

THE CONTRIBUTION OF CEMENT COMPANY IN CURCULAR ECONOMY

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SUMMARY

The cement industry contributes to circular economy through waste utilization, reducing its fuel and raw material requirements and subsequent emissions, sustainable and resilient construction for the adaptation to climate change. Greece has one of the lowest ranking among EU member states in the utilization of alternative fuels for co-processing in the cement industry, combined with one of the highest rates of disposal-landfilling for its waste in EU. TITAN Greece promoted the potential for transformational change that a Circular Economy can bring to the status quo of the Greek economy, both upstream and downstream, including the solving of chronic, confrontational problems, such as waste management, and extending to the provision of investment opportunities, as a catalyst towards sustainable growth.

TITAN cement plants used app. 22,4 million tons of industrial by-products and waste to substitute natural raw materials, between the base year of 2003 and 2018. The use of construction and demolition waste in cement production is an innovative solution that TITAN has implemented over the past years proving 100% recyclability of cement. Furthermore, waste concrete is sent back from the Ready Mix plants to TITAN cement plants as an alternative source of raw material in cement kilns. In 2018, the Kamari plant reached a 36% ratio (thermal-based substitution) in replacing conventional with alternative fuels.

INTRODUCTION

By moving to the Circular Economy, the cement industry can achieve sustainable development especially through recovery & recycling business model.

Circular economy business models:

Circular Supply-Chain: Introduces fully renewable, recyclable or biodegradable materials that can be used in consecutive lifecycles.

Recovery & Recycling: Creates production and consumption systems in which everything that used to be considered waste is revived for other uses.

Product Life-Extension: By maintaining and improving products this model elongates their life.

Sharing Platform: Examples include Airbnb, and Lyft. The model helps consumers save and make money while more effectively using assets.

Product as a Service: Prizes performance of a product over volume sales and “leases” products instead of selling them.

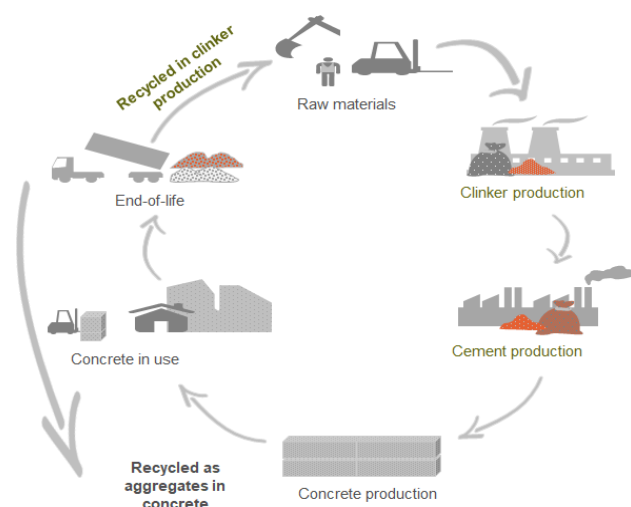


Figure 1: The role of cement company in Circular Economy

CONTRIBUTION TO THE CIRCULAR ECONOMY

Co-processing in cement industry

The European cement industry is committed to ensuring that society has sufficient cement to meet its needs, whilst at the same time reducing its fuel and raw material requirements and subsequent emissions. The use of waste materials in the cement industry, also referred to as co-processing, contributes towards achieving these objectives. Due to the characteristics of the production process, the cement industry is capable of co-processing alternative fuels, which have a significant calorific value. It is an optimum way of recovering energy and materials from the waste, thus is supplementary to the recycling of municipal and industrial waste. It offers a safe and sound solution to society providing a low-cost handling of waste and at same time reduces global CO₂ emissions and does not have a negative impact on production process emission. Furthermore, it is carried out in a safe manner, thus not affecting the health & safety of its workers or neighbourhood.

