

Status and prospects of co-processing of waste in EU cement plants

EXECUTIVE SUMMARY

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1 Introduction

The EU cement industry already uses more than 40% fuels derived from waste and biomass in supplying the thermal energy to the grey clinker making process. Although the choice for this so-called alternative fuels (AF) is typically cost driven, other factors are becoming more important. Use of AF provides benefits for both society and the company: CO₂-emissions are lower than with fossil fuels, waste can be co-processed in an efficient and sustainable manner and the demand for certain virgin materials can be reduced.

Yet there are large differences in the share of AF used between the European Union (EU) member states. Clearly, the societal benefits can be enlarged if more member states increase their AF share. In this study we assessed barriers and opportunities for further uptake of AF in 14 EU member states.¹ We found that **local factors constrain the market potential to a much larger extent than the technical and economic feasibility of the cement industry itself**. In this summary we present the overall findings. The detailed assessments are available in separate cases studies.

Co-processing of waste in cement kilns contributes to the solution of three major issues the EU is currently facing:

(a) Abatement of climate change

AF form one of the main levers for reduction of CO₂ intensity in cement manufacturing. According to the International Energy Agency (IEA), AF can contribute 0.75 Gt of CO₂ reductions worldwide up to 2050.

(b) Improved waste management

Co-processing can reduce the volume of waste that is being landfilled and use its energy content in a very efficient manner. In that sense, it fits directly into the EU waste management hierarchy under the EU Waste Framework Directive.

(c) Progress towards a circular economy

In co-processing, waste streams from other parts of the economy are valorised in the cement industry – thus contributing towards the circular economy. Furthermore, co-processing allows for partial material substitution replacing certain virgin materials used in cement making.

An [earlier Ecofys analysis](#) based on three case studies, helped to support this message. The European Commission included co-processing of waste in cement kilns in their recent [Communication on Waste-to-Energy](#) as one of the main waste-to-energy processes to consider for treating residual waste.

¹ The 14 members states that were analysed in the case studies included: Belgium, Bulgaria, Czech Republic, France, Germany,

Greece, Hungary, Ireland, Italy, Poland, Portugal, Spain, Sweden and United Kingdom.

The main conclusions of the European Commission Communication on Waste-to-Energy (WtE) are:

- WtE processes can play a role in the transition to a circular economy, provided that the EU waste hierarchy is used as a guiding principle.
- Following the waste hierarchy more strictly is expected to reduce the amount of waste available for WtE processes.
- It calls on member states to use the guidance to revise their waste management plans with a view to avoiding potential overcapacity in waste incineration due to the possibility of asset stranding.
- Co-processing of waste in cement plants is identified as one of the best proven techniques to improve energy efficiency of WtE conversion.

The 14 case studies have been carried out to:

- Provide more factual evidence on the opportunities of co-processing to support even better policy decisions.
- Create a deeper understanding of what is needed to accelerate the AF uptake of cement industry.
- Give member states and national cement associations input to improve the rate at which AF are applied in the cement industry.

2 Approach

The potential for increasing AF in 14 CEMBUREAU member countries, which collectively cover all geographical regions of

the EU, was assessed. Figure 1-1 displays the geographical spread of the case studies.



Figure 1-1: Map of countries analysed in case studies

The focus was on understanding the drivers and barriers to further fuel substitution in the cement industry. For each country a case study was made. We interviewed a local expert, analysed statistical data sources on waste and cement, and reviewed relevant literature.

Firstly, our focus was on deriving the experts perception on the local cement industry, waste management structure and associated policies. Secondly, we performed analysis of available data sources to complement these insights. Our specific aim has been to identify the key barriers to further waste utilization in the cement industry and to provide recommendations for improvement of the current situation for all relevant stakeholders. For all of the underlying calculations, 2014 (for some countries 2013) was selected as the baseline year.

The dataset was built primarily on data available in the *Getting the Numbers Right (GNR) database* and *Eurostat* to ensure maximum consistency between individual case studies.

For each of the case studies, potential benefits of increased co-processing rates (as compared to the baseline) are presented on four key performance indicators:

- (a) Avoided CO₂ emissions**
- (b) Volume of waste treated**
- (c) Energy saved in the form of tonnes coal equivalent**
- (d) Avoided investment in treating the waste in dedicated WtE plants**

3 Current status of co-processing and key findings of this study

The average co-processing rate in the EU was 41% in 2014.² The co-processing rates however vary quite distinctively between individual countries, depending on a multitude of factors which are further discussed in this report. Figure 3-1 shows the current co-processing rates in all of the analysed countries, along with the expected medium-term and long-term outlook, based on expert opinion of the local representatives.

