GREENHOUSE GAS MITIGATION ANALYSIS

INDUSTRY

Lebanon's Second National Communication

Ministry of Environment/UNDP

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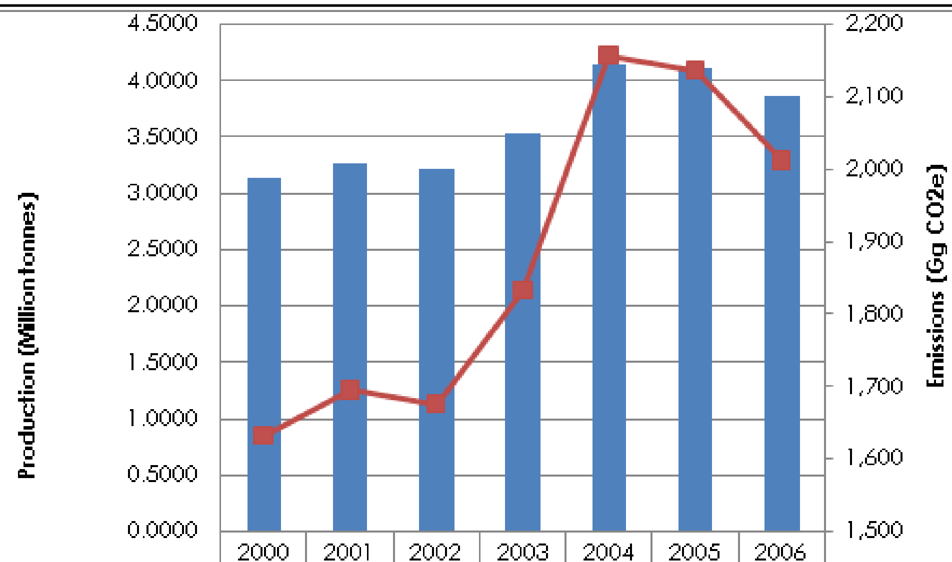
1. INDUSTRY

1.1. BACKGROUND

The cement industry is an important source of CO_2 emissions in Lebanon: emissions from the cement industry reached 2,156 Gg of CO_2-eq in 2004 representing 9.45 % of total GHG emissions for that year, and 92% of total industrial emissions (Refer to GHG inventory). Therefore, this chapter focuses on the mitigation of GHG emissions from cement industries.

In Lebanon, there are two Portland cement plants located in Chekka and one cement plant located in Sibline. While the two plants located in Chekka (Holcim and the National Cement Company) were established in 1929 and 1995 respectively, the Sibline plant (Ciments de Sibline) became operational in 1980.

According to the calculations made in the GHG inventory, the total production of clinker from all the plants is estimated at 4,143,809 tonnes in 2004, emitting 2,156 Gg of CO_2-eq (Figure 1-1).



	2000	2001	2002	2003	2004	2005	2006
Production (Million tonnes)	3.1351	3.2561	3.2188	3.5215	4.1438	4.1056	3.8681
Emissions (Gg)	1,631	1,694	1,674	1,832	2,156	2,135	2,011

Figure 1-1 Clinker Production and CO_2 emissions (2000-2006)

1.2. BASELINE SCENARIO: PROJECTED EMISSIONS

Two baseline scenarios are suggested to portray possible future clinker production and CO_2 emissions from the cement industry in Lebanon until year 2030. Scenario A assumes a low growth rate of 2% in the cement industry while Scenario B uses a higher growth rate of 4%. Figure 1-2 represent forecasts of cement production and CO_2 emissions under Scenario A and Scenario B.