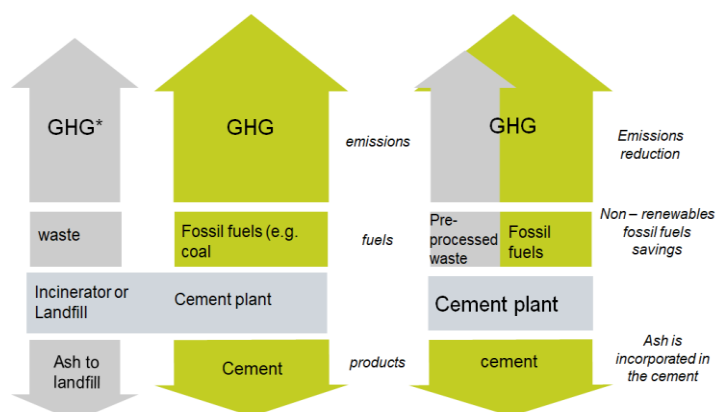


Figure 2: Facing the climate change through co-processing

Co-processing helps the cement industry lower its fossil fuel consumption and reduce its environmental impact. It is the simultaneous recovery of energy and the recycling of mineral resources when alternative fuels are used to replace primary fossil fuels in cement/clinker kilns: the traditional sources of energy in the making of cement clinker are fossil fuels like coal, lignite, petroleum coke, oil. In co-processing these are being substituted by waste-derived fossil fuels and waste biomass, together called alternative fuels. Due to the high temperatures and long residence time, the destruction of such waste-derived fuels is very efficient and complete. A difference compared to incineration is that the minerals in the waste fuel become part of the product (clinker): the inorganic components of waste derived fuels ('ash') are broken down and incorporated into the clinker as minerals in a water-insoluble form, thus replacing primary raw materials, and thereby recycling this fraction of the waste.

Table 1: the Advantages of Co-Processing

	Kiln of Cement Industry	Incinerator
Material's Temperature	1.450 °C	900 ° C
Gas's Temperature	T> 1.800 °C with excess air: complete combustion of organic components (PCDD / PCDFs)	1.200 °C
Residence Time	T>1.200° C for Dt >12 -15 sec	>2 sec
Degassing Temperature	Direct cooling in bag filters ~ 120 °C Minimum residence time of flue gases in the 300 °C-450 °C prevents the formation of PCDD / PCDFs	Probable secondary measures are required

Disposal of Ash	No ash is produced. Heavy metal incorporated to clinker in water-insoluble form.	Landfill for Hazardous Waste
Generation of acid gases (i.e. SO ₂)	Binding due to alkaline product.	Scrubbers for capture

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

– **Abate climate change.** Alternative fuels form one of the main levers for CO₂ - reduction in the cement industry. According to IEA, alternative fuels can contribute 0,75 Gtons of CO₂ worldwide to GHG emissions reduction up to 2050.

– **Improved waste management-avoid landfill.** Co-processing of waste can reduce the volume of waste that is landfilled and efficiently use the energy and material content of waste. It fits perfect in the EU waste management hierarchy as a supplementary solution after recycling.

– **Achieve a circular economy.** Minerals in waste are captured in the product of the cement plant and do not have to be landfilled as is often the case with waste incineration. Furthermore, as raw mineral materials are replaced, it is also a resource efficient option.

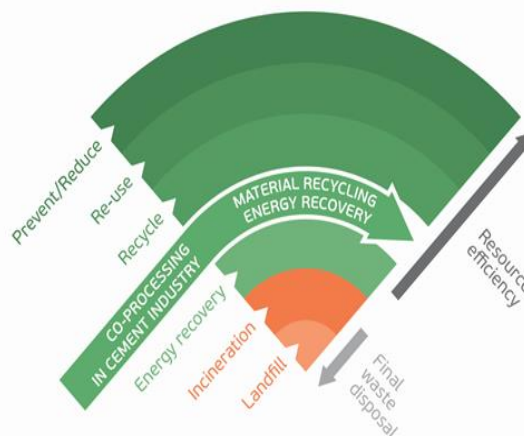


Figure 3: Co-processing in Cement Industry

ALTERNATIVE FUELS

Traditionally, the cement industry uses solid conventional fuel for cement production, but the past 40 years has been using alternative energy sources to reduce its dependence on coal and to provide a solution to the acute problem resulting from the accumulation of waste materials in natural environment. Alternative fuels are by-products or waste from other industries, waste treatment plant products, and materials that could not be recycled and which would otherwise result in landfill. These include secondary fuel (SRF/RDF), dried sewage sludge from waste water treatment plant, mineral oil residues mixed with sawdust, used oils and lubricants, packaging recycling residues, paper, wood, sawdust, fabrics, biomass from agricultural and forestry residues, feed and organic wastes such as plastics, end-of-life vehicle tires, end-of-life vehicles etc.

