing impurities;
- (3) Waste depolymerization for producing high-quality nylon;
- (4) Polymerization;
- (5) Transformation in new nylon wire;
- (6) Back to market.

Lucart

Lucart is a company producing hygienic paper that in 2013 started the natural project for a total recycling of the multilayer beverage packaging. This project was implemented in collaboration with Tetra Pak and recovery all the component of these kinds

of packaging. From the paper of the external part of the multilayer container, Lucart produces the Fiberpack tissue. From the polyethylene and aluminium components produce AL. Pe is a homogeneous material used for producing different components as pallet, urban furniture and other products completely recyclable.

5 Discussion and Analysis

In a successful implementation of circular use of the resource, the generation of waste will be significantly decreased and at least eliminated. This requires a complex action involving economic systems, technologies, product design, consumers’ attitude and also legal and economic supports. One of the main drivers for waste generation is represented by the increase in GDP and families’ expenditure. In general, the higher is the GDP, the higher is the amount of product and services delivered by a given economy; higher is the families’ expenditures, higher is the amount of product purchased. This, in a traditional approach led to a direct proportionality between these two socio-economic indicators and the waste generation (Fig. 8). For Italy, starting from the year 2015, macro-data concerning socio-economic and waste generation indicators showed that this paradigm is starting to be capsized. It is hence possible to have an economic grow at which do not correspond a directly proportional increase of the MSW generated (Figs. 8 and 9).

This is an important result concerning the pursuing of waste prevention according to the implementation of the hierarchy (Fig. 1).

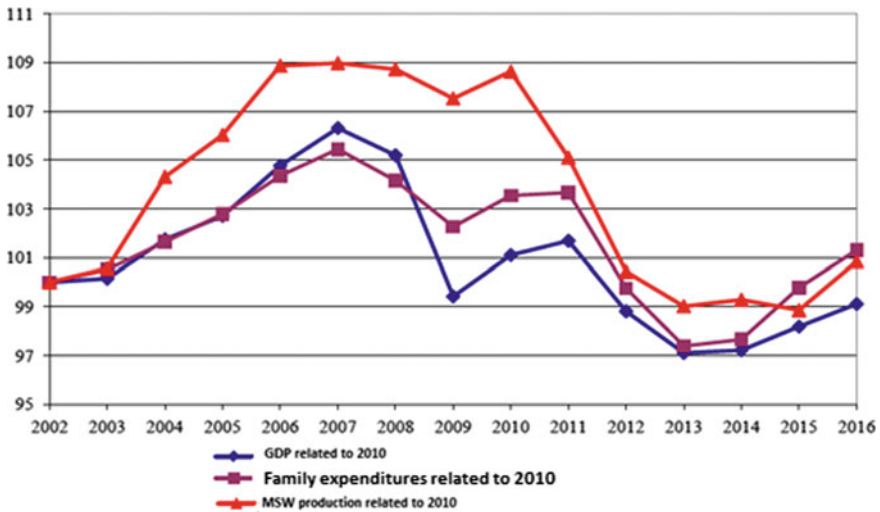


Fig. 8 GDP, families’ expenditures and MSW generation normalized to the levels of 2010

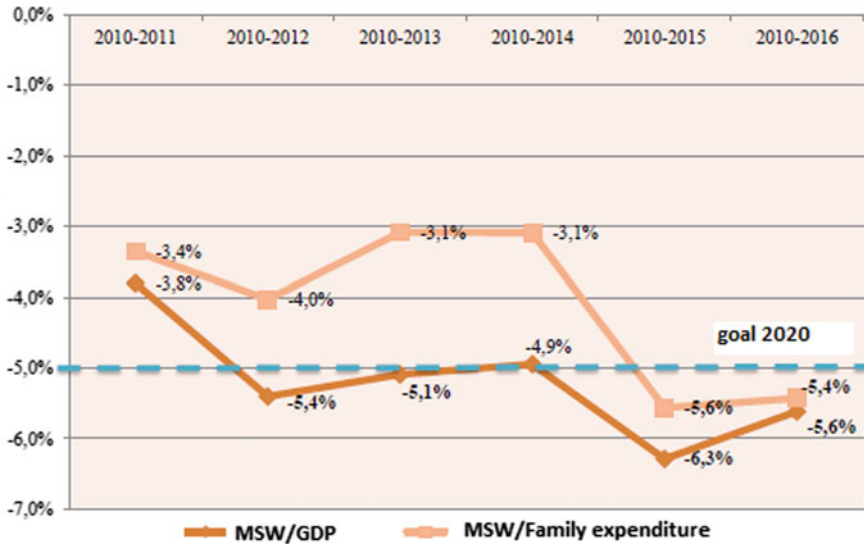


Fig. 9 MSW/GDP and MSW/families' expenditure ratios with respect to 2010 from 2011 to 2016

