Achieving Further Reductions of Energy Consumption and CO_2 Emissions in an Efficient Mexican Industry: The Case of the Cement Industry

L. Ozawa-Meida, N.K.Tovey, and S.P. Gerrard
University of East Anglia, School of Environmental Sciences

ABSTRACT

The objective of this paper is, through a stakeholders' analysis, to explore the strategies of the Mexican cement industry to achieve further reductions in energy consumption and carbon dioxide emissions. The main stakeholders identified are: managers of the companies in this industry, members of governmental institutions and members of environmental non-governmental organizations (NGOs).

This stakeholders' analysis intends to explain the conflicts that exist between the identified targeted groups. It is important to understand: 1) the drivers of this industry and the main barriers that the companies are currently facing; 2) the government efforts that remove barriers or that enhance the active participation of this industry in the emission-trading markets through the Clean Development Mechanism; finally, 3) the cooperation of environmental non-governmental organizations and local communities is important in order to use alternative fuels in substitution of the fossil fuels in the cement kilns.

In order to explore and examine the viewpoints of the stakeholders, 30 face-to-face semi-structured interviews were carried out. The selection of the interviewees and the content of the semi-structured interviews varied according to the targeted group of stakeholders. This paper summarises the information gained during the series of recent interviews between November 2002 and February 2003. It is then intended that the results be analysed further using open coding to disaggregate the qualitative data into different categories, then axial coding to recognize the relationships between the categories, and finally, a selective coding to integrate the categories.

Introduction

The cement industry contributes about 5% to the global anthropogenic carbon dioxide (CO_2) emissions (Worrell, et al. 2001). The CO_2 is emitted from the calcination of the limestone, the fuel combustion at the kiln, the electricity used at the grinding stages, and in the transport of raw materials.

The Mexican cement industry is the 12th largest cement producer in the world and it contributes about 2% of the global cement CO_2 emissions (Worrell, et al. 2001). At a national level, this industry contributed about 6% of the national CO_2 emissions in 1998.[1]

Worrell (1995, 2001), Ruth (2000) and Ellis (2001), among other researchers, have analysed some factors that influence the energy and GHG intensity in the cement

[1] The total CO_2 emissions in 1998 were 107.6 million metric tonnes of carbon (MMTC) (394,726 Gg CO_2) (including carbon sequestration) (INE 2000), of which the Mexican Cement Industry was responsible for 4.2 MMTC (15,395 Gg CO_2) due to the limestone calcination (INE 2000) and 2.6 MMTC (9,421 Gg CO_2) due to fuel combustion [estimated from energy consumption data and IPCC carbon emission factors].

manufacturing. According to their studies, these intensities depend on: 1) the fuel used in the main processes (raw material preparation, pyroprocessing and cement grinding), 2) the technologies for cement manufacturing, 3) the types of cement produced, 4) the proportion of clinker in the cement manufactured, 5) the properties of the raw materials and 6) the GHG intensity of the electricity used. Different strategies for mitigating CO_2 emissions from this industry have been proposed, such as improving energy efficiency in the main process stages, increasing the production of blended cements and using alternative fuels from waste (CEMBUREAU 1998). To some degree, cement manufacturers can influence the variables in their plants. However, the factors are also influenced by other constraints, such as the availability and price of different energy sources, their finances for acquiring new technologies, national legislation for blended cement manufacturing, environmental legislation for burning wastes on the rotary kilns, and demand of different types of cement according to their specifications (Ellis 2001).

On the other hand, government policy instruments such as voluntary agreements, energy efficiency standards, energy/carbon taxes, and tradable CO_2 credits, among others, can encourage emissions reductions (Humphreys & Mahasenan 2002). For Mexico, as a "non-Annex I" party, the Clean Development Mechanism is the only flexible mechanism of the Kyoto Protocol for trading carbon emission reduction credits with other parties.