Less than half of the assessed countries (Germany, Czech Republic, Poland, Sweden, Belgium and the UK) have achieved co-processing rates well above the EU average. Hungary and France operate near the EU average. Six countries (Ireland, Portugal, Spain, Bulgaria, Italy and Greece) performed more than 10 percent point below the EU average.

The perceived potential for further increase in fuel substitution varies significantly between all of the analysed states. When asked, the experts of the six best performing envisioned that the co-processing rate in their country can reach 65% or higher in the medium-term outlook (5 – 10 years), while five more country experts expected their fuel substitution to reach 40% in that period.

² Share of specific thermal energy consumption coming from alternative fuels in grey clinker making.

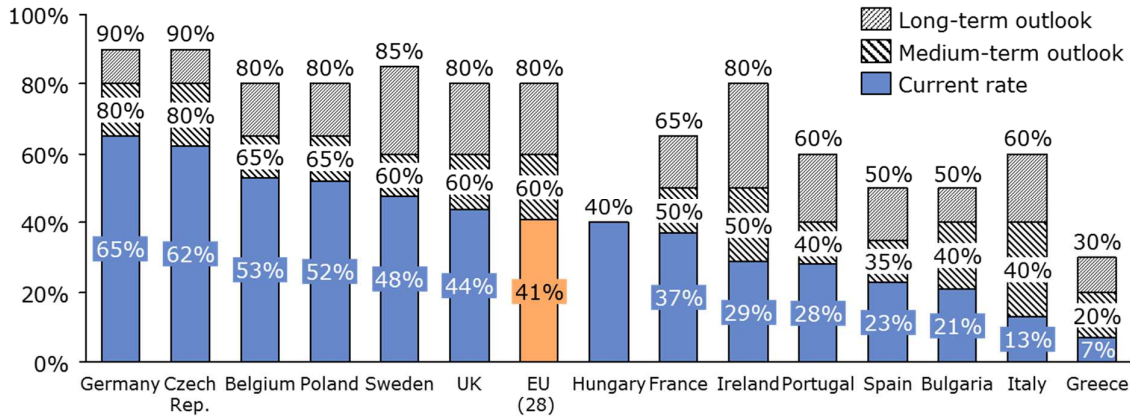


Figure 3-1: Current and expected co-processing rates in analysed countries

Since the co-processing rate depends on the availability of waste for fuel, it was expected that a relation exists between the maturity of the waste management system and co-processing rates. As Figure 3-2 shows, certain connection between the share of waste being landfilled and fuel substitution in cement kilns is noticeable, however the link is not conclusive.

Clearly, other factors that impact the relative co-processing rates play a role. We also analysed whether a relative large cement sector, compared to the inhabitants of a country, could explain a low co-processing rate. These countries would have to import waste, assuming that the amount of waste per capita is stable. This correlation could not be found.

% of waste being landfilled
(excl. major mineral wastes)

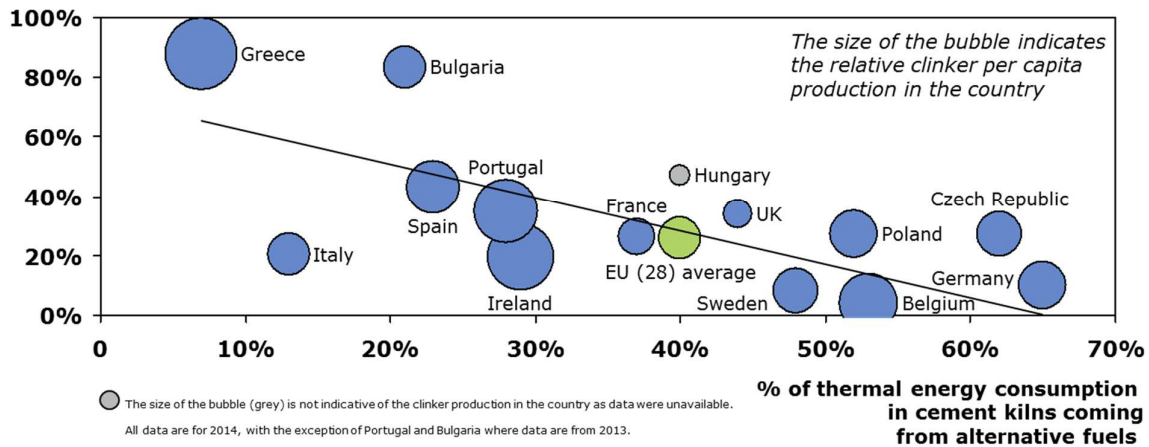


Figure 3-2: Relation between waste landfilling and co-processing rates

The potential benefits to further increase co-processing in both the EU and individual analysed countries have been expressed in four key performance indicators. Figure 3-3 illustrates these results under a scenario with 60% co-processing rate in all EU28 member states. At 60% average rate the member states would cumulatively:³

