Refuse Derived Fuel Usage In Cement Kilns: Bangladesh Scenario

ESDO

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Level: 5, House: 8/1, Block: C, Lalmatia, Dhaka-1207, Bangladesh
Phone: +880-2-55008178
Fax: +880-2-55008179
E-mail: info@esdo.org
Website: www.esdo.org

The Environment and Social Development Organization, ESDO, is an action research oriented non-profit and non-government organization in Bangladesh. It is an environmental action research group dedicated to a toxic-free, zero-waste planet. This entails fighting pollution and building regenerative solutions in cities through local campaigns, shifts in policy and finance, research and communication initiatives, and movement building. ESDO is working relentessly to ensure biological diversity since its establishment in 1990. It is the pioneer organization that launched the anti-polythene campaign in 1990, which resulted in a complete ban of polythene shopping bags throughout Bangladesh in 2002.

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Team Leader
Siddika Sultana

Editorial Team
Prof. Dr. Md. Abul Hashem, Dr. Shahriar Hossain

Study & Analysis
Tanjima Hoque Trisha, Subhatun Nur Prithy

Cover Design
Hridita Ferdous

Support Team
Khalilur Rahman, Juthi Rani Baroi

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Plastic wastes are stored infront of cement industry.
Source: ESDO, 2022

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Executive Summary

Solid waste management is the collection of waste generated by every human being and its disposal in an environmentally friendly way. Mainly solid waste consists of household, industrial, agricultural, e-waste etc. But improper management of waste can create serious health hazards and environmental pollution. Such diseases as malaria and other respiratory syndromes are also a result of improper waste management. Proper waste management can resolve several issues related to converting waste into energy in developing and developed countries that are using Refuse-Derived Fuel (RDF). Refuse-Derived Fuel is an alternative fuel that is obtained from municipal solid waste. It is claimed to be a renewable form of energy and particularly the cement industry and/or other industries are using RDF to replace coal, gas or electricity. But the harmful effects of using RDF are not known to them.

The demand for RDF in the world is increasing at present. There are several types of RDF: Solid Recovered Fuel (SFR), Process Engineered Fuels (PEF), Tyre Derived Fuels (TDF), and Waste Derived Fuels (WDF). The purchase cost is lower than traditional fuels like coal, gas, oil, fossil fuel and others.

Bangladesh is a small South Asian country located to the East of India. The waste products like waste parings and scraps of rubber, tyres, powders, granules, etc., are exported from Bangladesh. Bangladesh export most of its waste products to China, India, Indonesia etc.

In Bangladesh, the use of RDF in the cement industry is not popular yet. They usually use gas, oil, fossil fuel or coal as the main source of fuel. They are also using electricity in their kilns. Already a gazette has been published by the Ministry of Environment, Forest and Climate Change for Solid Waste Management in Bangladesh (December, 2021), where the criteria for using RDF are described [11]. To spread the introduction of producing and using RDF among the cement industries, boilers or other sectors, a megaproject named Waste to Energy Conversion is now under consideration by the Government of Bangladesh in Keraniganj area of Dhaka City (Bangladesh).

This study is an exclusive assessment done by the Environment and Social Development Organization (ESDO) as part of the IPEN-ESDO partnership with the primary objective to identify the adverse effects of using RDFs in cement kilns in Bangladesh and to review the government policy related to plastic waste, RDFs and fuels for cement kilns.

The questionnaires and face-to-face interviews were conducted by the team with selected cement factory workers and responsible persons. Also, the research team communicated with corporate officials. The study found that the use of RDFs is less known to the cement producers. All of the cement factories are using traditional fuels such as coal, gas, oil, or fossil fuel.

If the use of RDF is economically viable, they will think about it. The emission of carbon and other toxic gases or elements is harmful to both the environment and humans. The workers of the cement factories are suffering from various diseases and the fumes and ashes are responsible for environmental pollution as well.

Abbreviations

AF	Alternative Fuel
BCMA	Bangladesh Cement Manufacturers Association
DOE	Department of Environment
ECA	Environmental Conservation Act
MoEFCC	Ministry of Environment, Forest and Climate Change
MSW	Municipal Solid Waste
PEF	Process Engineered Fuels
POPs	Persistent Organic Pollutants
RDF	Refuse Derived Fuel
SRF	Solid Recovered Fuel
TDF	Tyre Derived Fuels
UNCED	United Nations Conference on Environment and Development
WDF	Waste Derived Fuels
Zn	Zinc

1. Introduction

With the growth of the world economy, the daily waste, generated by industry and households are also increasing. Since recycling does not solve comprehensively the problem of handling solid waste, significant resources are invested in the integration of combined systems and their management aimed at complete waste utilization. The Refused Derived Fuel (RDF) is a type of fuel that, after various technological processes, becomes a residual fuel from waste. After dissociation separation and collection of suitable residuals for the RDF production, they are dried, i.e. stabilized. Two technologies are applied in order to produce the highly calorific fraction of the RDF, namely: mechanical-biological treatment (MBT), and drying with hot air [1]. RDF is used as a substitute for fossil fuels in cement kilns, brick kilns, boilers, and other applications. This report aims to identify the usage of Refuse Derived Fuel (RDF) in cement kilns, find out about RDF exports or imports, identify health and environmental risks, increase awareness about RDF, review government policy and the standard level of using RDF in Bangladesh.

2. Background

Over the past decade, waste has become a major land and sea issue. “In a little over a century, waste has gone from being hailed as a scientific wonder to being reviled as an environmental scourge” [27].

The characteristics of RDF is just a transformation of wastes usages (plastic, tyre, paper, textile or solid waste). Usually, these wastes discharge into the land and water and pollute them severely. The RDF mainly reduces the direct discharge of waste and transforms it into energy for the cement industry and others severely impacting soil, water and air.

The demand for RDF in the world is expanding day by day due to its low cost as an alternative fuel to fossil fuels. In Bangladesh, still RDF is not used by cement plants as an alternative fuel. Cement manufacturing is highly energy-consuming. To make this process more cost-effective cement manufacturers from other countries such as India, Indonesia, Philippines, Malaysia etc are using a blend of alternative fuels (RDF) and conventional fossil fuels. “The alkaline environment, high temperature, and long processing time allow cement kilns to burn a wide range of alternative fuels and hazardous wastes [36].”

The use of RDF in the cement industry has been a common practice since 1993 in the EU. Austria, Belgium, Denmark, Italy and the Netherlands are some of the indicative countries where RDF utilization is common in the cement industry. According to the literature, around 115,000 t/y of MSW were co-incinerated in cement kilns in Europe in 1997 and more than 300,000 t/y of RDF in 2003. Also in Turkey, according to a recent publication, the target for a single cement plant is the utilization of 35,000 t/y of RDF [12] [10].

In Bangladesh, there are more than 522 towns and cities, which are hubs of rapid economic development and population growth, and generate thousands of tons of waste from domestic,

industrial, commercial, health care facilities and agricultural sources that must be managed daily. Low collection coverage, unavailable transport services and lack of suitable treatment, recycling and disposal facilities are responsible for unsatisfactory waste management, leading to water, land and air pollution, and for putting people and the environment at risk [4].

This report aims to detect the trade and burning of Refuse Derived Fuel (RDF) in Bangladesh and to detect the specific sites (cement kilns, incinerations, boilers, etc.) where RDF is used and quantify its amount per year. The study will also focus on reviewing the government policies, regulations and standards for using RDF, and will identify the health and environmental risks of using RDF in Bangladesh and aims to increase stakeholder awareness.

3. Objectives of the Study

The prime objectives of this project are:

- To identify the usages of RDF in Bangladesh, particularly in cement kilns
- To identify health and environmental risks of RDF usage in Bangladesh
- To increase awareness about RDF
- To review the existing government policies related to waste management and the use of RDF.

4. What is RDF?

Refuse Derived Fuel (RDF) is a relatively crude material, produced by shredding, pelletising or reprocessing residual municipal solid waste (MSW), construction and demolition waste, and commercial and industrial waste into a form suitable for combustion. Ideally, before MSW can enter the RDF production process, valuable commodities such as plastic, paper, metal, glass and wood should have been removed for recycling.

