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Burning waste in cement kilns: The story of Calusco d'Adda

Case Study

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The story of Calusco d'Adda

Burning waste in cement kilns is a widespread practice, but what is its impact on citizens' health and the environment?
In the cement plant of Calusco d'Adda, the partial switch from petroleum coke to waste-based fuels has substantially increased the emissions of many pollutants, which can have significant effects on human health.
Local citizens have voiced their concerns about the issue, and requested an epidemiological study on the area near the cement plant in order to assess the impact of hazardous emissions on public health.

The Cementeria di Calusco d'Adda

The cement plant Cementeria di Calusco d'Adda was built in 1907 and has been owned by the Italcementi Group since the 1920s. In 2016, Italcementi joined with the German construction group Heidelberg Cement Group, becoming the world's second largest cement producer[1].

The plant is located in the town of Calusco d'Adda in Northern Italy, at the base of the Bergamasque Prealps. The factory is close to the Adda river, with nearby quarries of marly rock and limestone providing a supply of raw materials.

The cement plant has been renovated several times since the early 2000s. With a cement production rate of 1,500,000 tonnes per year, it is one of the most productive facilities in Europe.

In 2008, Italcementi began trialling a partial switch from petroleum coke (petcoke) to refuse-derived fuel (RDF, 19 12 10[2]). The trial lasted for six years, with the amount of waste burned growing from the initial 8,000 tonnes of RDF to 30,000 tonnes in 2014.

Concerns about the toxic emissions from burning waste in cement kilns led to the establishment of two local associations, *Comitato La Nostra Aria* and *Rete Rifiuti Zero Lombardia*. These two groups have organised demonstrations and taken legal (and other) actions in protest.

Types and volumes of waste burned

At the beginning of the RDF trial period in 2008, the cement kiln in Calusco d'Adda was authorised to burn up to 8,000 tonnes of RDF, increasing gradually to 30,000 tonnes by 2014, with a maximum

[1] https://www.ft.com/content/51d86a0c-3557-11e5-b05b-b01debd57852
[2] Waste classification is based on the European List of Waste (Commission Decision 2000/532/EC) and Annex III to Directive 2008/98/EC.

of 4,160 kg/h. The trial was monitored for the entire six-year period[3], and an environmental impact study was subsequently published by Golder Associates. In 2014, on completion of the trial, the Italcementi Group applied to the provincial authority for authorisation to increase RDF to 110,000 tonnes per year. This would add the following fuels to the RDF already burned at the plant[4]:

- Plastic and rubber sorting residues rejected from mechanical treatment plants (19 12 04);
- End of life tyres (16 01 03);
- Woody biomass (191207);
- Common sludge (19 08 05);
- Sludge from biological treatment of industrial wastewater (19 08 12);
- Sludge from other treatment of industrial wastewater (19 08 14).

Table 1. Fuels used in the production process at the Italcementi Group's Calusco d'Adda cement plant, 2008-2013

Fuels (t)	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**Average**
Petcoke	103,322	106,122	102,642	100,962	89,233	93,897	99,363
Low sulphur mazut	1,905	660	634	1,170	1,754	519	1,107
RDF 19 12 10	8,059	15,173	18,779	21,587	23,375	25,266	18,707

Source: Golder Associates' environmental impact study (2014)

According to the environmental impact study, the burning of RDF is authorised when it fulfils specific criteria of calorific value, and chlorine (Cl) and mercury (Hg) content[5] (see Table 2).

Table 2. General legal criteria in assessing the quality of RDF

	Statistics	**Metric**	**Quality 1**	**Quality 2**	**Quality 3**	**Quality 4**	**Quality 5**
Calorific value	Average	MJ/kg t.q.	≥ 25	≥ 20	≥ 15	≥ 10	≥ 3
Cl	Average	%	≤ 0.2	≤ 0.6	≤ 1	≤ 1.5	≤ 3
Hg	Average	MJ/kg t.q.	≤ 0.02	≤ 0.03	≤ 0.08	≤ 0.15	≤ 0.5

Source: Golder Associates' environmental impact study (2014)

[3] The monitoring technology directly monitors the emissions from the chimney. For a description of the monitoring technology, see (in Italian): https://www.mavetec.it/en/strumenti-controllo-analisi/analisi-gas/monitoraggio-emissioni/sistema-monitoraggio-emissioni-sme

[4] Golder Associates (2014), Environmental impact study.

[5] UNI CEN/TS 15359.

The cement kiln in Calusco d'Adda was also authorised to burn solid biofuels (19 12 07, see Table 3).

Table 3. Authorised solid biofuels for the Italcementi Group's Calusco d'Adda cement plant

Solid biofuel	Code	Dimension
Woody biomass	1.1.8	5-100 mm
Herbaceous biomass	2.1.1.4	N/A
Fruit biomass	3.2.2.2	>10 mm
Fruit biomass	3.2.2.4	1-10 mm

Source: Golder Associates' environmental impact study (2014)

Despite the authorisation, the two new installations to stock and introduce these solid biofuels have not yet been built.