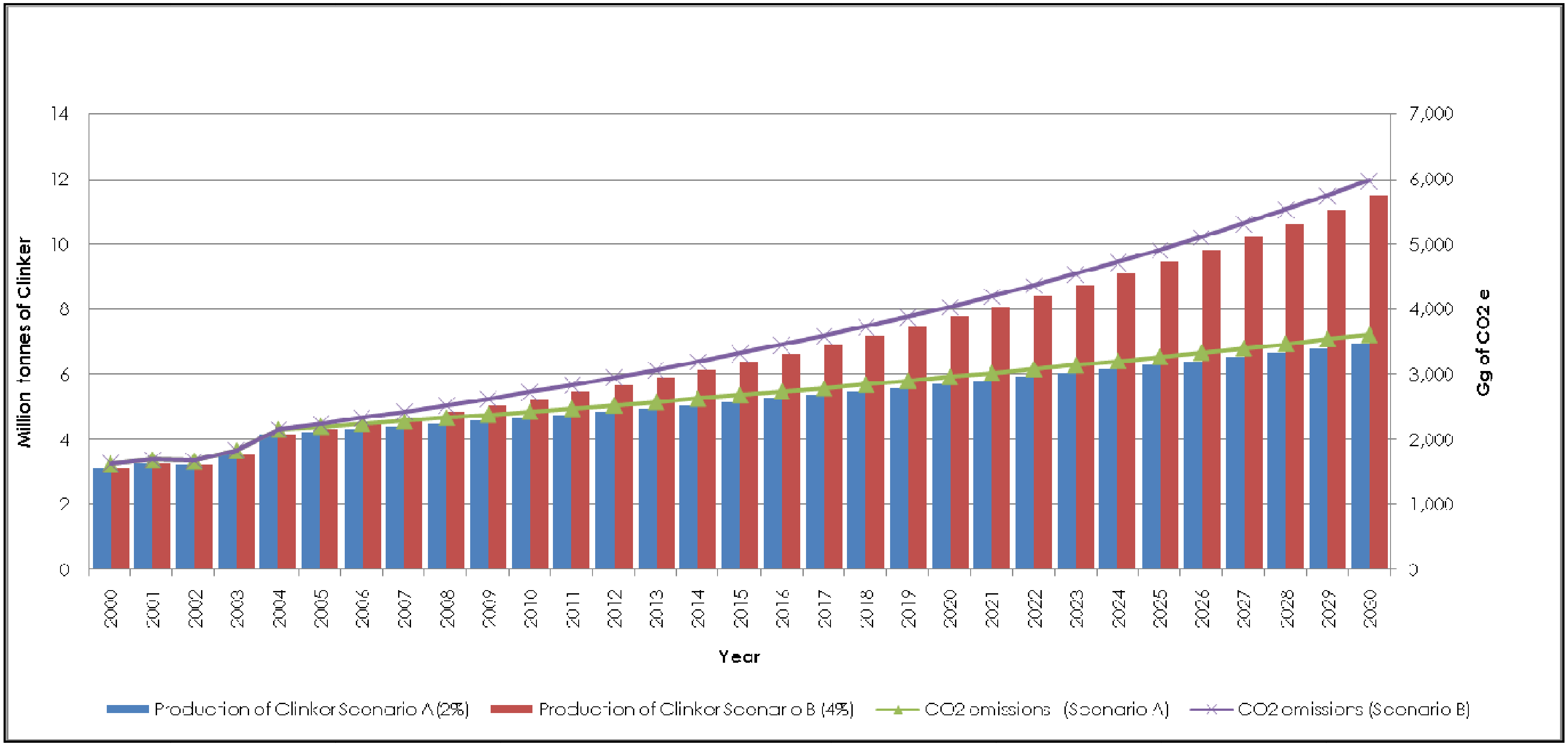


Figure 1-2 **Projected clinker production and CO_2 emissions under Scenario a and Scenario B**

1.3. MITIGATION OPTION: INCREASING THE ADDITIVE BLEND IN CEMENT PRODUCTION

The production of clinker is the most energy-intensive step in the cement manufacturing process and causes large process emissions of CO_2. In blended cement, a portion of the clinker is replaced with industrial by-products such as coal fly ash (a residue from coal burning) or blast furnace slag (a residue from iron making), or other pozzolanic materials (e.g. volcanic material) (Hendriks et al., 2004).