Alternative fuels offer the cement industry an efficient and reliable systemic solution to the evolving waste-management and energy-conservation challenges:

- ✓ Reduction of CO₂ Emissions
- ✓ Improving energy efficiency – cement industry becomes more competitive
- ✓ Safe and low-cost handling of municipal and industrial waste
- ✓ Reduction of non-renewable fossil fuels

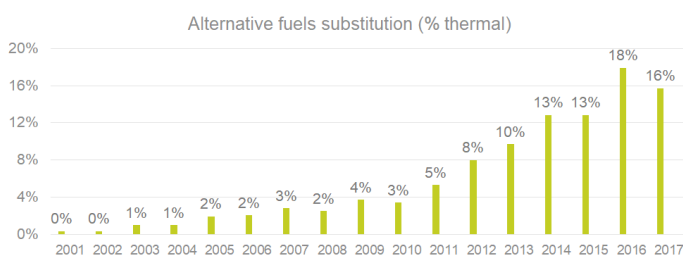


Figure 4 : Progressively increase of AF use

SRF/RDF (Residue Derived Fuel) is an alternative fuel that can be derived from the industrial processing of urban (municipal and packaging waste) and commercial industrial waste. Especially in the case of municipal mixed waste (MSW), it is produced after their Mechanical & Biological Processing, i.e. the removal of organic waste for composting and the recyclable materials sold (metals, glass, paper).

The residual part of this process includes paper, plastic, cloth and very small amounts of wood, and does not contain metals. After pretreatment RDF (e.g. drying, shredding) can achieve the specifications needed by cement industry as an alternative fuel.

However, not all waste materials can be co-processed in the cement industry. Several factors must be taken into consideration when deciding on the suitability of the materials. Alternative fuels used for the substitution of conventional solid fuels must meet stringent standards not to impair the health and safety of workers and the environment, but also to ensure the quality of the product produced, clinker, which is a necessary ingredient for cement production. It should be clarified that the cement industry is not an incinerator. It does not use municipal waste for direct incineration in the kiln, but products from wastewater treatment plants such as SRF/RDF (Solid Recovered Fuel) from recycling plants or dry sewage sludge from sewage treatment plants. As a result, Standard EN 15359:2011 provides the right guidelines for producers and users of SRF in order to classify the produced SRF. Below you could see a useful table presenting the five different classes. In cement industries a SRF/RDF class of less than 3 should be used according to Ministerial Decision 56366/4351 12-12-2014.

SRF/RDF Classification Property	Statistical Measure	Classes (EN 15359:2011)				
		1	2	3	4	5
Net Calorific Value (MJ/kg)	Mean	≥ 25	≥ 20	≥ 15	≥ 10	≥ 3
Chlorine (%)	Mean	≤ 0.2	≤ 0.6	≤ 1.0	≤ 1.5	≤ 3.0
	Median	≤ 0.02	≤ 0.03	≤ 0.08	≤ 0.15	≤ 0.50
Mercury (mg/MJ)	80 th Percentile	≤ 0.04	≤ 0.06	≤ 0.16	≤ 0.30	≤ 1.00

Figure 5 : Classification of the SRF based on EN 15359:2011

Except from the above mentioned, an institutional framework has been defined in recent years and there are commitments concerning co-processing in the cement industry. The existence of environmental, quality, health and safety management systems has ameliorated the processes. A national waste management plan recognizes energy recovery as a supplementary form of management and the solution that the cement industry can provide and at the same time the Directive 2008/98/EU defines co-processing as a R1 recovery method. In addition to these, there is the Industrial Emissions Directive 2010/75/EU. According to the guideline of the EU's circular economy package, 26.1.2017 COM (2017) 34 "The role of waste-to-energy in the circular economy" that mainly concerns countries with high landfilling rates, recognize the solution of co-processing in the cement industry and favor it compared to other technologies.

THE TITAN CASE

In its endeavour to protect the environment and promote sustainable development, TITAN already ranks among the leaders in the global cement sector as a core member of the World Business Council Cement Sustainability Initiative (WBCSD/ CSI). The Group seeks to achieve sustainability by a balance between environmental protection, employment and business expansion and societal

needs. This objective requires capacity building as well as maximum effectiveness in the company operations. Therefore, the implementation of new and innovative solutions, such as the use of alternative fuels to help combat climate change has to be further explored and has become one of the key milestones to our commitment for sustainable development. TITAN has always endeavoured to cultivate good relations and a spirit of cooperation with the communities where its plants and facilities are located. We have seen continuous improvement in these relations, which have proved productive. Good communication and transparency require clarity and consistency. The reports on various aspects of corporate social responsibility that TITAN has been issuing since 1983, its commitment to open systematic communication with stakeholders and, last but not least, "open-plant days" and Stakeholders' Forums and Integrated Report (financial and not-financial performance) demonstrate that the Group has adopted the principles of transparency and accountability as basic prerequisites for Sustainable Development. The Group is proactively demonstrating its role as a responsible enabler of integrated and sustainable energy and waste-management solutions, rather than becoming passive, isolated from social dynamics.