With regard to the Mexican cement industry, it is relatively homogeneous and efficient in its 29 plants inside the country.[2] In the last decade, high domestic energy prices and the economic globalisation process have challenged the Mexican cement industries, and they have had to invest in the best available technologies to improve their productivity and to reduce their operational costs. Most of these plants have introduced energy efficiency and eco-efficiency programs in order to use efficiently non-renewable resources, and improve their image as well as their competitiveness in the national and international markets. In 2000, the specific primary energy consumption (SEC_p)[3]of this industry was 3.9 million BTU per ton of cement (4.5 GJ/tonne of cement), while the carbon emissions intensity was 0.195 metric tonne of carbon (MTC) per ton of cement (788.3 kg CO_2/tonne of cement) (CANACEM 2000; SENER 2002, 105).[4] From a technical viewpoint, there will probably not be many technological options in the Mexican cement industry due to its high efficiency performance. Further improvement on environmental performance of cement companies is seen as lying in increased in-house responsibility, i.e., a process of continuous improvement through the implementation of environmental management systems or eco-efficiency programs (Quervain 1997). In addition, the increase of blended cements production and the use of waste as an alternative fuel in the cement kilns can be attractive options for an

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[2] Currently, 29 cement plants, owned by 6 companies (CEMEX, Apasco, Cruz Azul Cooperative, Chihuahua Cement, Portland Moctezuma, and LaFarge), are operating across the country.

[3] The specific energy composition in primary energy terms (SEC_p) is given by:

$$SEC_{p,t} = SEC_{f,t} + SEC_{e,t}/\eta_t$$

where SEC_f is the specific energy consumption for fossil fuels in the year t, SEC_e is the specific energy consumption for electricity in the year t, and η_t is the electricity generation efficiency in year t.

[4] The carbon emission factor for cement production was 0.127 MTC per ton of clinker (0.517 tonne CO_2/tonne clinker) (NAEI 2002). Due to the lack of availability of clinker data for 1970 and 2000, an average of clinker/cement ratio for available years were considered as 0.89. The carbon emissions for fossil fuels are based on IPCC (1996). The carbon emission factor for electricity consumption in 2000 is 54.8 MMTC per quadrillion BTU (190.5 tonne CO_2/TJ) (IPCC 1996, 1.6; SENER 2002, 127).

efficient use of resources and an environmentally-safety disposal of waste without a significant increase of CO_2 emissions. There could be some barriers to implement the options mentioned above like financing, policy, legalities, public and technical knowledge and information, market, and institutions.

The paper addresses these issues by first considering the basic methodology adopted. A section on the strategies to improve energy efficiency and reduce CO_2 emissions follows, and this is subdivided into Technological Change, Environmental Management Systems, Fuel Substitution, Production of blended cements, and Carbon Emission Credits.

Methodology

According to Brown and colleagues (2001), stakeholders are the persons, organizations or groups with power as well as those with no influence. In particular, Hund (2002) defines that "the stakeholders for the cement industry are all individual and groups who see themselves as potentially affected by or who can impact cement operations at the local, national or international scale. This includes neighbours, community organizations, employees, trade unions, governmental agencies, the media, non-governmental organizations (NGOs), contractors and suppliers." For the purpose of this study, the following groups of stakeholders were selected in the issues related to the cement industry: 1) corporate and plant managers as well as members of the ecology commission of the Industrial chamber (industrial viewpoint); 2) members of governmental institutions related to industry and Climate Change (institutional viewpoint); and 3) environmental NGOs (social viewpoint).

This paper is based on the content of thirty face-to-face interviews that were carried out with members of the cement industry, governmental institutions and environmental NGOs in Mexico between November 2002 and the end of February 2003. The sample included thirteen interviews with managers of the cement industry, thirteen with members of governmental institutions, and four with campaigners of environmental NGOs.

The selection of face-to-face semi-structured interviews as the qualitative strategy was related to the exploratory and explanatory nature of the study. Most of the questions asked in the interviews were open-ended and they intended to understand the reasons behind the opinions of the respondents. The semi-structured interviews also provide the opportunity to discuss areas that were not previously considered, but that can be significant in understanding and addressing the research questions (Saunders et. al. 2000).