These products are blended with the ground clinker to produce a homogenous product which is blended cement. The reduction in clinker requirement in the production of cement results in reduction of CO_2 associated with calcination of limestone in kilns (UNFCCC, 2005):

The future potential for application of blended cements in Lebanon depends on the current application level, on the availability of blending materials, and on standards and legislative requirements. It was however not possible to obtain this information during the course of this study.

A case study in India (UNFCCC, 2005) revealed that an increase of the share of additive (fly ash in this case) from 27.66% to 35% (which is the maximum percentage of the fly ash that can be accepted in cement according to Bureau of India Standards BIS) would reduce the emissions by an estimated average of 33,608 tonnes of CO_2-eq per year resulting in a 1.32% reduction of total CO_2 emissions.

In the United States, the costs of blending materials may vary between 15 and 30 USD/Gg for fly ash and approximately 24 USD/Gg for blast furnace slag.

1.4. LIMITATIONS, RECOMMENDATIONS AND CONCLUSIONS

Due to the difficulty of accessing local technical data, the option proposed in this report is based on international experience to provide an indication of the possibility of application in Lebanon.

A recent study has investigated a comprehensive list of possible measures in the cement sector in Thailand. A total potential for CO_2 abatement of up to 15% of total emissions was found to be cost-effective in Thailand. The most cost effective measures, based on Thailand's conditions along with other possible mitigation options applied in other countries, are summarized in Table 1-2 These options could be further explored in Lebanon. However, if the Lebanese government would like to see a genuine effort to reduce GHG emissions in the country from the cement sector, the following measures are proposed to be followed:

- Creation of a dialogue platform between the government and the cement factories management representatives;
- Establishment of annual targets for GHG emissions reduction in cement factories;
- Support to increase the flow of CDM revenues to encourage costly mitigation measures in the cement sector.

1.5. MITIGATION STRATEGY

Table 1-1 below presents the mitigation strategy for the cement industry (relating to the cement production process), and Table 1-2 summarizes the constraints associated with its implementation.

Table 1-1 Mitigation strategy for the Industry sector (process)

TARGET	PROPOSED MITIGATION STRATEGY	ACTIVITIES	RESPONSIBILITY	PRIORITY (ST/ MT/ LT)	INDICATIVE BUDGET (USD)	SOURCES OF FINANCING/ IMPLEMENTATION PARTNERS
Reduction of GHG emissions from the Cement Industry	Reduce GHG emissions from the cement manufacturing process.	The main activities include: Increasing the additive blend in cement production. Substitution of conventional pre-calcination method by a pre-calcination method aimed at CO2 production in a highly concentrated form. Replacing parts of the plant (motors, raw mill vent fan, preheater fan, kiln drives, etc.) by high efficiency ones.	Cement companies (private sector) MoI MoE ALI (Association of Lebanese Industrialists)	ST	Cost to be determined based on technology selection and plant size.	The Arab Fund for Economic and Social Development (AFESD) The European Investment Bank (EIB) Kuwait Fund for Arab Economic Development (KFAED) The Abu Dhabi Fund for Development (ADFD) USAID UNIDO

Table 1-2 Constraints to the implementation of mitigation measures

MITIGATION STRATEGY	Constraints/ Gaps			
	Legal/ Policy	**Institutional**	**Technical/ environmental**	**Capacity and Awareness**
Reduce GHG emissions from the cement process	Insufficient regulation and standards relating to GHG emissions from cement factories	Lack of enforcement power by MoE, which is in charge of monitoring industrial emissions	High cost of technology and lack of financial support and incentives for industries to promote low emission technologies.	None