Concerning the implementation of the other levels of the hierarchy, preparation for reuse and recycling, a fundamental instrument for its increase was represented by the separated collection. Based on the results reported in Fig. 10, it is possible to detect a quite parallel increase of the amount of waste collected separately and



Fig. 10 Percentages of separated collection and recycling for the period 2010–2016

the amount of waste recycled, indicating the relevance of the collection phase. But starting from the 2015, it was observed that for continuing to pursue the same trend in the increase of previous periods for the waste recycling rates, the efforts in the separated collection of waste have to increase to a higher extent compared to the previous years. In fact, the two curves that were practically parallel since the 2010 from the 2015 started to be divergent with the one indicating the waste separation percentage increasing more than the one of the recycling.

This fact opens the floor to a critical discussion about the causes of this trend and on the convenience of pursuing to higher values the separated collection based on the current status of the art (e.g. waste quality, collection systems, recycling markets, legal support). In fact, there are two main opposite effects concerning the separated collection and the recycling. On the one hand, the extended producer responsibility imposes to the producers of packaging to provide their collection. But on the other hand, not all the materials collected separately have an effective recycling pathway. This last aspect is a consequence of different causes among which the absence of adequate recycling markets for such materials; the absence of specific regulation able to provide the necessary support for the recycling; the absence of adequate economic support for promoting specific recycling pathways; the decreased quality of materials collected separately. All this indicates the complexity of the action to be pursued for a successful implementation of the circular use of resources.

Meanwhile for the MSW, there are a lot of signals indicating that the efforts concerning the implementation of the hierarchy (Fig. 1) and consequently of the circular use of resources are starting to give positive results, the signals arising from the management of special waste indicate that there is no evidence of similar trend (Fig. 11). The linkage between GDP and special waste production still remain characterized by a direct proportionality. This is of course partially due to the quality of these wastes but also to the difficulty in the implementation of efficient approaches in specific sectors as the one of construction and demolition waste representing more than 41% of the whole special waste produced. Another 27% of these wastes are represented by those arising from remediation and reclamation of contaminated soils, and finally, about 20% are those generated by the manufacture sector. All this indicates that further efforts have to be pursued in this sector for an effective implementation of CE.

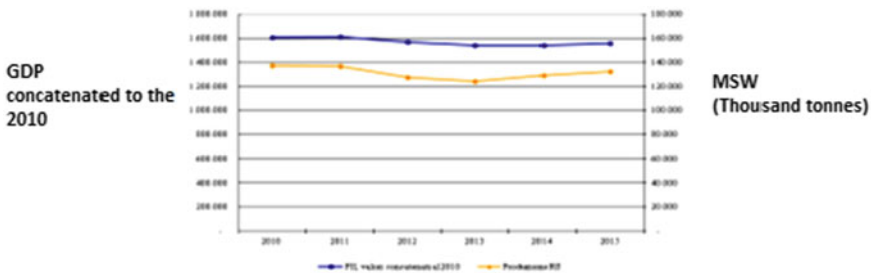


Fig. 11 Percentages of separated collection and recycling for the period 2010–2016

6 Conclusion

Implementation of circular use of resources is a complex activity involving different aspects among which the most relevant are represented by adequate legislation and economic support for promoting specific activities in each specific market.

Industrial sectors as the plastic, the paper, the metals and the glass have, nowadays, achieved high levels of recycling of waste materials even if more ambitious target are going to be implemented. But the final goal of a circular use of resources is related to avoid the production of waste. Waste represents a symptom of a ‘hilliness’ that is located somewhere else in the economic systems and along the values chain of products.

It is important to identify and remove these obstacles hampering the avoidance of the waste generation phase and implement an effective circular use of resources. By the current state of the art, represented by the quality of the products generated, the materials used for their production, the industrial processes, the economic convenience and the legal support some positive signals concerning waste prevention have been detected for the household wastes. For those generated by the industrial and commercial sectors, there is no evidence of the avoidance of waste generation, indicating that more efforts resulted necessary.

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