RDF consists of wastes with high calorific values that produce heat and energy when burned. The main users of this waste fuel are cement kilns and incinerators (mainly, in Northern Europe). RDF is typically produced in bales or pellets, although in some countries such as Indonesia, it only goes through the shredding phase and is known as ‘fluff’.

Italy, Belgium, Denmark and the Netherlands are among the countries that have at least one cement kiln processing RDF. MSW must be sorted to remove the recyclable, inert, and sometimes wet fractions before input into cement kilns. The remaining material accounts for about 20-50 percent of the original MSW weight and can be incinerated directly or pelletized. The RDFs from MSW have different physical and chemical properties depending on their source, especially concerning their ash, chlorine, sulfur, and water contents. There are notable differences among RDFs, and certain physical and chemical properties can cause difficulties in the

kiln combustion process where the RDF is introduced directly. The industries claim that using RDF as a supplemental fuel in cement production is an economically viable option to minimize fuel costs and landfill disposal. However, in reality it adds to a financial and ecological burden and threatens human and environmental health. [12] [39].

Similar waste fuels

- **Solid Recovered Fuel (SRF) -** a fuel produced by drying, filtering, and shredding solid waste. SRF usually consists of combustible components obtained from municipal solid waste. SRF may be derived from food and kitchen waste, paper, green waste, plastic bottles, toys, fabrics and composite waste.
- **Process Engineered Fuels (PEF) –** also made from municipal waste and construction and demolition wastes, mainly, in Australia.
- **Tyre-Derived Fuels (TDF) –** tyres are one of the most used alternatives to traditional fuels used in the incineration process in the cement industry. The high temperature in a cement kiln ensures the complete destruction of end-of-life tyres (ELT).
- **Waste Derived Fuel (WDF) –** It is similar to RDF due to its inferior reprocessing and complex structure. WDF is merely fuel created from mostly non-recyclable waste materials and usually includes paper, cardboard and plastics.

5. Characteristics of RDF Pellets

Refuse Derived Fuels (RDF) derived from industrial waste such as tyres, waste oil, plastics, solvents and many more are commonly used by the cement industry as substitute fuels. RDF used in cement industries is solid. Hazardous organic waste is also used as a co-fuel since the early 1970s. RDF used as an alternative fuel in cement kilns is generally prepared by cutting, sorting, and separating metals and other materials that cannot be used as fuel to make fluffy solid fuels or other forms such as pellets of uniform size.

Table 1: Characteristics of RDF

Size	dia 8/20/30 mm, length 8-40 mm
Calorific value	4000 Kcal / Kg (minimum)
Bulk density	0.7 MT per cu.m.
Density	1.3 gm per cc. (minimum)
Ash content	< 15%
Moisture	10% (approx.)

[8]

6. Comparison between RDF and Other Fuels

A. RDF vs. Coal:

Table 2: Comparison of RDF vs. coal

Fuel/Factor	Coal	RDF
Moisture content (weight, %)	39	10
Calorific value (Kcal/Kg)	4000	3500-3700
Ash content (weight, %)	4.2	<15
No_x content (weight, %)	1.2	1-1.5
Carbon (weight, %)	31.4	35-40
Oxygen (weight, %)	7.4	25-30
Hydrogen (weight, %)	4.3	5-8

[8]

The table is showing the comparison between RDF and Coal. The moisture content of coal is higher than RDF. The calorific value of the two is different from each other. Coal is about 4000 Kcal/Kg and RDF is about 3500-3700 Kcal/Kg.

B. RDF vs. Firewood

Table 3: Comparison of RDF vs. firewood

Fuel/Factor	Firewood	RDF
Moisture content (weight, %)	10-20	10
Ash content (weight, %)	24.5-26	<15
No_x content (weight, %)	0.75	1-1.5
Carbon (weight, %)	3.2	35-40
Hydrogen (weight, %)	-	5-8
Oxygen (weight, %)	-	25-30

[8]

The ash content released from firewood is higher than for RDF. From firewood it is about 24.5-26% and from RDF it is <15%.

C. RDF vs. furnace oil:

Table 4: Comparison of RDF vs. furnace oil

Fuel/Factor	Furnace oil	RDF
Moisture content (weight, %)	1.0	10.0
Ash content (weight, %)	0.1	<15
No_x content (weight, %)	0.1	1-1.5
Carbon (weight, %)	8-30	35-40
Oxygen (weight, %)	5-20	25-30
Hydrogen (weight, %)	0.1	5-8

[8]

Oil is a very common fuel for cement manufacturers. Almost all cement manufacturing companies use oil as their main fuel in their kilns. RDF has a higher carbon and oxygen content than furnace oil. Released gases are harmful for both humans and the environment. The workers of the cement kilns are exposed to these gases.

7. General Use of RDF

It is a fact that not many kilns are designed to adopt co-combustion. They are basically old models more so in case of old wet process kilns with first generation incinerators. During use of RDF, cement kilns require to take care of the followings: it should run at optimum excess air to improve combustion efficiency, control kiln parameters more precisely, prevent kiln solid ring formation, and maintain pollution control devices such as baghouses and Electrostatic Precipitators (ESPs) in good operating conditions. This will reduce the environmental hazards to a minimum [8]. In addition, RDF is used in boilers, incinerators or other heat-producing chambers in many countries.

8. RDF in Cement Kilns (Global Use)

Cement clinker burning uses up most of the fuel energy consumed in cement manufacture. To a lesser extent, thermal energy is also used for drying raw materials and other major cement constituents, such as granulated blast furnace slag. Apart from fossil fuels (coal, lignite, heavy fuel oil, petcoke), the use of alternative fuels such as RDF in the clinker burning process is gaining support nowadays. The use of fossil fuels, especially hard coal and lignite, decreased continuously. As a result, only 40% of the fuel energy demand is covered by fossil fuels today. The high-energy efficiency of the cement production process was not affected by this substitution. In 2013, German cement kilns used 3,032 million mt of secondary fuel per year, i.e., 62% of the energy demand of the cement-producing industry was covered by secondary fuel. Commonly used are waste tyre, waste oil, fractions of industrial and commercial waste, bone meal and animal fat, solvent and sewage sludge.

The core reason that the cement-producing industry limits using RDF produced from household waste is that quality specifications are not met. The examples most often cited by the industry are having very high levels of chlorine content, the heating value is too low and the metal content is too high. The ashes produced by RDF are not considered a viable ingredient for the manufacturing of high-quality cement. [18]. This means limitations on chloride content and mercury levels in the RDF as required under EU standards. Such standards are not applied elsewhere.

Despite the hazards associated, RDF is widely used in Indian cement kilns and they are major importers. In addition, several plants are ready to use a host of waste derived fuels like petroleum refinery sludge, shredded tyre, paint sludge, agro-industrial waste etc. A few among them had even invested in installing environment-friendly systems for collecting, handling, pre-processing and conveying such wastes in their continuous manufacturing process [8]. In UK, more than 20 cement factories use tyres as alternative fuel to produce 13 million tons of cement with the permanent authorization of the Environment Agency. While in Netherlands

and Germany, several cement factories are running on alternative fuels. The two Norwegian kilns are already in line with the directives set by the Environment Agency [8].

According to the European Cement Association, the proportion of alternative fuels used in clinker kilns between 1990 and 1998 in particular countries were as follows: Belgium — 18% France —52.4%; Italy —4.1%; Portugal —1.3%; Spain —1%; Sweden -2%; Switzerland — 25%; Czech Republic — 9.7%; Great Britain —20%; Germany —15%; Poland —1.4% [8][14].