The governmental institutions and their members were selected according to their participation on the Climate Change Inter-ministerial Committee or their interaction with industry regarding energy and environmental policies. The environmental NGOs were selected based on their involvement on industrial issues. Finally, environmental and production managers were selected within the cement industry due to their knowledge about environmental performance and energy efficiency issues of their plants or corporate groups. It is important to mention that all the interviewees of the cement industry requested to be reported anonymously, i.e., without mentioning their corporate group, position, plant and personal name. Therefore, the citations are written according to corporate group (A, B, C, D, E, and F) and to cement plant or corporate interview (corporate, plant 1, plant 2…). The citations are given in two forms. Where they are the actual words said, these are enclosed in inverted commas. Where the quote has been modified – e.g. to incorporate more than one response, these are left without quotes, but properly acknowledged at the end.

Interviews ranged from one to two hours, depending on how much respondents had to say. The transcripts of the interviews provide a set of qualitative data that is separated in meaningful and related parts called categories. The categorization allows the identification of key themes, so the data is consequently reduced and rearranged in different matrices. The matrices with data are refined continuously, because within existing categories the relationship between categories and new categories can emerge. At the time of writing, the data are being disaggregated into units (open coding), relationships between categories are being recognized (axial coding), and the categories will then be integrated to produce the final findings (selective coding) following the method of Strauss & Corbin (1998). The research approach intends to explore inductively the qualitative data derived from the interviews. Thus, it seeks to build up findings which are adequate to the Mexican context and, if possible, to a number of similar cases. This approach is known as "grounded theory".

Strategies to Improve Energy Efficiency and Reduce CO_2 Emissions

Members of governmental institutions and members of environmental NGOs perceive that the environmental behaviour of industry is mainly driven by the following factors: compliance of environmental legislation, competitiveness in the national and international markets due to the globalisation phenomena, economic benefits and image.

The cement industry recognises itself as a great contributor of CO_2 emissions due to the chemical reactions in clinker formation and the fuel combustion for achieving the high temperatures requirements. In addition, within the cement manufacturing, energy costs (fuels and electricity) represent around 50% of the total production costs per tonne of cement (Foster, 1996). Hence, the reduction of energy consumption is considered as fundamental to achieve economical and environmental benefits.

A fundamental component of survival in the national and international markets is the search for competitiveness, and within this quest, energy efficiency and environmental programmes became an essential guideline. The implementation of Environmental Management Systems (EMS), in particular, has encouraged continuous in-house improvements of processes and practices in several companies. Through EMS, companies have identified the opportunities to reduce their production costs, to generate profits and improve their image.

Technological Change

The modernisation and the expansion of the installed capacity with more energy efficient technology were carried out strongly since the 1980s. In the last two decades, seven new plants started up with the best technologies for cement manufacturing, such as short kilns with pre-heater/precalciner, vertical mills, horizontal mills, high efficiency separators for the grinding systems, process control, and raw material analysers; as well as pollution control equipment such as filter bags and electrostatic precipitators. On the other hand, six plants with obsolete technologies were decommissioned due to their low productivity or due to their high polluting emissions in critical areas like Mexico City. In 2000, total cement installed capacity was 51.3 million tons (46.5 Mtonnes) (CANACEM 2000). The entire cement industry uses the dry process; and about 75% of the clinker capacity consists of dry kilns with pre-heaters or precalciners (CEMBUREAU 1996, 110-120), which is at present the most energy efficiency technology.