In this direction and in order to comply with the new Industrial Emissions Directive 2010/75/EU (IED) protecting human health and environment, the company has made a lot of environmental investments: Closed storage and feeding systems, power systems, continuous operation bag filters, Selective Non-Catalytic NO_x Reduction (SNCR), new low NO_x burners, On-line emissions monitoring, Quality control equipment, Automatic samplers and By Pass for Volatiles (Cl). The table below shows how the limits have been tightened in recent years.

Table 2: Continuous tightening of operating conditions and limit emissions for co-processing

Emissions (mg/Nm ³) dry, 10% O ₂	Old limits	Old limits with AF (before 26-3-2017)	New limits IED 2010/75 (post 26-3-2017)
Dust	50	30	20
NO _x as NO ₂	1.200	800	500
SO ₂	400	200	50 – 200
TOC	-	10 – 40	10 – 40
HCl	-	10	10
HF	-	1	1
PCDD/PCDFs mg/Nm ³	-	0,1	0,1
Hg	-	0,05	0,05
Cd + Tl	-	0,05	0,05
Sb + As + Pb + Cr + Cu + Mn + Ni + V	-	0,5	0,5
NH ₃ slip	-	50	50

The company wants to ensure air quality in the neighbouring areas by conducting dispersion studies:

- The gases are discharged in a controlled manner through a chimney, the height of which is calculated on the basis of the protection of human health and the environment
- At the licensing stage, it is ensured that the gas emissions of the cement kilns do not adversely affect public health with relevant mandatory dispersion studies accompanying the Plant Environmental Impact Studies and according to the Directives; 2008/50 / EC on ambient air quality & 2004/107/EC on AS, Cd, Ni and B(a)P in ambient air.

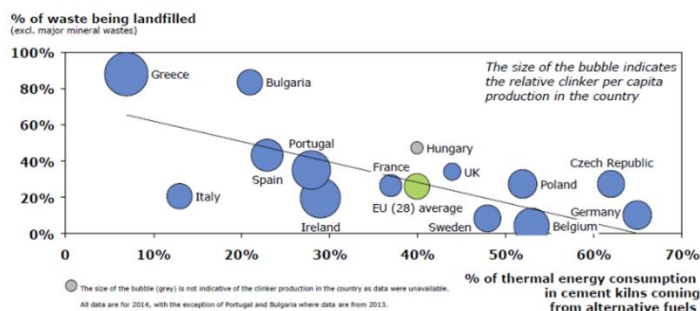


Figure 7 indicates that we have low thermal substitution rates in Greece but significant potential for improvement, as there is a tendency of increasing that number. The main problem is the regulatory framework and the lack of infrastructure & public perception which consist the main barriers.

Figure 7: The position of Greece thought the other European Countries based on the % of waste landfilled and the use of AF.

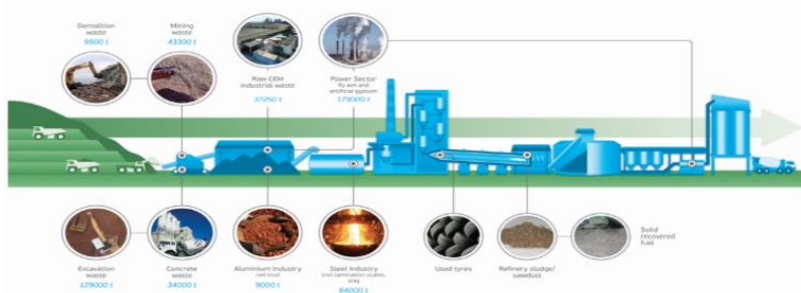


Figure 8: Alternative Raw Materials and Fuels used at TITAN Cement Company

In addition to the above mentioned the concept of co-processing consists a supplementary solution in Greece’s waste management and especially to the increased percentages of landfilling. It is necessary to reduce landfill through re-use and recycling.

CONCLUSIONS

In a world of change, working for long-term sustainability is not just about staying in business, but exploring new opportunities. Cement is a traditional product which can play a major role in the new era. Modern cement plants have mitigated production environmental effects, introducing the alternative fuels in their production and doing environmental investigations. New challenges for cement manufacturing arise taking into account the tightened emission limits and the need for decreasing the CO₂ footprint. Cement sector has the capacity in terms of infrastructure, knowledge & experience to lead the way and become an example in the new model of circular economy but structural & fiscal reforms are needed to lift the barriers. Last but not least trust is needed between all stakeholders’ society, business and competent authorities.