9. Regional Scenario of RDF Use

In examining the regional scenario of RDF use, this study focused on two specific regions: South Asia and Southeast Asia. In the region of South Asia, RDF is widely used in Indian cement kilns and they are considered as one of the major importers of RDF. In India, most of the cement industries like Grasim Cement Industries, Lakshmi and Rajshree Cement Industries have attempted co-firing of TDF in the kilns. In addition, several plants are ready to use a host of waste derived fuels like petroleum refinery sludge, shredded tyre, paint sludge, agro-industrial waste etc. A few among them had even invested in installing systems for collecting, handling, pre-processing and conveying such wastes in their continuous manufacturing process [8]. Pakistan's Waste-to-Energy (WtE) power plants is currently limited, with power plants situated in Lahore, Karachi, and Punjab. In 2018, Pakistan's National Electric Power Regulatory Authority (NEPRA) granted approval for the country's first 40 MW WtE power station in Lahore. Pakistan generates approximately 30.76 metric tons of Municipal Solid Waste (MSW) annually [47]. In 2008, Fauji Cement Company became the first cement plant in Pakistan to integrate a Refuse Derived Fuel (RDF) processing plant with a capacity of 12 tons/hour. Situated in Jang Bahtar, Punjab province, Fauji Cement Company manages a cement plant with a daily output of 3700 tons. Concurrently, efforts are underway to establish a new production line with a capacity of 7200 tons per day, running in parallel with the existing line.[1] On the other hand, despite the fact that Sri Lanka has not directly developed RDF plant yet, the recent launch of its first waste-to-energy power plant in Kerawalapitiya clearly demonstrates that the country is gradually moving towards that direction.[2]

Analyzing the region of Southeast Asia, it has been found that the cement industries in Thailand use approximately 0.4 million tons of RDF per year, with a substitution rate of less than 20%. This rate is significantly lower compared to the MSW volume and substitution rates in cement plants in other countries [46].[3] In Indonesia, although RDF technology is still in its early stages, noticeable advancements are evident in its development. Situated in Lulut Village, Bogor, the

[1] https://www.cement.pk/wp-content/uploads/2019/06/Alternative-Fuel-Pakistan-Cement-Industry.pdf
[2] https://www.dailymirror.lk/business-news/Aitken-Spence-launches-SLs-first-waste-to-energy-power-plant/273-206041
[3] https://ieeexplore.ieee.org/document/10113510

Regional Waste Processing and Final Processing Site spans 15 hectares and has the capacity to generate RDF ranging from 577 to 630 tons per day.[4] Malaysia has developed capacities that can generate around 7713 tons MSW per day, and is able to produce 2466 tons RDF per day.[5] In the Philippines, almost 35% of plastic waste leaks into the open environment due to poor implementation and enforcement of regulations [44].[6]

10. Cement Industry Overview of Bangladesh

The first cement factory of Bangladesh Chhatak Cement Factory Limited was established in Sylhet in 1941. Formerly known as "Assam Bengal Cement Factory", Chhatak Cement Factory Limited is currently a state-owned cement company. Later, in 1973, the second cement factory in the country Chittagong Cement Clinker and Grinding Factory Limited was established in Chittagong.

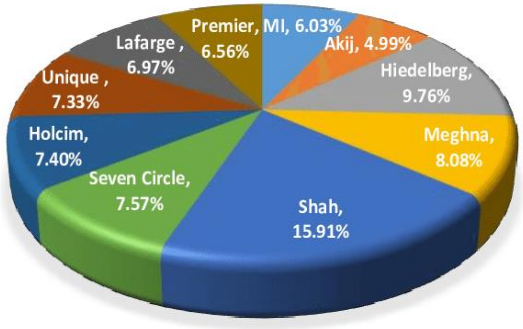

Figure 1: Top ten cement producers of Bangladesh [10]

With the development of the country and the increasing amount of construction, local entrepreneurs and various multinational companies started producing cement in Bangladesh during the nineties after witnessing the potential of this industry. Companies like Confidence Cement Limited (1991), Meghna Cement Mills Limited (1992), and Aramit Cement (1995) started operating in the country in the '90s.

In 1996, Heidelberg Cement Group started its journey in Bangladesh by creating a floating terminal with an onboard packaging facility at the Chittagong Port. Later in 1999, the Heidelberg Group established a plant named Scan Cement Limited at Kanchpur, further strengthening its position on the domestic market. In 2000, they bought a minority stake in the country's second cement factory, Chittagong Cement Clinker and Grinding Factory Limited. In 2003, the two companies merged to continue operating as Heidelberg Cement Bangladesh Limited.

According to the Bangladesh Cement Manufacturers Association (BCMA), there are about 76 registered cement manufacturing companies in the country. As per "The Daily Star" issue of December 2020, there are 37 active cement factories in the country. The country's top 10 companies currently control about 81% of the total cement market. According to BCMA, Shah Cement is leading the market with a market share of about 13% (12.96%), and with more than

[4] https://www.un-pageindonesia.org/en/article/read/how-refused-derived-fuel-rdf-solve-waste-problems-in-indonesia#:~:text=In%20addition%2C%20RDF%20can%20also,coal%20fuel%20with%20biomass%20fuel.
[5] http://journalarticle.ukm.my/1590/1/Masoud09.pdf
[6] https://ipen.org/sites/default/files/documents/ipen-pef-philippines-v1_1-en.pdf

12% market share (12.13%) Bashundhara Kings is in the 2nd position, followed by Fresh (8.62%) in the 3rd position, followed by Crown (8.26%) in the 4th position, and Seven Circle Cement (8.21%) in the 5th position. Of all the cement companies, seven are currently listed on the country's stock market which includes Aramit Cement, Confidence, Heidelberg, Lafarge, Meghna, MI and Premier Cement. The majority of the country's cement grinders are located in five regions that include Munshiganj, Narayanganj, Meghnaghat, Chittagong, and Mongla [17].[7]

At present, cement manufacturers are using Ball Mills or Vertical Roller Mills for their cement production. Their machinery is more cost-effective and produces more cement than in the past.

Figure 2: Ball mills and VRM used by cement manufacturing companies.

Cement is responsible for 8% of global carbon emissions or 3 billion tonnes of carbon dioxide (CO_2) per annum. It is the major constituent material of concrete, which is the most used construction material in the world. Cement is therefore a key component in supporting the economic activity generated by the construction industry [17].

11. Utilization of RDF

The co-incineration of RDF in coal-dust-fired power plants, cement and brick kilns is a threatened technology for both human and environment. However, because of the low amount of only 4,325 MT per year, the operators of coal-fired power plants currently have no interest in RDF. The cement kilns of Bangladesh are not an option for RDF incineration because they use

[7] https://businessinspection.com.bd/cement-industry-of-bangladesh/

oil and gas as fuel. During the last years, researchers gained some experience in using fabric waste from the garment industry as an RDF because of high coal prices. [18].

60% of textile waste is polymer and plastic waste. But due to a lack of proper knowledge and inefficient implementation of government policies, approximately 40–60% of the generated textile waste is not properly collected or disposed of in Bangladesh [3]. Mixed plastic, rubber and textile waste show maximum heating value [2]. It has a dangerous effect on environment. Because burning of RDF i.e., textile or other MSW release greenhouse gases in air and create air pollution. Because of the waste disposal issue of textile industries, the authority is using RDF illegally in their plant.

12. Waste as source of RDF in Bangladesh

As a developing country, urban solid waste generation is increasing with the growth of population (Table 5). As reported by Alamgir and Ahsan (2007), a total of 7690 tons of municipal solid waste (MSW) is generated daily by the six major cities of Bangladesh, and namely, Dhaka, Chittagong, Khulna, Rajshahi, Barisal and Sylhet, where Dhaka city contributes 69% of the total waste stream (Table 6). The waste consists of 74.4% organic matter, 9.1% paper, 3.5% plastic, 1.9% textile and wood, 0.8% leather and rubber, 1.5% metal, 0.8% glass and 8% other wastes. The factors that contribute to waste composition are population density, lifestyle, economic conditions, fruit seasons, climate, recycling, and waste management programs. The huge amount of waste in this country can be the source of RDF production. In Bangladesh, there is only one RDF production site in Sirajgang who are producing SRF but have no environmental clearance certificate from the Department of Environment (DoE), which is mandatory for legally producing RDF in Bangladesh.