Smaller scale energy efficiency projects such as the modification and substitution of equipment are conducted in the existing plants according to financial and production priorities of the companies. Two important aspects for decreasing thermal energy consumption are the improvement of combustion efficiency and heat recovery. Some plants are acquiring low NO_x burners and gas monitoring systems for improving the combustion efficiency [Group C, corporate, cement industry, interview, February 2003; Group F, plant 1, cement industry, January 2003]. With regard to heat recovery, kiln and cooler exhaust gases are used at other stages of the process for drying materials at the grinding systems, for preheating the air introduced in the precalciner, and in some cases for preheating the fuel oil. [Group C, plant 2, cement industry, interview, November 2002; Group E, plant 1, cement industry, interview, December 2002; Group F, plant 1, cement industry, interview, January 2003]. As regards to the reduction of electricity use, some environmental managers mentioned the installation of efficient DC motors, variable speed drivers, variable speed fans and capacitors to improve the power factor [Group C, plant 2, cement industry, interview, November 2002; Group F, plant 1, cement industry, interview, January 2003]. In addition, some cement companies have examined cogeneration as an opportunity for energy efficiency, secure electricity supply, and CO_2 reduction [Group B, corporate, cement industry, interview, November 2002; Group C, corporate, cement industry, interview, February 2003]. However, the main barriers mentioned were the lack of a clear definition in the legislation due to the slow progress in the current Electric Reform, the minimum economic benefit due to the current price per kilowatt-hour, and the lack of incentives and governmental support [Group C, plant 1, cement industry, interview, January 2003; Group C, plant 2, cement industry, interview, November 2002; Group F, plant 2, cement industry, interview, January 2003].

The companies are always looking for a cost-effective operational margin with maximum profits. One environmental manager considered "…payback periods of 2, 3, 4 or 10 years are still attractive" [Group F, plant 1, cement industry, January 2003]. However, some respondents believe that there is a current market recession that hinders the investment recuperation [Group A, corporate, cement industry, interview, November 2002; Group F, plant 1, cement industry, January 2003]. Besides, one environmental manager perceived that there is low access to financial resources with focus on environmental and energy efficiency issues, and that loans and credits for this type of investments are poorly developed in Mexico [Group B, plant 2, cement industry, interview, January 2003]. With regard to this issue, the National Commission of Energy Savings (CONAE in Spanish) is currently conducting efforts with commercial banks and financial institutions in order to develop this type of credit lines [CONAE, finances and environment director, governmental institution, interview, November 2002].

Finally, one environmental manager considered that additional reductions of thermal energy consumption in the cement kilns are limited without technological innovations [Group F, plant 1, cement industry, interview, January 2003].

Environmental Management Systems

In the last decade, most of the cement plants conducted voluntary environmental audits. Subsequently, global cement companies in particular began implementing Environmental Management Systems (EMS), which normally includes continuous improvement, pollution prevention and a systematic environmental auditing process. Currently, all the plants have received the award of "Clean Industry." In addition, fourteen out of 29 cement plants (48.3%) satisfy the international environmental standard ISO14000.

Some of the benefits that environmental managers perceive of the EMS are that they do not only examine state of the art technologies for the process and for pollution prevention, but also good practices and procedures at the operation that allows further reductions of energy consumption [Group B, plant 1, cement industry, interview, January 2003; Group B, plant 2, cement industry, interview, January 2003]. Some of the practices mentioned by one manager were: optimising air introduced in the kiln, searching the optimal chemical composition of the raw materials, and introducing raw meal in the kiln with an adequate fineness, among others [Group F, plant 1, cement industry, interview, January 2003].

In addition, the EMS have aimed not only at compliance with environmental regulations, but also for responding to public and market demands. As one manager of a cement plant stated: "EMS have several benefits, not only in the economic sense. First, they aim to accomplish the legal compliance of the Mexican environmental regulation. Second, they guide you to reduce pollution. Third, in the social aspect, they benefit the public image. Fourth, they are important for the health and safety of the employees and the local communities. Finally, they open opportunities at the markets" [Group B, plant 1, cement industry, interview, January 2003].

From the viewpoint of members of the governmental institutions and environmental NGOs, the environmental performance of the cement industry has improved at the same time that the environmental legislation has progressed. They also perceived that EMS have guided the cement industry to reduce their environmental impacts, to achieve economic savings, and to improve their image and relationship with the communities [SEMARNAT, industry regulation director, governmental institution, interview, November 2003; PROFEPA, environmental auditing sub-officer, governmental institution, interview, November 2002; UGAM, NGO, interview, November 2002; CEMDA, air and energy co-ordinator, NGO, interview, December 2002]. In spite that environmental NGOs acknowledge the efforts of the cement industry, they still consider that this industry have environmental impacts, such as dioxins and furans emissions, that it must reduce.