- 1) **Avoid 26.0 Mtonnes of CO₂ emissions**
- 2) **Process 15.7 Mtonnes of waste**
- 3) **Save 11.1 Mtonnes of coal equivalent**
- 4) **Avoid 12.2 EUR billion investment in dedicated WtE plants**

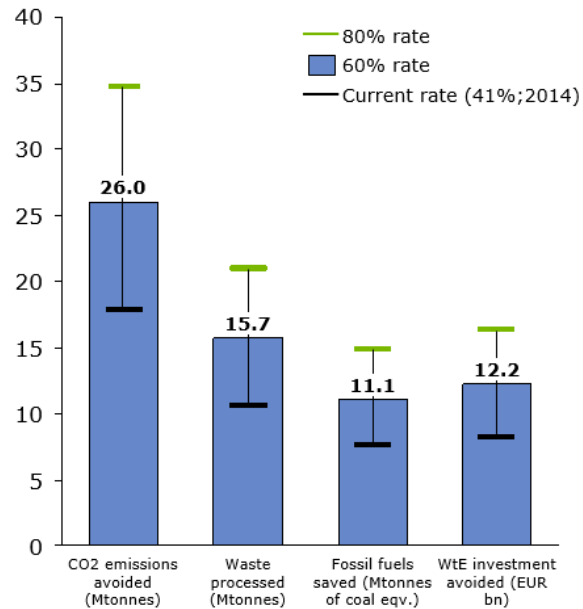


Figure 3-3: Estimated benefits at 60% average co-processing rate across EU 28

³ **The current rate shows the estimated impact in the four categories in the baseline year (2014).**

The bars in the chart display expected mid-term outlook in terms of co-processing rates in the country. The impact in the four categories is calculated by extrapolation of the baseline data to a higher co-processing rate. The long-term outlook (higher end – green dash) is calculated in the same way.

CO₂ emissions avoided are calculated as a sum of thermal energy consumption (excluding drying of fuels) coming from Alternative Fossil Fuels and Biomass, using the average calorific value for fossil-based fuels used in cement kilns (emission factor 93.5 kg CO₂/GJ) from the Cement Sustainability Initiative Protocol. We are using the term “avoided emissions,” but please note that there is a difference from the term “emission reductions” used in the EU ETS.

Waste processed potential is calculated by extrapolation of current amount of waste processed by fixing both the average

calorific value of Alternative Fuels and production levels while increasing the share of Alternative Fuels on the total thermal energy consumption.

Fossil fuels savings are calculated as coal equivalent avoided due to use of Alternative Fuels using the average calorific value for coal as a primary fuel (25.1 MJ/kg) from IPCC. Potentials are based on extrapolation of the baseline data.

Investment in dedicated WtE avoided is calculated using the current volume of waste co-processed (in tonnes) as baseline, utilizing the average incineration investment cost (0.78 MEUR/ktonne of waste incineration capacity- figure based on consultants’ expertise). The potential is based on extrapolation of the baseline data. Please note we do not make a difference whether the WtE investment would come from public or private sources. The WtE investment avoided does not include the respective expenditures in cement kilns and pre-treatment facilities.

4 Main drivers for co-processing

The country experts mentioned several drivers that influence fossil fuel substitution in the cement industry. However, four main drives emerged from the interviews:

(a) Waste management policy

incentivising more advanced waste treatment methods than landfilling and production of high quality pre-treated waste. Examples might include good implementation of the EU Waste Framework Directive, coordination of waste management between various regions in the country or landfill bans, taxes and gate fees. Figure 4-1 displays the current (2015) status in regards to landfill bans and taxes in the analysed countries.

(b) Low levels of bureaucracy in regard to permitting for both waste utilization in cement kilns and imports of pre-processed waste.

(c) Modernized cement industry ready for further waste uptake and its experience with higher co-processing rates requiring substantial operational excellence.

(d) Price (total) and price volatility of conventional fossil fuels which can further strengthen the business case for the use of AF, in particular at times when the relative cost of EU emission allowances is low.