Table 5: Urban Solid Waste Production in Bangladesh

Year	Total urban population	Urban population (% total)	Waste production rate (kg/cap/day)	Total waste production (ton/day)
1991	20872204	20.15	0.49**	9873.5
2001	28808477	23.39	0.5***	11,695
2004	32765152	25.08	0.5***	16,382
2025	78440000	40.0	0.6 **	47,064

** Source: ADBI and ADB, 2000, *** Zurbrugg 2002

Table 6: Generation of Different Categories of Wastes in Six Major Cities of Bangladesh

Waste category	Per capita waste generation (kg/day)						
	DCC	CCC	KCC	RCC	BCC	SCC	Entire waste stream
Organic matter	3647	968	410	121	105	158	5409
Paper	571	130	49	15	9	18	792
Plastic	230	37	16	7	5	8	303
Textile & wood	118	28	7	3	2	5	163
Leather & rubber	75	13	3	2	1	1	95
Metal	107	29	6	2	2	2	148

Glass	37	13	3	2	1	2	58
Others	555	97	26	18	5	21	722
Total	5340	1315	520	170	130	215	7690
Population	11.00	3.65	1.50	0.45	0.40	0.50	-
Per capita (kg/day)	0.485	0.360	0.347	0.378	0.325	0.430	0.387

DCC = Dhaka City Corporation, CCC = Chittagong City Corporation, KCC = Khulna City Corporation, RCC = Rajshahi City Corporation, BCC = Barisal City Corporation, SCC = Sylhet City Corporation [6].

13. Waste Fuel Trading and Crisis

Globally, waste generation is expected to gradually increase to unprecedented levels. The world generates 2.01 billion tonnes of municipal solid waste annually, with an extremely conservative estimation that at least 33 percent of that is not managed in an environmentally safe manner [42]. The world is on a trajectory where waste generation will drastically outpace population growth by more than double by 2050 [41]. According to the World Bank, without urgent action, global waste levels will increase by 70% from current levels by 2050, amounting to an estimated 3.40 billion tonnes annually. If not properly dealt with, these wastes might pose threats to public health and the environment [28].

Most of global waste is generated in developed and high-income countries. Though they only account for 16 percent of the world's population, high-income countries generate about 34 percent or 683 million tonnes of the world's waste [41].

Global waste trade is a lucrative industry. The legal and regulated movement of waste is a multi-billion-dollar industry. Data from the United Nations Commodity Trade Database recorded that in 2017, the world's plastic waste export and import were valued at USD 4.5 billion and USD $6.1 billion, respectively [37].[8] The Association of Southeast Asian Nations (ASEAN) countries, which includes the Philippines, is a primary destination of traded waste. China was formerly the primary endpoint for global waste trade, particularly for plastics recycling [35]. It moved tonnes of developed countries' waste to jurisdictions in East Asia and the Pacific with less regulated, ill-prepared, and already overburdened waste management systems unable to deal with local waste in an environmentally sound manner [9]. In 2019, these Southeast Asian countries such as Bangladesh started putting a halt to waste imports from wealthy countries as well [24].[9]

The transboundary shipment of SRF and RDF is also significant in Europe. For example, the United Kingdom exports significant amounts to countries like Germany, the Netherlands, and Sweden. Different factors drive the trade, but policy, waste treatment capacities, and current market prices are some of the main reasons. From Bangladesh it is legal to export waste

[8] https://com¬trade.un.org/data/

[9] https://theconversation.com/as-more-developing-countries-reject-plastic-waste-exports-wealthy-nations-seek-solutions-at-home-117163

products to other countries but from other countries to Bangladesh the import of waste products is strictly prohibited by the Bangladesh Government (Import Policy, 2015-2018) [45].[10] Bangladesh mostly exports its waste products such as waste tyres, scraps, textiles or paper wastes to China and India.

In Asia, RDF and SRF are traded between Cambodia, China, India, Indonesia, Thailand, Malaysia, Myanmar, and Vietnam for many years [22].

14. Bangladesh Government's Initiatives to Control Waste

There is a gazette with the criteria of RDF production in Bangladesh but the government is still not giving permissions to produce RDF. The government officials from Department of Environment (DoE) think that, if they give clearance then it will be difficult to control the burning of waste. Some private companies have been promoted intensively to support local authorities, especially in dealing with municipal waste management. Some of the private companies are trying to illegally establish the RDF technology in country by taking approval from foreign sources. There are many wastes collection and management station in country and secondary transfer station. The technology backed by the relevant agencies for sanitary landfills, landfill gas capture and utilization, landfill mining, thermal treatment, RDF, recycling, and various composting techniques [11].

In the last ten years, the Bangladesh government has launched various incentives to support private investments in the waste sector through several relevant agencies.

A project on waste to energy conversion in Keraniganj area of Dhaka City (Bangladesh) is proposed. The feasibility study report was already submitted. The project will be implemented by focusing on the production of RDF from municipal waste.[18] Other initiatives such as composting household waste and other waste management processes are now increasing in Bangladesh.

[10] https://nbr.gov.bd/uploads/policy/IMPORT_POLICY_2015-2018_(2)_2.pdf

15. Methodology

The methods employed for this particular research include data collection from credible secondary sources or literature by means of extensive desk study, physical surveys and interviews with officials and workers from different cement factories.

The questionnaire survey (Annex 1 and 2) was conducted with factory workers and responsible persons in 3 major cement manufacturing areas in Bangladesh: Dhaka, Chittagong and Khulna. Also, face to face interviews were conducted with corporate officials. Interviews were conducted in the top ten renowned cement factories listed above from 02 October 2022 to 27 October 2022 to detect the specific sources where RDF is used and if used, then how much per year, to identify the health and environmental risks of using RDF in Bangladesh. Individual workers from cement factories were the study unit. Then the data was compiled and analyses were made to generate relevant assessments.

A structured interview schedule in the Bengali language was used for face-to-face interviews with factory workers. Also, observations of the cement factory environment were carried out. No clinical tools were used for disease verification. Only reported symptoms were considered for the disease occurrence. Workers with prior respiratory diseases were also included in the study.

The interview schedule was translated (Bengali-English) and modifications were made accordingly as per the context like the usage of RDF, availability of RDF or others. Under occupational health risk, respiratory and musculoskeletal health problems were considered. Workers with at least one symptom of respiratory and musculoskeletal illness were considered to be exposed to respiratory health risk and musculoskeletal health risk respectively. Knowledge and practice-related questions were asked of participants. [32]

16. Targeted Cement Factories

A total of ten cement factories including 5 in Dhaka, 3 in Chittagong and 2 in Khulna were selected for the survey and research. Two types of individuals were selected, i.e., factory responsible person to detect the specific sources and usages of RDF and the factory workers to identify health and environmental risks of using RDF in Bangladesh.

17. Sample size

Questionnaire surveys with 10 factory workers and 10 with factory responsible persons and face-to-face interviews with 10 corporate officials from the targeted cement factories were done by the research team.

18. Ethics Statement

Approval for interviews was obtained from factory administration so that workers feel free to express their views. Informed and written consent was given before the interview. Participants were assured confidentiality of their responses and were not lured to participate in the study. Workers queries in the research area were clarified after the interview [32].

19. Timeline

Aug 22 Sept 22 Oct 22 Nov & Dec 22 Jan & Feb 23

20. Findings

After about 4 months of study, the research team has made the following conclusions based on information collected from cement manufacturing companies and other related government officials and non-government activists. Information was collected from government departments, but there was no clear and enough information. Because they only have the legal fuel export and import information but they do not have the information regarding illegal trade. But the communication with them helped the research team to find out the types of fuel which are being using in cement kilns and the diseases it is causing to the workers. All the collected information is described under the headings below:

The research team conducted questionnaire survey among the factory workers and factory responsible persons. In total 30 questionnaires were for factory responsible persons and 30 were for workers. All the questions were focusing on the type of fuel, diseases etc. The survey results are as follows:

20.1. Type of fuel

The study revealed that 80 % respondents used coal as fuel. 10% used gas in their cement plant and 9.99% used other fuels like wood, oil and others. No one directly informed us about the usage of RDF or other fuels but 0.01% said that, there is use of plastics, papers, tyres or textile wastes in some brick fields or cement kilns.