EMS can be a crucial factor for the use of waste fuels, because this practice requires the acceptance by the public, by the employees, and by the environmental authorities. The environmental management systems can create the necessary transparency. With regard to public information and transparency, the environmental legislation was modified on December 2001 in order that the industrial registration of emissions and transference of pollutants (RETC in Spanish) become obligatory for the entire sector and its environmental information become public. Members of environmental NGOs consider it as a good governmental instrument for information to the society [Greenpeace Mexico, toxics campaigner, NGO, interview, November 2002; UGAM, NGO, interview, November 2002]. From the industrial viewpoint, one environmental manager believes that this registration will not affect considerably the public image of the cement industry. The main concern is the competition: “For example, it is not convenient for me that ‘Group C’ knows how many alternative fuels I am using because it is my competitor” [Group A, corporate, cement industry, November 2002].

Fuel Substitution

Cement kilns have been intensive users of fuel oil and natural gas. Electricity has been mainly used for grinding and cooling. Diesel has been used minimally for transportation, fuel oil preheating and pumping. Fuel requirement in the kiln is about 75% of the total energy consumption for cement manufacturing. During the last decade, the participation of natural gas in the fuel mix increased slightly initially. However, due to the scarcity of natural gas supply and its volatile price, several cement plants began substituting it by pet coke and coal [Group B, plant 1, cement industry, interview, January 2003; Group B, plant 2, cement industry, interview, January 2003; Group F, plant 1, cement industry, interview, January 2003]. According to a cement company, “this strategy aims to secure a consistent supply of energy and minimize price volatility and optimise global and regional energy costs (capitalising synergies and economies of scale)… The company has developed a diversified fuel structure in which almost 80% of its fuel cost is based on sources with low price volatility” (CEMEX 2000). However, one member of a governmental institution considers the use of coal as a regression concerning to energy efficiency and emissions reduction [SEMARNAT, RETC director, governmental institution, December 2002].

With regard to electricity, some companies are examining and implementing alternative power generation such as wind power and CFB (coal fluidised bed) [CANACEM, ecology commission, cement industry, December 2002] (de Aguinaga et. al. 1999). The CFB plant is currently in operation, while wind power is still facing the barriers mentioned for cogeneration.

Waste-Derived Alternative Fuels

The great debate between environmental NGOs, environmental authorities, legislators and the Mexican cement industry is related to the waste incineration for energy recovery in cement kilns [Greenpeace – Mexico, toxics campaigner, NGO, interview, November 2002; UGAM, NGO, interview, November 2002].

Environmental authorities and cement manufacturers consider the cement kilns as viable co-incinerators of waste due to their operational characteristics such as high temperatures (1450^{o}C), high flame temperatures (2000^{o}C), long residence time of gases (5 to 6 seconds above 2000^{o}C) and fixation of heavy metal traces in the clinker structure [SEMARNAT, industrial hazardous waste sub-director, governmental institution, interview, November 2002].

Twenty-two cement plants, out of a total of 29 plants in Mexico, are authorised to burn hazardous waste by the environmental authorities. These permits allow them to substitute from 5% up to 30% of their thermal requirement through liquid and solid wastes such as tyres, used oil and solvents, oily wood chips, battery cases, etc. However, the energy recovery from liquid and solid wastes of the overall cement industry in 2000 was 1.2 trillion

BTU (1.1 PJ), which represented only 1.1% of the final energy consumption (excluding electricity) (SENER 2002).

According to environmental managers, this low substitution is due to problems related to availability, composition variability, public perception and legislation [Group A, corporate, cement industry, interview, November 2002].

Waste availability and recollection. The availability depends on the type of waste. For example, the tyres, which have a good calorific value, are quite dispersed and their recollection is difficult [Group E, plant A, cement industry, interview, December 2002]. With regard to liquid wastes, there is a black market, where used oils are sold to lime and brick manufacturers that burn these wastes without any treatment or environmental control [Group C, plant 1, cement industry, January 2003].