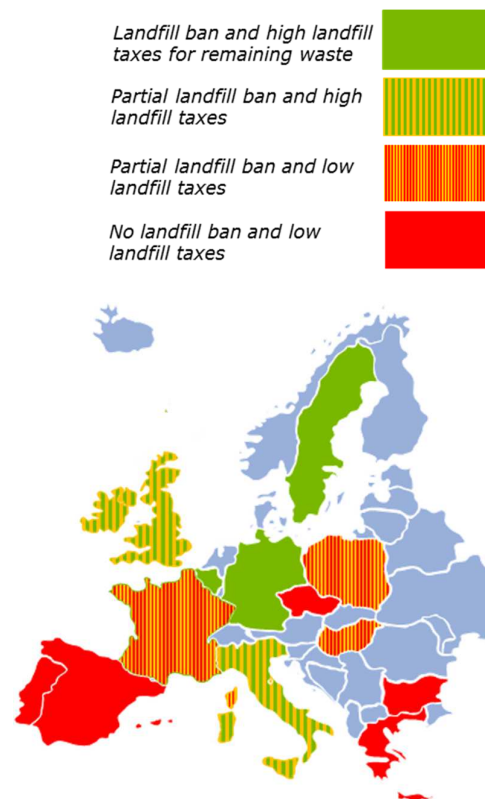


Figure 4-1: Landfill bans and taxes

5 Barriers to higher co-processing rates

In section 2 we showed that a correlation between the maturity of the waste management and co-processing rate exists, but is not conclusive. Other factors seem to play a role. We evaluated other barriers that hamper a higher co-processing rate. Three main barriers were identified as key by the experts, yet their occurrence does not always coincide with low co-processing rates:

- unavailability of high quality waste fuels
- excessive bureaucracy
- public unacceptance of waste combustion

Figure 5-1, Figure 5-2 and Figure 5-3 depict the presence of these barriers across Europe. In three of the case studies (Italy, Spain and Greece) low availability of high quality waste fuels, perceived bureaucratic obstacles in regards to permit issuance and negative public attitude towards waste combustion coincided with below average co-processing rates. However, in other cases, for instance in Czech Republic, Poland or Sweden, all with fuel substitution well above the current EU average, at least one of the key barriers has been identified. For certain countries, the explanation for relatively lower co-processing rates can also lie elsewhere – France has a problem with outdatedness of its cement plants, whereas in Portugal and Bulgaria, very low landfill taxes do not stimulate more advanced waste treatment methods.



Figure 5-1: Availability of high quality waste streams for the cement industry

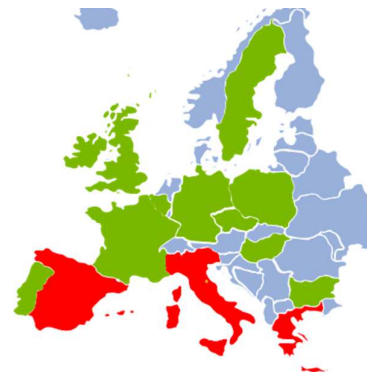


Figure 5-2: Perceived bureaucratic obstacles in regards to permit issuance



Figure 5-3: Public perspective towards waste combustion

The three barriers described above were perceived as key, however these were not necessarily the most common ones by occurrence. The section below depicts the occurrence of the barriers, outlines the associated issue and provides recommendations for key stakeholders in regards to each of the barriers.

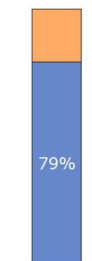
High quality waste not available to the cement sector in sufficient quantity

To make uptake of alternative fuels a viable business case, the cement industry needs stable streams of high quality (e.g. high calorific value, low chlorine content, etc.) wastes that can be processed into alternative fuels. Often, the local waste industry is not incentivized enough to process the waste to make alternative fuels, leaving the cement industry dependent on industrial wastes and imports only.

Relates to: Waste market organization

Number of countries that identified this barrier:

11/14 (79%)



Recommendations for the cement industry:

- Incentivize pre-processing facilities to upgrade the quality of produced wastes
- Provide a guaranteed uptake of high quality Refuse-Derived Fuels or Solid Recovered Fuels produced domestically, including premiums

Recommendations for the waste management industry:

- Improve the quality of domestically produced pre-processed wastes to suit the needs of the cement industry

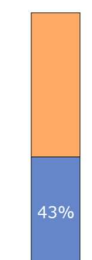
Waste processing industry is not well-developed

There is a gap in waste management capacities which may be related to infrastructural and logistical issues and / or to lack of organization in the market. Usually, this coincides with underdevelopment in pre-processing facilities resulting into higher share of waste being landfilled and lower share of waste being prepared for the cement industry.