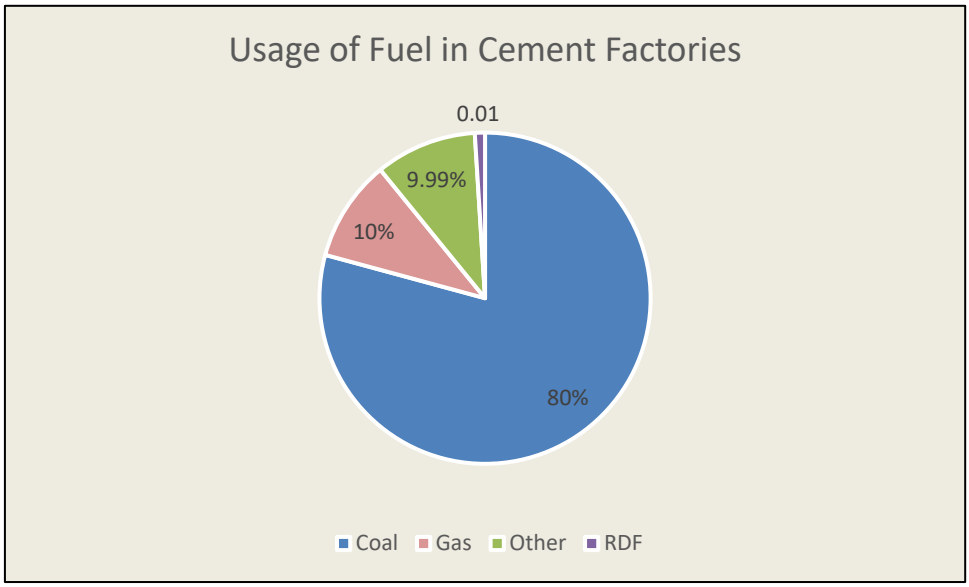

Figure: Different types of fuel used in cement kilns.

20.2. Type of Disease

The workers in a cement factory were facing different types of diseases. Most of them said that, they have respiratory disease, 25% have allergy problem, 15% have skin disease and 5% have other different types of disease.

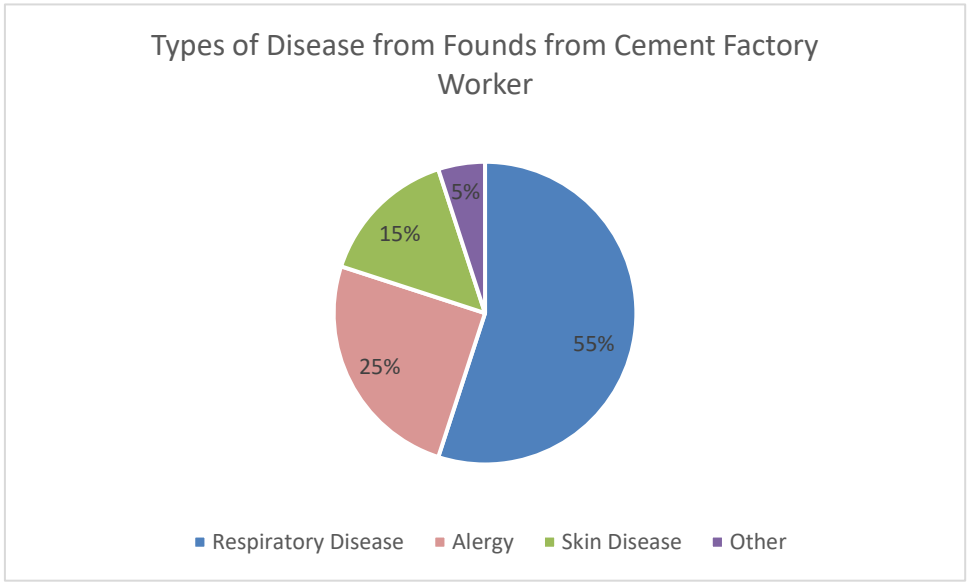

Figure: Different types of disease which affect the worker or people near cement factories.

20.3. Knowledge about RDF

90% of respondents claimed they were unfamiliar of RDF. However, they have noticed that waste products are burned in certain industries, such as boilers and brick kilns. 10% of respondents claimed to be informed about RDF as a commercially viable product. However, they believe that burning RDF also carries the risk of air and water pollution.

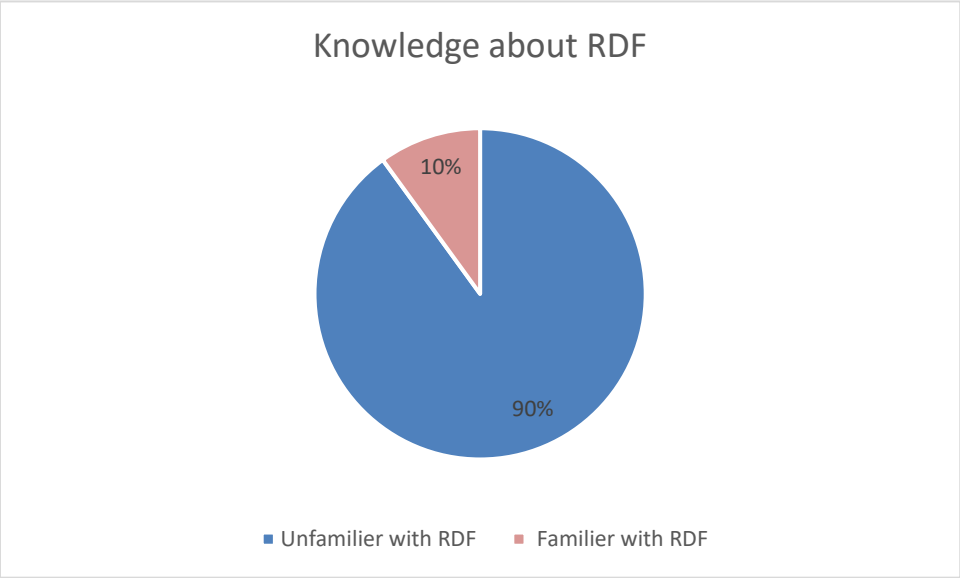

Figure: Familiarity with RDF

20.4. The use of RDF should be prohibited or not

The survey team talked to the respondents about the effects of using RDF as the majority of them were unfamiliar with it. The team informed them of the adverse effects burning RDF does to the environment and human health. Despite being cost-effective, it has long-term detrimental effects on both health and the environment. Once informed of these adverse impacts, 95% of respondents then said, yes, the usage of RDF should be prohibited if someone is illegally burning RDF or waste products. 5% of respondents responded that no, we ought to give it some thought because it is cheap and a possible option for managing our waste.

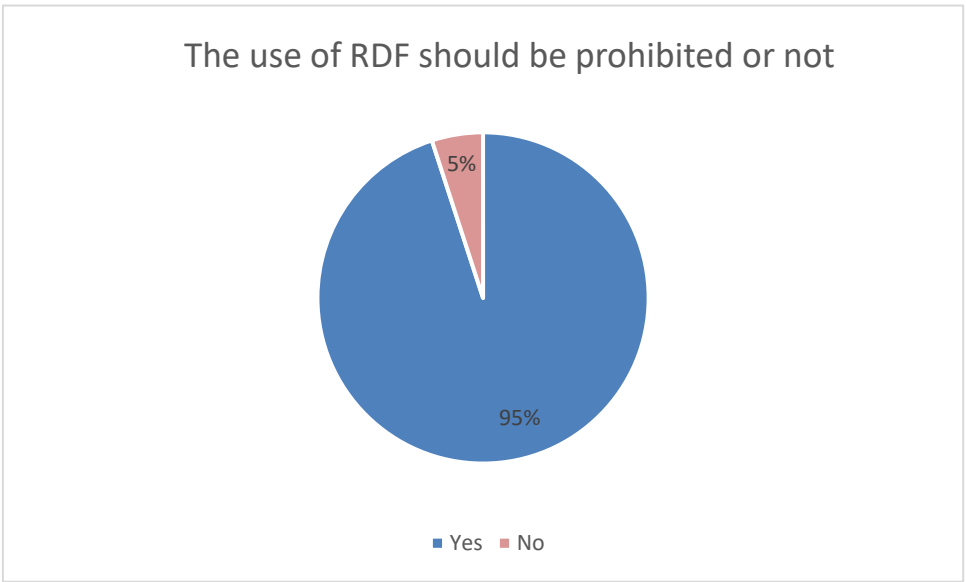

Figure: The use of RDF should be prohibited or not

21. Use of Refuse-Derived Fuels by the Cement Industry

In Bangladesh, the responsible persons for cement factories said that they mainly use traditional fuel such as oil, gas and coal. One respondent said that they only use diesel as fuel in their kiln, they do not use any other fuel. Another respondent told us that they use natural gas supplied by a government company. They do not have knowledge about RDF. As we were restricted to make photos of the cement kilns, we did not get permission to take photographs within the factories. But we found plastic or tyre storage and recycling areas near the cement factories we visited. Although we did not learn where these plastics or tyres were used, we think that there is a chance they were used as a fuel in the cement factories.

