

# **Polyethylene recycling: waste policy scenario analysis for the EU-27**

## **Abstract**

This paper quantifies the main impacts that the adoption of the best recycling practices together with the implementation of the amended Packaging and Packaging Waste Directive could have on the 27 Member States of the EU. The main consequences in terms of employment, waste management costs, emissions and energy use have been quantified for two scenarios of polyethylene (PE) waste production and recycling. The main results show that socio-economic and environmental benefits can be generated across the EU by the implementation of the best practice scenario. However, the net energy requirements are expected to increase as a consequence of the reduction in the energy produced from waste. The main analysis provided in this paper, together with the data and the model presented, can be useful to identify the possible costs and benefits that the implementation of PE waste policies and Directives could generate for the EU.

## **Long abstract**

Waste management and its impacts on the economy and the environment are some of the most important challenges for countries experiencing increasing consumption rates (Laurent et al., 2014). Within the European Union, large attention has always been paid to waste reduction and recycling and a large number of policies have been drawn up with that aim. The Packaging and Packaging Waste Directive (94/62/EC), the Waste Framework Directive (2008/98/EC) and the recent proposal for an amended Packaging and Packaging Waste Directive<sup>1</sup> are examples of some of the most important actions taken to deal with waste management and recycling. According to data publicly available from Eurostat, the quantity of waste generated in the EU-27 decreased by around 115 million tonnes between 2004 and 2010. However, further improvements are expected to take place and particular attention needs to be paid to identify the possible socio-economic and environmental impacts

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<sup>1</sup> Proposal for a Directive of the European Parliament and of the Council amending Directive 94/62/EC, COM(2013) 761 final

generated by waste (Cucchiella, 2014). If from one side waste generation can potentially represent enormous costs in terms of pollution and resources depletion, on the other side an efficient management of waste can reduce the demand for primary materials and contribute to the energy supply (Menikpura, 2013). With this in mind, a large number of models and studies have recently been put forward to support decision-makers in the design of efficient waste management strategies (Tan et al., 2014). Great attention has also been paid to investigate technological innovations, cost-efficient solutions and indirect effects on socio-economic and environmental variables (Al-Salem et al., 2014, Milutinovic, 2014). Until now, however, only a limited number of studies have been specifically oriented to consider, at the same time, the three impact categories reported above, or to investigate the socio-economic and environmental impacts generated by the management of a specific waste category (Ferrao et al., 2014 and Antonopoulos et al., 2014). In particular, to our knowledge, no previous studies quantify the socio-economic and environmental impacts generated by different scenarios of polyethylene (PE) waste management strategies in the EU as a whole and in individual Member States. For this reason, the main objective of this paper is to investigate the impacts generated by an improvement in the PE recycling rate and by the reduction in PE production linked to the implementation of the amended Packaging and Packaging Waste Directive. Two scenarios have been considered in this paper:

**Scenario A:** This scenario represents the baseline, reflecting the 2012 situation of PE consumption, waste management and recycling. It is a “business as usual scenario” where the 2012 performances of the different EU Member States are extrapolated to 2020, while taking into account an increase in polyethylene consumption linked to economic growth.

**Scenario B:** This scenario reflects full implementation of the best available recycling practices, plus full implementation of Option 3 defined in the Impact Assessment document prepared by the European Commission<sup>2</sup> for the amended Packaging and Packaging Waste Directive. In particular, this scenario assumes:

- Full implementation of the best available recycling practice. It starts from the hypothesis that by 2020 all Member States will have a PE recycling rate of 56%, which corresponds to the recycling performance of Germany in 2010. The recycling

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<sup>2</sup> Impact Assessment for a Proposal for a Directive of the European Parliament and of the Council amending Directive 94/62/EC on packaging and packaging waste to reduce the consumption of lightweight plastic carrier bags.

rate for every country is assumed to increase with a constant trend between 2013 and 2020. The non-recycled waste will be allocated to landfill, incineration and mechanical biological treatment based on the same 2012 allocation.

- Adoption of the amended Packaging and Packaging Waste Directive. The Packaging and Packaging Waste Directive will be implemented following the conditions established in the Option 3 of the Impact Assessment document prepared by the European Commission. A steady decrease in single-use carrier bags is assumed to take place in all Member States until an 80% reduction is reached in 2020.

Since Member States will be free to determine the instruments used to meet this target, such as pricing measures or market restrictions, the economic impacts generated by Option 3 have not been included in the Impact Assessment prepared by the European Commission and will not be considered in this study.

- A kerbside system for collecting PE waste from households and businesses will be gradually introduced, such that by 2020 all EU-27 countries will operate a 90% kerbside collection system. Specialist items, such as agricultural plastic, are assumed to be collected via a bring-based system.

To estimate the socio-economic and environmental impacts generated by different scenarios of waste production, disposal and recycling, a Polyethylene accounting model has been proposed in this paper based on the links between an EU-27 material flow model and an EU country-specific waste flow model. In particular, the quantity of PE waste generated by the different EU countries are disaggregated according to different the PE product and are linked to polyethylene production in the EU-27. The EU country-specific waste flow model includes one worksheet for each country and accounts for the PE product type waste production together with the different disposal options. On this basis, the quantity of recycled materials, the waste management costs and the associated environmental impacts can be calculated for the EU as a whole and the 27 Member States individually. The data used to estimate the costs and the impacts have been mainly collected from Eurostat, European Environmental agency, Plastic Europe, Europe's Energy website, Eurostat Energy Statistics.

The main results show that socio-economic and environmental benefits can be generated across the EU by the implementation of the best practice scenario. In particular:

- A reduction of 4.4 million tonnes of non-recycled PE waste, together with a reduction of €90 million in waste management costs, is expected to take place in 2020.

- As a consequence, the quantity of CO<sub>2</sub> equivalent emissions should reduce by around 1.46 million tonnes. However, the total energy requirement should increase by 17 million GJ, calculated as the difference between the reduction of the energy produced from waste and the energy required for PE production and for PE waste management.
- The number of waste management-associated jobs is expected to increase in both scenarios. However, in the best practice scenario the number of jobs created has been estimated to be 35,600 higher than in the business as usual scenario.

According to the results provided in this paper, the adoption of the best available recycling practices, together with the implementation of the amended Packaging and Packaging Waste Directive would be able to generate socio-economic and environmental benefits across the EU, with some differences between Member States.

The main analysis provided in this paper, together with the data and the model presented, can be useful to identify the possible costs and benefits that the implementation of PE waste policies and Directives could generate for the EU.

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