Table 4. Types of waste included in the environmental authorisation for Italcementi Group's Calusco d'Adda cement plant

Installation	Primary burning oven (t/h)	Calcinating furnace (t/h)	Overall use limit (t/h)	Status
RDF	4	4	4.16	Functioning
Solid biofuel	4	4	4.16	Authorised but not built
Solid biofuel	-	4	-	Authorised but not built

Source: Golder Associates' environmental impact study (2014)

Emissions and permitted levels of certain pollutants

Following the trial period, Golder Associates' environmental impact study[6] confirmed the economic and technical feasibility of burning waste at the plant, stating that all of the limits for the emissions were respected.

[6] The study is available at: http://silvia.regione.lombardia.it/silvia/

However, the environmental impact study[7] also pointed out that the introduction of new fuels has led to significant increases in emissions of many pollutants, namely sulphur dioxide (SO_2) +525%, dust +271%, heavy metals +600%, and polychlorinated biphenyl[8] (PCB) +60% (see Table 5).

Emissions at the plant are monitored under two different regimes[9]. Carbon monoxide (CO), hydrogen chloride (HCL) nitric oxide (NOx), ammonia (NH3) sulphur dioxide (SO2), total organic carbon (TOC), and hydrogen fluoride (HF) emissions are continuously monitored through the mavatec technology, while micropollutants such as heavy metals, dust and PCDD/F (dioxins) are monitored every four months. Neither the Italcementi Group nor the HeidelbergCement Group has ever revealed how the monitoring of these micropollutants is carried out. Since 30 July 2013, data from continuous monitoring are shared with the regional monitoring network, but data on micropollutants are not similarly shared. In addition, while the continuous monitoring data refer to daily intervals of 30 minutes, the monitoring intervals for micropollutant data are not known.

Table 5. Balance of emissions from the Italcementi Group's Calusco d'Adda cement plant 2008/2013

		2008	2008	2008	2013	2013	2013	
Pollutant	**Capacity (Nm3/h)**	**Concentration (mg/Nm3)**	**Hour (kg)**	**Year (t)**	**Concentration (mg/Nm3)[10]**	**Hour (kg)**	**Year (t)**	**Balance (%)**
CO	540,000	301	162,540	1170.3	245.8	132,732	955.7	-18
HCL	540,000	0.8	0.43200	3.110	3.2	1.728	12,442	+300
NOx	540,000	498	268,920	1936.22	444.2	239,868	1727.05	-11
NH3	540,000	2.5	1.350	9.72	5.3	2.862	20.61	+112
SO2	540,000	3.9	2.106	15,163	24.4	13,176	94,867	+526
Powder	540,000	0.7	0.378	2.722	2.6	1.404	10,109	+271
TOC	540,000	19.1	10.314	74,261	20.3	10,962	78,926	+6,28
Σ (Cd, Tl)	540,000	0.0001	0.00005	0.38880 (kg)	0.001	0.00054	3.888 (kg)	+900
Σ (heavy metals)[11]	540,000	0.0026	0.00140	0.010	0.0182	0.00983	0.0707	+600

[7] *Ibid.*
[8] The law requires that the content of PCB in industrial emissions be monitored but does not set a limit value.
[9] The monitoring regimes (except that of PCB) are described in Golder Associates' environmental impact study (2014).
[10] Concentration limit values (mg/Nm3): Powder 10; SO2 50; NOx 500; CO 900; TOC 50; HCL 10; NH3 50; HF 1; Σ (Cd, Tl) 0.05; Σ (heavy metals) 0.5; PCDD/F 0.1 ng/Nm3.
[11] Antimony, arsenic, cobalt, chromium, manganese, nickel, lead, copper, tin, vanadium.

HF	540,000	0.317	0.171	1,234	0.365	0.197	1,418	+15
PCB	540,000	0.0005	0.00027	0.00194	0.0008	0.00043	0.00311	+60
PCDD/F	540,000	0.0000046	0.00000	0.01788 (Kg)	0.0000012	0.00000	0.00467 (Kg)	-74

Source: Golder Associates (2014) environmental impact study

Currently, the cement plant uses a tissue filter to capture dust and micropollutants before the gaseous effluents of combustion are emitted into the atmosphere. The current capacity of the tissue filter is 6,000 Nm3/h but if the cement plant was to be authorised to burn 110,000 tonnes of waste per year, a new filter would be required, with a capacity of 8,400 Nm3/h[12].

Breaches, environmental and health impacts, and complaints from local populations

Although no legal breaches of industrial emissions were found, annual measurements of air quality in the town of Calusco d'Adda show fluctuating pollution trends, according to the latest annual report published by the Regional Environmental Protection Agency (*ARPA Lombardia*)[13]. Breaches of air quality standards and high concentrations of hazardous pollutants have also been reported by ARPA, namely PM10 (daily permitted exceedances each year, see Table 6), PM2.5 (see Table 6), and O3 (see Table 7).