22. RDF Production in Bangladesh

The Municipal Solid Waste (MSW) to Solid Recovered Fuel (SRF) Production Plant, Sirajgang, Bangladesh project has received approval to import RDF/SRF at a 1:1 ratio to production capacity. As a result, we now have the opportunity to import RDF/SRF into Bangladesh. This plant meets the UK/EU Environment Agency's requirement. According to the project objectives, this will save 100,000 tons of MSW going to landfill annually. Also, the finished product SRF will be used by cement kilns replacing coal. At present, Bangladesh produces more than 35,000 tons of MSW every day without having a proper disposal system. [19]. As per the Department of Environment (DoE), this project do not have any type of legal environmental clearance certificate from the government of Bangladesh to produce RDF. The project is only thinking about the waste management and SRF production. But they are not aware about the harmful environment and health impacts of burning SRF in cement kilns or brick kilns.

23. RDF Trade in Bangladesh

The government of Bangladesh does not have available data on the production of RDF, however, there is available data on waste pairings and scrap rubber. In Bangladesh, huge amounts of waste parings and scrap rubber are produced. Tyres are dumped everywhere after use. A number of shipments are sent from Bangladesh to other countries. They use the HS code 4004 and 400400 for these types of waste products. Waste parings and scrap or plastics are also exported to other countries from Bangladesh under the HS code 3915.

Export Data (2022)

HS Code	Product	Quantity (kg)	Country
4004	Waste, parings and scrap of rubber (other than hard rubber) and powders and granules obtained therefrom	7000	China

400400	Rubber; waste, parings and scrap of rubber (other than hard rubber) and powders and granules obtained therefrom	7000	China
3915	Waste, parings and scrap, of plastics	514110	United Kingdom

[37]

Figure 3: Tyre wastes infront of a tyre recycling station, Keraniganj, Dhaka (ESDO, 2022).

24. Government Laws and Policies

There is growing support from the government of Bangladesh for the production of RDF and PEF or TDF and its use in cement kilns, boilers or other incinerators as a solution to the waste crisis. WTE is also pushed as one of the quick fixes for the plastic problem. The "Feasibility Study on Waste to Energy Conversion in the Keraniganj Area of Dhaka City (Bangladesh)" report is completed and submitted. This report states that concerned citizens, including those who may be directly affected by the related facilities (i.e., where the operations will be conducted), are not given the full information on risks and impacts. In most cases, respondents reported only being informed on the benefits of PEF/RDF or WTE use, which is to provide a

quick and easy solution to the growing waste problem. But they are not warned of the potential long term health hazards of living in the vicinity of facilities which use PEF/RDF [18].

25. Existing laws and policies on waste management

In dealing with the dreadful environmental conditions of the country, a series of environmental laws were passed. There are more than 200 area specific laws that are in force dealing with environmental issues in Bangladesh. They are largely focused on soil use, soil and toxic water waste, sound, noxious chemicals, unyielding waste, forest preservation, flora and fauna protection, mineral resources, coastal management, industry, ecological wellbeing and hygiene etc. In Bangladesh, prior to 1995, there was not an all-inclusive piece of legislation to comprehensively describe the term 'waste'. However, the Environment Conservation Act, 1995 provides a relatively sound meaning of 'waste' despite the fact that it is not applicable for each and every one purpose, although there is no all-inclusive legal framework related to waste management in Bangladesh. However, there are a number of area specific legislation dealing with waste disposal in Bangladesh [31].

25.1. The Environmental Conservation Act, 1995

The Environmental Conservation Act, 1995 is at present the key legislative framework for protecting the environment in Bangladesh. The key stipulations of this Act include guidelines for vehicles emissions injurious for the atmosphere, environmental clearance certificate, regulation of the industries and other documents, promulgation of standards for quality of air, water, noise and soil for different areas for different purposes, promulgation of standard limits for waste production and disposal. The Director General (DG), Department of Environment (DoE) has the power to shut down actions considered injurious to human life or the environment. Any person affected or impacted by toxic waste may submit an application to the DG for damages, declaration of an area affected by pollution as an ecologically critical area (Section 5, ECA, 1995).

The Act covers the entire environmental disorders with a view to conserving, improving, controlling and mitigating pollution of the environment [31].

25.2. The Bangladesh Labour Act, 2006

Bangladesh is a party to the Basel Convention on the Control of Transboundary Movement of Hazardous Waste, and the Stockholm Convention. Hazardous waste management remains a moderately unpublicized part of the industrial progress of Bangladesh. In 1996, Bangladesh set a regulatory framework. There is a number of conventional courses of action and legislation that can support hazardous waste management and meet the requirements of the Basel Convention. Section 54 of the Bangladesh Labour

Act, 2006 provides that "effective arrangements shall be made in every establishment for disposal of waste and effluents due to the manufacturing process carried on therein". Section 351 prescribes "arrangements are to be made in an establishment for disposal of its wastes and effluents or for requiring approval from prescribed authority for such arrangements" [31].

25.3. Bangladesh Import Policy Order 2015-2018

The import of any type of plastic waste or scrap is totally prohibited in Bangladesh according to the import policy (2015-2018).[45]

25.4. Solid Waste Management Regulations, 2021

The Ministry of Environment, Forest and Climate Change (MoEFCC) of the Government of Bangladesh published the Solid Waste Management Regulations on 23 December 2021. In the Rules 10 (20) from Schedule 4, the waste-to-fuel conservation criteria are highlighted. The main points are as follows:

- Non-recyclable waste of 1000 kcal or above must be converted to fuel and not disposed of in landfills.
- High calorific value waste can be directly used for fuel production or can be produced using any technology for RDF preparation. In addition, these wastes can be used as feedstock for RDF production.
- High calorific wastes may be used for co-processing by cement plants or other similar industries or individual operators for fuel production.
- A city corporation, municipality or any individual operator can take up waste-to-energy projects [11].

26. Environmental and Health Effects of RDF

It is highly inaccurate to state that the burning of waste-derived fuels such as TDF does not produce hazardous materials. It is an established fact that burning tyres in the open is extremely harmful to human health and the environment. The fumes emitted are contaminated with several toxic chemicals that tyres contain such as volatile organic compounds like benzene, metals such as lead, polycyclic aromatic hydrocarbons such as benzopyrene, and synthetic rubber components such as butadiene and styrene. Additionally, the chlorine content in tyres leads to the creation of dioxins and furans, which are extremely toxic chemicals [8].

Because the burning of RDF emits toxic gases such as CO_2 and other greenhouse gases, its illegal use should be strictly prohibited. Gas emissions pollute the environment and are hazardous to human health. It also has an impact on workers and those who work in the cement industry.

According to the statistics 5 percent of greenhouse gases in the world is produced in these plants. Carbon dioxide, carbon monoxide and other toxic gases pollute the air and trap the heat and increase the global temperature which causes global warming. Carbon dioxide a dominant greenhouse gas is firmly connected to global warming and climate change. This should lead to an increase in soil, water and air temperature, and causing extreme weather conditions or storms [8].
Lastly, burning waste and contaminated plastics creates a greater environmental impact than burning the equivalent oil they are made from.

RDF plants emit toxic gases into the environment such as dioxins and furans. These are known persistent organic pollutants (POPs) regulated by the Stockholm Convention. They degrade very slowly in the environment and mostly affect humans through the food they consume or the air they breathe. Even from a distance, these pollutants easily affect the environment and human health through the wind and ocean currents [13].[11]

According to Greenpeace, people who live near and work with incinerators that burn waste, including RDF, are vulnerable to adverse impacts on their health. Because of the high levels of dioxins and furans, adults and children, are prone to cancer, heart disease, respiratory problems, immune system problems, allergies, and congenital abnormalities [29].[12]

The potential pollutants generated from burning of RDF or waste products create toxic loading on environment, leads to contaminated water, land pollution and air pollution. The smog is responsible for contributing low ozone and vegetative damage. By mixing with water a cancer-causing agent PAHs are incorporating into fish and other species.