Waste variability. On the other hand, there are wastes that demand previous preparation before its use and it differs for each kind of waste. According to one environmental manager, "the cement industry must have an operative flexibility for the waste treatment that currently nobody has… The problems arise from the changing composition of the waste materials and the lack of the specifications provided" [Group A, corporate, cement industry, interview, November 2002].

Public perception. For the cement industry and members of governmental institutions, the use of waste-derived alternative fuels is an important strategy for energy recovery and waste reduction, which allows economic and environmental benefits. However, some cement plants prefer to examine this strategy carefully due to the public perception. According to one environmental manager, "it is better to observe that the community accepts the use of waste-derived alternative fuels and it realises that this is beneficial, so the use of alternative fuels can be successful in the short term" [Group B, plant 2, cement industry, interview, January 2003].

From the industrial viewpoint, this practice is also beneficial because there is a lack of infrastructure of waste management (recollection, treatment and disposal) in the country [Group A, corporate, cement industry, interview, November 2002; Group B, plant 2, cement industry, interview, January 2003; Group D, cement]. There is only one hazardous waste disposal facility in Mexico; and the rest of these wastes are currently dumped in rivers, cliffs or municipal open-air landfills. Despite the lack of waste management and waste disposal infrastructure, some environmental NGOs oppose strongly the co-incineration of waste in cement kilns. Their main reason is due to the dioxins and furans emissions. From the viewpoint of an NGO, the interviewee considered that this topic is socially difficult to manage because people do not want any waste disposals, incinerators, or anything close to them. The interviewee considered that "all the technologies for waste incineration should be taken into account, but they should be totally proven and the consequences of their use should be completely known… Once the consequences are evaluated, it should be determined if those consequences are worse than the present ones of not having anything" [UGAM, NGO, interview, November, 2003]. As a response to social pressure, cement companies have made a commitment to measure dioxin and furan emissions in 2003, and to report them to the environmental authorities. [CANACEM, ecology commission, interview, December 2002].

Legislation regarding waste-derived alternative fuels. Up to February 2003, the Hazardous Waste Law and the Incineration Law are still being discussed in the Mexican Congress. It seems that the process is politicised due to political and group interests [Group B, corporate, cement industry, interview, November 2002; Greenpeace - Mexico, toxics campaigner, NGO, interview, November 2002; UGAM, NGO, interview, November 2002]. The endorsement of this legislation will be crucial for prohibition or enhancement of the use of alternative fuels in cement kilns.

Production of Blended Cements

The production of blended cements reduces the clinker requirement per tonne of cement manufactured, and consequently there is a reduction in the fuel consumption.

The most common types of cement manufactured in Mexico are the Ordinary Portland Cement (OPC), Pozzolanic Portland Cement (PPC), and the Composite Portland Cement (CPC).[5] The production of blended cements (PPC and CPC) has increased notably in the last decade. Currently, blended cements constitute about 60% of the overall production. This type of cements is more accepted by the consumers than in the past, particularly in the centre and southern regions of the country where good quality natural pozzolanas (volcanic material with cementitious properties) are available close to the cement works. This is partially due to the presence of the cement standard NOM-414-ONNCCEE-1999.

Besides the use of natural pozzolanas, some plants are utilising granulated blast furnace slag. This option is strategic where the cement market can accept this type of cement, because the production volume can increase notably without enlarging the installed capacity of the plants [Group F, plant 1, cement industry, January 2003]. In spite of the fact that transportation costs are high, the production cost can decrease due to the smaller amount of clinker required, and hence result in lower energy costs [Group D, plant 1, cement industry, interview, November 2002]. However, one corporate sales manager considers that some factors must be examined carefully before positioning the granulated blast furnace slag cement strongly in the market: "First, the availability of this additive must be guaranteed at a national and international level. Second, the consumers' acceptance is not yet wide. Third, joint ventures with steel companies can be developed, where a steel company can invest on a slag mill and buy clinker from a national or foreign cement company" [Group C, corporate, cement industry, interview, February 2003].