The ARPA report warns that, given its strongly oxidising nature, O3 can attack all classes of biological substances with which it comes into contact. Respiratory tissues are particularly exposed, with effects ranging from irritation of the eyes, nose and throat to diseases of the respiratory system, starting from hourly average concentrations of 200 µg/m3, with decreases in functionality of the respiratory system in children and young people at hourly concentrations in the 160-300 µg/m3 range. In addition, ozone can cause reduced plant growth, with chlorosis and necrosis of the leaves in cases of high concentrations.

The ARPA report states that the composition of the particulate matter (PM10 and PM2.5) presents a toxicity that does not depend solely on the quantity of such matter but also on its physico-chemical characteristics. The toxicity is likely to be amplified by the ability to absorb gaseous substances such as PAH (polycyclic aromatic hydrocarbons) and heavy metals, some of which are powerful carcinogens. Their small size allows the dust to penetrate human airways, causing disorders and diseases of the respiratory system.

[12] Golder Associates (2014), Environmental impact study.
[13] http://www.arpalombardia.it/qariafiles/RelazioniAnnuali/RQA_BG_2016.pdf

Table 6. Particulate matter concentrations in air 2008-2013

Pollutant	Data	Units	2008	2009	2010	2011	2012	2013	Limits
PM10	Yearly average	(µg/m3)	34	33	31	38	34	30	40 µg/m3
PM10	Number of days	Days	52	68	57	89	61	52	35 days exceeding 50 µg/m3
PM2.5	Yearly average	(µg/m3)	28	26	31	29	25	21	25 µg/m3

Source: Regional Environmental Protection Agency (ARPA Lombardia) Annual Report (2016)

Table 7. Ozone concentrations in air 2008-2013

Pollutant	Data	2008	2009	2010	2011	2012	2013	Limits
O3	Yearly average	59 µg/m3	70 µg/m3	71 µg/m3	41 µg/m3	57 µg/m3	64 µg/m3	---
O3	Maximum daily 8-hour mean	63	74	65	53	49	47	25 days over 3 years (120 µg/m3)
O3	Information threshold	14	19	26	0	12	16	180 µg/m3
O3	Alert threshold	0	1	2	0	2	1	240 µg/m3

Source: Regional Environmental Protection Agency (ARPA Lombardia) Annual Report (2016)

Conclusion and recommendations

Since its partial switch from petroleum coke to refuse-derived fuel (RDF, 19 12 10), the Italcementi Group's cement plant in Calusco d'Adda has increased the RDF burned from 8,000 tonnes per year in 2008 to 30,000 tonnes per year in 2014. The Group is awaiting authorisation to further increase its RDF to 110,000 tonnes per year. However, local citizens have voiced their concerns about the health consequences of such increases, and have requested an epidemiological study on the area near the cement plant in order to assess the impact of hazardous emissions on public health.

The use of new fuels has increased the emissions of many pollutants, especially sulphur dioxide (SO_2) +525%, powder + 271%, heavy metals +600% and polychlorinated biphenyl (PCB)

+60%, which can have significant effects on human health. The Stockholm Convention[14] (2001) requires every action and measure to be taken to lower the emission into air of Persistent Organic Pollutants (POPs) such as dioxins and other chlorinated organic compounds (e.g. polychlorinated biphenyls (PCBs) and dichloro-diphenyl- trichloroethane (DDT)). Annex C, Part II of the Convention explicitly refers to the potential for comparatively high formation and release of these chemicals to the environment from cement kilns burning RDFs as industrial sources.

As yet, there are no commonly adopted European limit values for PCB, unlike in the U.S., where standards and regulations have been developed for PCB content in the atmosphere. The National Institute for Occupational Safety and Health (NIOSH) recommends an upper limit of a 10-hour exposure of 1.0 µg/m3[15].

ARPA reports that, as a result of the partial substitution of petcoke with waste, the air quality in the town of Calusco d'Adda is low[16], with several breaches of air quality standards since 2008, chiefly relating to particulate matter and ozone. With a population of only 8,300 inhabitants and given its distance from highways or heavily trafficked roads, it is difficult to point to other sources of pollution than industrial emissions.

It is worth noting that while the ARPA does not monitor heavy metal contamination around Calusco d'Adda, the Golder Associates' environmental impact study (2014) reported a consistent increase of heavy metals (+600%)[17] in the emissions from the cement plant.

Cement production which relies on the burning of waste does not seem environmentally sound and, should the cement plant be authorised to increase the amount of waste burned to 110,000 tonnes per year, the resulting toxic emissions seem likely to harm the local population.

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Zero Waste Europe was created to empower communities to rethink their relationship with the resources. In a growing number of regions, local groups of individuals, businesses and city officials are taking significant steps towards eliminating waste in our society.

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[14] http://chm.pops.int/TheConvention/Overview/tabid/3351/Default.aspx
[15] https://www.atsdr.cdc.gov/csem/csem.asp?csem=30&po=8, last accessed on 23 February 2018.
[16] Regional Environmental Protection Agency (ARPA Lombardia), Annual report on air quality in the province of Bergamo.
[17] See Table 5.