APPENDIX A: CO_2 ABATEMENT MEASURES FOR THE CEMENT INDUSTRY

CO_2 ABATEMENT TECHNOLOGY/ MEASURE	Average annual CO_2 abatement during scenario period (ktonnes CO_2/year)	CO_2 abatement cost (USD/tonne CO_2)
OPTIONS FROM THAILAND (HASANBEIGI ET AL., 2010)		
Adjustable peed drive for kiln fan	2.61	-73.62
Replacement of separator in coal mil circuit with an efficient grit separator	1.12	-72.93
Replacement of cement mill vent fan	0.06	-68.90
High-efficiency motors	18.99	-68.30
Variable frequency drive (VFD) in raw mill vent fan	1.79	-67.93
High efficiency fan for raw mill vent fan with inverter	0.15	-65.55
Bucket elevator for raw meal transport from raw mill to homogenizing silos	1.01	-64.75
Replacement of preheater fan with high-efficiency fan	0.30	-64.73
VFD in cooler fan of grate cooler	1.37	-62.79
Energy management and process control in grinding	36.73	-58.74
Adjustable speed drives	37.95	-56.82
Efficient vertical roller mill for coal grinding	5.21	-55.32
Installation of variable frequency drive and replacement of coal mill bag dust collector's fan	1.45	-54.02
Bucket elevators for kiln feed	0.53	-36.79
Replacing a ball mill with vertical roller mill	190.37	-35.26
Preventative maintenance	28.03	-32.76

Raw meal process control (vertical roller mill)	9.8	-32.72
High pressure roller press as pre-grinding to ball mill	100.12	-32.51
Efficient kiln drives	1.09	-27.58
Kiln shell heat loss reduction	545.73	-19.76
Energy management and process control systems for clinker making step	222.6	-17.04
Modification of clinker cooler (use of mechanical flow regulator)	37.55	-16.55
Portland limestone cement	156.86	-14.38
Optimize heat recovery/upgrade clinker cooler	34.97	-13.85
Upgrading the preheater from 4 stages to 5 stages or from 5 stages to 6 stages	377.34	-137
High-efficiency classifiers	2.16	22.01
High efficiency vertical roller mill for raw material grinding	19.97	47.33
Efficient transport system (mechanical transport instead of pneumatic transport)	1.33	145.15
Use of gravity system instead of pneumatic system in raw meal blending	23.92	246.35

CO_2 ABATEMENT TECHNOLOGY/ MEASURE	Average annual CO_2 abatement during scenario period (%)	CO_2 abatement cost (USD/ tonne CO_2)
	CASES FROM OTHER COUNTRIES	
Substitution of conventional pre-calcination method by a pre-calcination method aimed at CO_2 production in a highly concentrated form[1].	50% of CO_2 emissions associated with the cement manufacturing process	Not available

Utilizing CO_2 sequestration in the waste product Cement Kiln Dust (CKD)[2]	5% reduction in impact score over traditional Portland cement	Not available

Sources: 1- Rodriguez N. et al. (2009)

2-Huntzinger D. & Eatmon T. (2009)

REFERENCES

Hasanbeigi, A., Menke, A., & Price, L. (2010). The CO_2 abatement cost curve for the Thailand cement industry. *Journal of Cleaner Production*, 10: 1509-1518.

Hendriks, C.A., Worell, E., De Jager, D., & Riemer, P. (2004). *Emission Reduction of Greenhouse Gases from the Cement Industry* (Adobe Digital Editions version). Retrieved from http://www.ieagreen.org.uk/prghgt42.htm

UNFCCC, (2005). Clean Development Mechanism Project Design Document form (CDM-PDD)- Increasing the Additive Blend in cement production by Jaiprakash Associates Ltd (JAL).

Huntzinger, D. and Eatmon, T. (2009). A life-cycle assessment of portland cement manufacturing: comparing the traditional process with alternative technologies. *Journal of Cleaner Production*, *17*: 668-675.

Rodriguez, N., Alonso, M., Abanades, J.C., Grasa, G. and Murillo, R. (2009). Analysis of a process to capture the CO_2 resulting from the pre-calcination of the limestone feed to a cement plant. *Science Direct*, 1: 141-148.