According to one environmental manager, the main barrier to increase the blended cements production is a commercial issue: "We are still working in the marketing aspect… This product has a value that must be acknowledged, and if it has not been recognised by our consumers, it is because we have not had the ability to inform, to promote, to demonstrate and to make it widely acceptable" [Group A, corporate, cement industry, November 2003].

[5] The Mexican cement manufacturing standard NOM-414-ONNCCEE-1999 indicate that the production of Ordinary Portland Cement (OPC) requires 95% of clinker and 5% of gypsum, whereas, the requirement of clinker for blended cements varies accordingly to the additives ground with the OPC. For Pozzolanic Cements, the composition is 50-94% of clinker, 6-50% of pozzolana and 0-5% of gypsum. For granulated blast furnace slag cements, the proportion of clinker is between 40% to 94%, 6 to 60% of blast furnace slag and 0-5% of gypsum. For composite Portland cement (CPC), the composition is 50-94% of clinker, 6-35% of granulated blast furnace slag or pozzolana or limestone or 1-10% of silice fume, and 0-5% of gypsum.

Emissions Carbon Credits

The WBCSD, the Battelle Research Institute and ten cement global companies developed a Sustainable Cement Initiative that includes specific actions related to Climate Protection. The WBCSD initiative states a general proposal of reducing carbon emissions for the global cement industry. However, each corporate group will carry out its particular actions according to the commitments and regulations of the countries where the cement plants are operating [CANACEM, ecology commission, cement industry, interview, December 2002].

In general, the environmental managers agreed that there is not enough information, or instruments and mechanisms in the country: neither is there a national guideline. Though the Ministries of Environment and Energy are leading the national climate change policies, there is not a clear authority or office that certifies the carbon emission reductions [CANACEM, ecology commission, cement industry, interview, December 2002; SHCP, governmental institution, interview, January 2003]. Cement companies are interested in their efforts of reducing carbon emissions through the production of blended cements, the use of alternative fuels and the development of renewable or cleaner electricity generation being acknowledged with carbon emissions credits.

According to one environmental corporate manager assistant, the international emission trading markets are becoming more attractive than conducting mitigation projects. The reason was that the prices per tonne of carbon mitigated are established in a market that does not exist yet, hence they are low and the cost-benefit of mitigation projects in cement plants is small. In addition, he considered that if U.S. does not ratify the Kyoto Protocol, there would not be enough pressure for Mexico to carry out mitigation projects [Group F, corporate, cement industry, personal phone communication, January 2003].

Conclusions

This paper summarises the information gained during the series of recent interviews between November 2002 and late February 2003. The very recent completion of the fieldwork for this paper means that the analysis is currently at an early stage, and thus represents preliminary findings. The results are currently under further analysis and will be reported in due course. This further analysis is including open coding, then axial coding and finally selective coding following the ideas of Strauss & Corbin (1998).

The combination of external factors (trade liberalisation, price reform and modernisation of environmental regulations) and internal factors (market, finances and corporate image) promoted an environmental cultural metamorphosis of the Mexican cement companies towards sustainability during the last decade. Simultaneously, the participation of environmental NGOs concerned about environmental and social needs has also increased.

According to the different groups of stakeholders, the environmental performance of the Mexican cement industry has improved with time. However, there are still issues that must be addressed for achieving additional improvements not only by the cement companies, but also by the governmental institutions.

The key issues that have been identified so far as a results of this research are:

1. A requirement of technological innovations in cement kilns for further reductions,
2. The need for developing accessible credit lines for environmental and energy efficiency projects,
3. A clearer definition of the electricity legislation regarding to cogeneration and renewable sources is required by the Private Sector,
4. A stronger commercialisation and information campaigns for the use of blended cements,
5. Public access to historical and current data about dioxins and furans emissions among other pollutants, in the cement industry as in incinerators,
6. A better definition of an official authority concerning to Climate Change as well as the national guidelines for emissions trading participation.

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