Relates to: Waste market organization

Number of countries that identified this barrier:

6/14 (43%)



Recommendations for the policy makers:

- Invest into waste collection, source separation and waste processing
- Improve waste management law enforcement

Recommendations for the waste management industry:

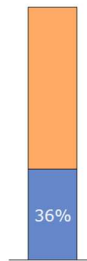
- Invest into waste collection and waste processing
- Ensure reliable waste collection and treatment system and ensure stable stream of pre-treated waste to the cement industry

Public acceptance of incineration in general is low

Public disagreement with R1 operations (or specifically co-processing) can play a major role in the political willingness to support / permit co-processing in a given country. Examples from Spain and Greece (but also in other countries to some extent) show that public pressure (with support from NGOs) can significantly limit the possibility of waste combustion.

Relates to: Societal perspective

Number of countries that identified this barrier:
5/14 (36%)



Recommendations for the cement industry:

- Continue the efforts to gain the public acceptance for use of waste co-processing
 - Stimulate an open debate and transparency between the opposition groups, public and the cement industry
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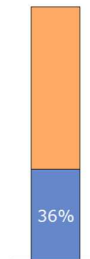
Competition for available waste

In particular in countries with highly developed waste management systems and in which incineration of waste plays a major role, waste which would otherwise be available to the cement industry gets diverted to other thermal treatment methods. This can be further emphasized by additional market distortions (e.g. subsidies and special energy tariffs for use of waste biomass to generate heat and power).

Relates to: Waste market situation

Number of countries that identified this barrier:

5/14 (36%)



Recommendations for the policy makers:

- Balance the development of WtE to prevent overcapacities and market distortions
- Investigate the best utilization of waste streams in line with relevant EU policies and optimize their flows

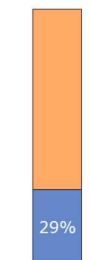
Landfill taxes too low

Low landfill taxes and gate fees, along with availability of large landfill capacities in general do not stimulate utilization of more advanced waste treatment methods, while in many cases the cement industry is not able to pay significant premiums for pre-processed waste. Where these two factors combine, waste which could have been potentially energetically valorised ends up being landfilled.

Relates to: Waste market situation

Number of countries that identified this barrier:

4/14 (29%)



Recommendations for the policy makers:

- Incentivize further development of production of high quality waste, for
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- example, by introducing a legislative framework and increasing the landfill taxes
- Increase landfill taxes closer to EU average level to incentivize advanced waste treatment

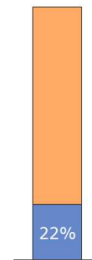
Excessive bureaucracy in regards to permitting for co-processing

The cement industry have to obtain co-processing permits if it plans to use waste streams as a source of energy. If the industry is not allowed to utilize alternative fuels or the permitting process is significantly delayed (thus distorting the business case), the potential to increase co-processing share is substantially limited. In all the three countries where observed, this barrier has been a major one.

Relates to: Waste market situation

Number of countries that identified this barrier:

3/14 (22%)



Recommendations for the policy makers:

- Decrease the wait-time for permit issuance
 - Alleviate the bureaucratic barriers for permit issuance
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6 Conclusions

Co-processing of waste in cement kilns provides benefits for both society and the cement industry. It is an effective and efficient way to process waste, it lowers the CO₂ emissions and reduces the demand for certain virgin materials.

There are considerable differences in co-processing rates across the studied EU member states, varying from 7% to 65%. The EU average lies at 41%. These differences cannot be explained by only looking at the waste management strategy of these member states.

In the medium-term outlook (5 – 10 years), **6 country experts anticipate that a co-processing rate of 60% or more is technically achievable, with 2 country experts anticipating to achieve rates over 80%.**

The **key drivers** for accelerating the uptake of co-processing are a **mature waste management system, smooth permitting procedures, a modern cement industry and high prices of fossil fuels** (including a price on carbon).

Generally speaking, countries with **lower share of landfilling** have a **higher co-**

processing rate. Waste not being landfilled finds its way to different and new applications.

The amount of waste available is not the issue, but rather the availability of **waste of sufficiency quality** for the cement industry is perceived as one of the main barriers. In many countries, a substantial business incentive for the waste processing industry produce high quality waste is lacking.

In most countries, there are **no perceived permitting issues.** However, in countries with this barrier (Spain, Italy and Greece) the development of co-processing is severely slowed down.

The low public acceptance of waste combustion is seen as a barrier in five countries. This attitude does not seem to relate to the waste management strategy of these countries.

There are **differences across member states in terms of political treatment of co-processing.** Although sitting in the R1 category under the EU Waste Framework Directive, different countries treat co-processing as a preferred or ill-favoured option to incineration with energy recovery.

In all of the analysed countries but two (France and to some extent Greece), the main barriers for further waste uptake lies outside of the cement industry itself, i.e. **the sector is perceived as technically ready to increase its use of alternative fuels.**