Table: Potential pollutants generated from burning of wastes and their health and environmental effects.

Potential pollutant generated from burning of wastes	Health effects	Environmental effects
Carbon Monoxide	Causes dizziness, headaches and slowed reflexes. Affects mental function, visual acuity and alertness	Oxidized to carbon dioxide (which is a greenhouse gas) in the atmosphere
Dioxins and Furans	May cause cancer; causes growth defects; affects DNA; affects immune and reproductive systems	Increased toxic loading on environment; leads to contaminated water/land or air.
Polynuclear Aromatic Hydrocarbons (PAHs)	Cancer causing agent in most animal species including mammals, fish and birds	Increased toxic loading on environment, leads to contaminated water/land, air.
Volatile Organic Compounds (VOCs)	Directly toxic including problems ranging from cancer	Contributes to low level ozone (smog), causes vegetative

[11] https://www.no-burn.org/wp-content/uploads/RDF-Final.pdf
[12] https://www.dioxinnz.com/pdf-X-greenpeace/GP-archive-rpts-euincin-01.pdf

	risks to nervous disorders. Causes respiratory irritation/illness, chronic lung disease	damage.
Particulate Matter (PM)	Irritation of respiratory tract, aggravated asthma, contributes to chronic obstructive pulmonary disease	Causes air, water and soil pollution by mixing with them.
Aldehydes	This is a animal carcinogen. Causes eye and respiratory illness and headaches	Increased toxic loading on environment, leads to contaminated water/land and air.

27. Lack of Accessibility of Information on the Use of RDF

One challenge that this study encountered was the difficulty in accessing and obtaining data on the use of RDF. As noted above, there is no readily available information on RDF use, neither from government sources nor from private sector proponents and users.

This study also shows that information on users of imported or exported RDF is not readily available. Local users are not interested and some of them do not even know about RDF. Some of the environmental groups and civil society organizations have raised the alarm on waste management and alternative use of waste recently, but still, there is lack of certified SRF production system in Bangladesh. However, so far government officials and users of these materials – in particular cement industry players – have not heeded these calls and have only spoken about the "positive benefits" of its use. They cite the potential to quickly and conveniently dispose of mounting piles of garbage, and a "renewable" source of energy, which can also give additional revenues to local governments in the form of energy savings and sales.

This is due to the fact that waste management laws and facilities are not being fully and properly implemented. The poor implementation of waste management laws also increases the risk of using mixed waste in facilities, both from local and foreign sources. Government authorities do not have the capacity to inspect all shipments that come in, or to properly monitor all facilities using RDF. There is a limited capacity of institutions to ensure the health and safety of the public when using these materials and technology. There have also been reports that proponents of WTE facilities are encouraging local governments to just place all their garbage – without any sorting or segregation – into incinerators and burners. The ongoing problem of illegal waste importation also adds "fuel to the fire". In recent years, the vigilance of environmental groups and concerned citizens have stopped the entry of illegal waste shipments – containers labeled as recyclable products, but which in fact contained mixed or municipal waste. Also, there are documented cases when imported PEF does not appear to be properly processed and mixed waste with plastic particles are visually present.

28. Recommendations for Using RDF

The following recommendations should follow:

- Authorities should prohibit the production and usages of RDF and find safer more effective alternative management of MSW.
- Each municipality should have their own solid waste collection facilities and environmental friendly disposal of the residual waste.
- Cement factories should restrict or prohibit the usages of RDF
- Strict Environmental rules should be followed during the disposal of the discharged gases from the industries (say cement factories, etc.)
- Public awareness should be strengthened to promote waste management and spread knowledge about the health and environmental impact of using RDF.
- Appropriate and adequate provisions should be made by the municipalities for the traceability, treatment and recycling of solid wastes.

29. Conclusions

A number of issues should be considered when using waste-derived fuels: first, energy efficiency of waste combustion in cement kilns; second, constant cement production and fuel quality; third, emissions into the atmosphere; fourth, trace elements and heavy metals; fifth, alternative fate of waste; and sixth, production of secondary waste. Potential disadvantages are the adverse effects on cement quality and producing emissions with increased content of harmful gases. It should be noted that emissions generally depend more on kiln operation conditions than on the type of fuel. The net emission reduction depends on the nature and characteristics of the waste and on the waste-treatment process that is displaced. Waste processing is feasible and is current practice in the cement industry. Cement plants are using waste as alternative fuel [14] [15].

But in Bangladesh, RDF is not currently used widely. There is a little record of legal RDF production in the country i.e., Sirajganj Bangladesh. The use of RDF or co-firing is very much dangerous to both human and environment. It creates greenhouse gases and release other toxic chemicals which will be harmful for all like marine and aquatic environment, human, biodiversity and others. The use of a large volume of RDF is not safe for the environment as well as the workers. The burning of waste fuel made from rubber, tyres, or plastic release dangerous gases into the environment. The emission of gases creates air pollution. The ashes from the clinker are hazardous for the workers of cement kilns. They would face serious health problems if exposed. So, we should prohibit the usages of RDF as soon as possible.

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Annexes

Annex1: Survey Questionnaires for Factory Responsible Officers.

Questionnaires for Factory Responsible Officers

Time: …… **Date: ……..** **Location……..**

Part-1 [Participant's Identical outline]	
Name of the cement factory	
Name of the responsible person	
Sex	Male Female
Age	≥ 19 20-29 30-39 40-49 ≤ 50
Designation	

Part-2 [Survey Questions]	
1. What is the name of the group of cement factory?	
2. What are the main products of your factory (Type of cements)?	
3. Which process do you follow for cement production?	☐ Dry Process ☐ Wet Process
4. What is the main fuel you are using in your cement kiln?	☐ Coal ☐ Gas ☐ Oil ☐ Others
5. If others then what?	
6. Do you have any idea about Alternative Fuels (RDF)?	☐ Yes ☐ No
7. Are you using RDF in your cement factory?	☐ Yes ☐ No
8. Type of the RDF/ alternative feuls	☐
9. From when, you are using RDF?	
10. What is the source of RDF? If abroad, which country	Home Abroad
11. How much RDF do you export per year?	
12. Do you think, RDF is harmful for environment?	☐ Yes ☐ No
13. Do you agree with us that the use of RDF should be prohibited?	☐ Yes ☐ No

Name of Interviewer:

Signature & Date

Annex 2: Survey Questionnaires for Factory Workers.

Questionnaires for Factory Workers

Time: …… **Date: ……..** **Location……...**

Part-1 [Participant's Identical outline]	
Name of the cement factory	
Name of the worker	
Sex	Male Female
Age	≥ 19 20-29 30-39 40-49 ≤ 50

Part-2 [Survey Questions]	
1. What are the challenges you are facing during working?	
2. Are you maintaining occupational health and safety?	☐ Yes ☐ No
3. Have you any health problem?	☐ Yes ☐ No
4. If yes, in which disease you are suffering from ?	
5. From when you are suffering?	☐ After working here ☐ Before working here
6. Have you taken any initiative to overcome the problem?	☐ Yes ☐ No
7. If yes, then what?	
8. Do you think that the environment of the working place and fuel you are using in the cement kiln is responsible for your health problem?	☐ Yes ☐ No
9. Do you agree with us to change the fuel you are using?	☐ Yes ☐ No

Name of Interviewer:

_____
Signature & Date

Annex 3: Permission Letter for Different Cement Factories.

Environment and Social Development Organization

ESDO no: AD/255/08/22 1st September, 2022

Managing Director
……..
Dhaka, Bangladesh

Subject: Application to take permission for survey study …….

Dear Concern,
Greetings from Environment and Social Development Organization – ESDO!

It is with great pleasure we would like you to know that ESDO is a non-profit and non-government organization based in Bangladesh. Since the official formation of ESDO in 1990, it is working for environmental conservation and has focused on generating knowledge amongst the wider community about how human activity can negatively impact on the environment of Bangladesh. ESDO strives to improve the livelihoods, the socio-economic status, and simultaneously the environmental education of some of the most vulnerable communities in Bangladesh.

The mission of ESDO is to promote and encourage an environmental movement through a participatory democratic framework involving diverse social groups, and to assist them with ideas, information, and leadership for promoting a safe, sustainable, and toxic-free world.

The vision of ESDO is to see Bangladesh, as well as all developing nations in Asia, Africa, and Latin America, achieved the Sustainable Development Goals, and in contributing to this works to protect and conserve the nature and life from toxic and plastic pollution; reduce poverty; increase literacy and education; empower women in rural communities, and improve sanitation and health services through sustainable environmental livelihood.

Now a days the factories and industries are concern about environment and health. We came to know that your cement factories also follow the rules and regulations about environment. So we want to conduct a survey in your factory to highlight your environment friendly activities.

We are going to conduct a survey study with around 10 cement industries in Bangladesh from 16th October 2022, to 27 October 2022 in three different project areas. If you grant our proposal to get permission for survey study in your cement factory, it will be grateful for us.

Thank you for considering the issue. We look forward to your positive response regarding the acceptance of the letter.

Sincerely,

Siddika Sultana,
Executive Director, ESDO

Member of .....
House # 8/1, Level # 5,Block# C, Lalmatia, Dhaka-1207, Bangladesh. Phone : 88-02-912-2729,
Fax : 88-02-913-0017, E-mail : info@esdo.org, URL:www.esdo.org

Annex 4: Solid Waste Management Regulations, 2021(Gazette)

(২১) জৈবিকভাবে পচনশীল বা অপচনশীল কঠিন বর্জ্য হইতে সম্পদ আহরণের লক্ষ্যে পরিবেশসম্মত পদ্ধতিতে কম্পোস্টিং, বায়ো-গ্যাস জেনারেশন, রিফিউজ ডিরাইভড ফুয়েল (RDF), সলিড রিকোভার্ড ফুয়েল (SRF), বিদ্যুৎ উৎপাদন, জৈব পচনশীল সার উৎপাদন ও বাস্তবায়নে অগ্রাধিকার প্রদান;

(২২) সরকারি ও বেসরকারি প্রতিষ্ঠানের সহিত যৌথ উদ্যোগ গ্রহণ এবং প্রয়োজনে পচনশীল কঠিন বর্জ্য বিনামূল্যে সরবরাহের ব্যবস্থা গ্রহণ;

(২৩) পুনর্ব্যবহার উপযোগীকরণ বা পুনঃচক্রায়নযোগ্য বর্জ্য সরকারি বা বেসরকারি প্রক্রিয়াকরণ কারখানায় প্রদান;

(২৪) কঠিন বর্জ্য প্রক্রিয়াকরণ ও পুনর্ব্যবহার উপযোগীকরণ কারখানা হইতে পরিত্যক্ত বা উদ্বৃত্ত এবং জৈবিকভাবে অপচনশীল বর্জ্য মানমাত্রা বজায় রাখিয়া স্যানিটারি ল্যান্ডফিল বা ভস্মীকরণের মাধ্যমে চূড়ান্তভাবে পরিত্যজন করা;

(২৫) নূতন সিটি কর্পোরেশন অথবা পৌরসভা প্রতিষ্ঠা করিবার সময় নগর ব্যবহার পরিকল্পনায় কঠিন বর্জ্য প্রক্রিয়াকরণ, পরিশোধন, পরিত্যজন এবং ল্যান্ডফিলের জন্য নির্দিষ্ট স্থান অন্তর্ভুক্তকরণ;

(২৬) কঠিন বর্জ্য চূড়ান্তভাবে পরিত্যজনের স্থানে উহার ব্যবহার শুরুর অন্যূন ১ (এক) বৎসর পূর্বে নির্বাচন এবং, প্রয়োজনে, উহা অধিগ্রহণের বিষয়ে পদক্ষেপ গ্রহণ;

(২৭) কঠিন বর্জ্য দ্বারা ভূমি ভরাটস্থল নির্বাচনের ক্ষেত্রে পরিবেশগত প্রভাব নিরূপণ; এবং

(২৮) উৎসে বর্জ্য হ্রাস ও উৎসে বর্জ্য পৃথককরণের বিষয়ে জনগণের মধ্যে সচেতনতা সৃষ্টির লক্ষ্যে উদ্বুদ্ধকরণ কর্মসূচি গ্রহণ।

১১। **অন্যান্য কর্তৃপক্ষের দায়িত্ব।**—অন্যান্য কর্তৃপক্ষের দায়িত্ব হইবে নিম্নরূপ, যথা :—

(ক) পরিবেশবান্ধব ও স্বাস্থ্যসম্মত উপায়ে কঠিন বর্জ্য ব্যবস্থাপনা কার্যক্রম সম্পাদন এবং তফসিলসহ এতৎসংশ্লিষ্ট নির্দেশনাবলিতে বর্ণিত পদ্ধতি অনুসরণ;

(খ) স্ব স্ব এলাকা, স্থাপনা বা গণপরিবহনে স্বীয় ব্যবস্থাপনায় বা নিয়োজিত ব্যক্তি, ঠিকাদার বা প্রতিষ্ঠান দ্বারা জৈবিকভাবে পচনশীল কঠিন বর্জ্য, জৈবিকভাবে অপচনশীল কঠিন বর্জ্য ও গার্হস্থ্য ঝুঁকিপূর্ণ কঠিন বর্জ্য ৩ (তিন) শ্রেণিতে পৃথকভাবে সংগ্রহ করা এবং নদ-নদী, পুকুর বা জলাধারে কোনো প্রকারের বর্জ্য নিক্ষেপ বা পরিত্যজন বন্ধে প্রচারণার উদ্যোগ গ্রহণ;

(গ) সংগৃহীত কঠিন বর্জ্য সংশ্লিষ্ট স্থানীয় সরকার কর্তৃপক্ষ কর্তৃক নির্ধারিত স্থানে বা নিজস্ব ব্যবস্থাপনায় পরিত্যজনের যথাযথ ব্যবস্থা গ্রহণ;

(ঘ) যাত্রীবাহী বাস, ট্রেন বা নৌযান হইতে সৃষ্ট কঠিন বর্জ্য নিজস্ব ব্যবস্থাপনায় পরিবেশসম্মতভাবে সংগ্রহ এবং স্থানীয় সরকার কর্তৃপক্ষ কর্তৃক নির্ধারিত স্থানে পরিত্যজনের ব্যবস্থা গ্রহণ;

তফসিল ৪
[বিধি ১০ (২০) দ্রষ্টব্য]

বর্জ্য হইতে জ্বালানিতে রূপান্তরের মানদণ্ড

১। ১০০০ কিলোক্যালরি বা তাহার উর্ধ্বে অ-পুনঃচক্রায়নযোগ্য বর্জ্যকে জ্বালানিতে রূপান্তরের জন্য ব্যবহার করিতে হইবে এবং ল্যান্ডফিলে উহা নিষ্পত্তি করা যাইবে না।

২। উচ্চ ক্যালরিফিক মানসম্পন্ন বর্জ্য সরাসরি জ্বালানি উৎপাদনে ব্যবহার করা যাইবে অথবা রিফিউজ ডিরাইভড ফুয়েল (RDF) প্রস্তুতের জন্য যেকোনো উপযুক্ত প্রযুক্তি ব্যবহার করিয়া উৎপাদন করা যাইবে। ইহা ছাড়াও এই সকল বর্জ্য রিফিউজ ডিরাইভড ফুয়েল প্রস্তুতের জন্য ফিড স্টক হিসাবে ব্যবহার করা যাইবে।

৩। উচ্চ ক্যালরিফিক বর্জ্য সিমেন্ট প্ল্যান্ট বা অনুরূপ অন্য কোনো শিল্প প্রতিষ্ঠানে কো-প্রসেসিং এর কাজে অথবা স্বতন্ত্র অপারেটরে জ্বালানি উৎপাদনের জন্য ব্যবহার করা যাইবে।

৪। সিটি কর্পোরেশন, পৌরসভা বা যে কোনো স্বতন্ত্র অপারেটর বর্জ্য হইতে জ্বালানি উৎপাদনের প্রকল্প গ্রহণ করিতে পারিবে।

Environment & Social Development Organization – ESDO
House # 8/1, Level # 5, Block # C, Lalmatia,
Dhaka-1207, Bangladesh
Website: http://esdo.org/