Balancing Development, Sector Competitiveness, and Challenges of Complying with the EU Environmental Acquis

Republic of Turkey's Cement Manufacturing Sector and Implementation of the EU Directive on Integrated Pollution Prevention and Control

Sector Note

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Table of Contents

Figures

Tables

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Abbreviations

AELs	Average emission limits
BATs	Best Available Techniques
BREF	BAT Reference Documents
CO	Carbon monoxide
CO_2	Carbon dioxide
DEFRA	Department for Environment, Food and Rural Affairs (United Kingdom)
EBITAD	Earnings before interest, tax, amortization, and depreciation
EIA	Environmental Impact Assessment
ELVs	Emission limit values
EP OPRA	Environmental Protection Operator and Pollution Risk Appraisal
EPDS	Environmental product declarations
ESES DPL	Environmental Sustainability and Energy Sector Development Policy Loan
ETS	Emission trading schemes
EU	European Union
GBRs	General Binding Rules
GDP	Gross domestic product
HCI	Hydrogen chloride
HF	Hydrogen fluoride
IPPC	Integrated Pollution Prevention and Control
ISO	International Organization for Standardization
kcal/kg	Kilocalorie per kilogram
kg	Kilogram
kton	Kiloton
kWh	Kilowatt-hour
MBI	Market-based instruments
Mg	Milligram
MENA	Middle East and North Africa
mg	Milligram
MJ	Megajoule
MJ/ton	Megajoule per ton
MoEF	Ministry of Environment and Forestry
MSs	Member States
Mt	Metric ton
Nm^3	Normal cubic meter
NO_2	Nitrogen doxide
NO_x	Nitrogen oxides
PCDD	Polychlorinated dibenzo-p-dioxins
PCDF	Polychlorinated dibenzofurans
PM	Particulate matter
R&D	Research and development
SNCR	Selective non-catalytic reduction
SO_x	Sulphur oxides
t	Tons
TCMA	Turkish Cement Manufacturers Association
TEPA	Turkish Environmental Protection Agency
TOC	Total organic carbon
TTGV	Technology Development Foundation of Turkey
TÜBİTAK	The Scientific and Technological Research Council of Turkey
VOC	Volatile organic compounds
WBCSD	World Business Council for Sustainable Development

Executive Summary

1. The Government of Turkey has launched a renewed effort to strengthen environmental management and national, regional, and local policies with the goal of meeting national sustainable development goals. Key steps toward such improvements include the integration of environmental management systems in national economic development and a commitment to align national environmental legislation with the European Union (EU) Environmental Acquis. The EU Integrated Pollution Prevention and Control (IPPC) Directive 2008/1/EC[1] offers an important leverage point for Turkey, not only for improving the environmental condition of the country, but also to facilitate productivity improvements in the industry, to strengthen the institutional capacity for ecological modernization, and to better engage the general public in the sustainability discussion. As an important policy tool the IPPC Directive is instrumental in reducing industries' impact on the environment and in catalyzing resource productivity gains. Turkey, like EU member States will be faced with a decision regarding how best to transpose the provisions of EU IPPC Directive. The challenge lies in adopting policy approaches that help realize the benefits of the Directive while avoiding potential drawbacks to the extent possible.

Implementation of EU Integrated Pollution Prevention and Control Directive

2. Various countries struggled through the process of implementation of the IPPC Directive and they learned by doing. The analyses of international experience with the IPPC Directive and other examples provided in this sector note can serve as a reference point for decision makers who can adapt them to their own country circumstances. In many ways the IPPC Directive brings a totally new approach to environmental management systems, and it applies to areas that are not traditionally regulated in most countries – such as energy efficiency. The Directive itself has flexible elements that leave room for interpretation, making the work both for the regulator and regulated more demanding. The note presents a set of policy options and incentives that can stimulate industrial compliance with the IPPC Directive.

Cement Industry and IPPC Implementation Challenges

3. The cement industry is an important and rapidly developing sector in Turkey with high environmental awareness. The policy options and incentives presented in the note aim to help achieve compliance with the IPPC Directive by the Turkish cement industry. At the same time, the public sector and other industries may also benefit from many of the conclusions and recommendation in the future.

4. There is sufficient evidence that many of the Best Available Techniques (BAT) requirements put forward for IPPC Directive compliance in the cement sector appear to already be in place in the majority of Turkish plants. The industry has

[1] 2008/1/EC is the codified version of the original Directive 96/61/EC which includes changes of amendments applied to it.

understood the win-win nature of the compliance measures and has adopted them in new developments or during facility expansions. To become IPPC compliant, however, new investments will be necessary, particularly with regard to the reduction of Nitrogen Oxide (NO_x) and particulate matter (PM) emissions, and regarding energy efficiency. While the energy efficiency investments are likely to have reasonable payback times and can have a positive net economic effect, NO_x and PM control will bring a net cost.

5. The precise cost of IPPC compliance will greatly depend on the emission limit values (ELVs) that will be imposed and the current performance level of the industry, both of which are uncertain. The overall cost increase per unit production is estimated to around €1.3/ton of clinker (for the whole sector). This increase appears unlikely to affect competitiveness in the sector significantly provided that the industry is given sufficient time to plan for and incorporate these additional costs into their investments. The environmental aspects of the cement industry are primarily linked to a singular medium – that is, air emissions. The sector, thus offers a narrow context to make a judgment for an integrated approach that addresses pollution arising from different media sources. Therefore, prior to a final decision on the legal and normative base for transposition of the IPPC Directive, it will be helpful to study the implications of another sector with significant interactions with multiple environmental media.

Public Benefits - Private Gains

6. From an environmental management perspective, the introduction of the IPPC Directive presents an opportunity for (further) factoring in the costs of pollution in areas where public costs are known or likely to be high and an overall benefit is likely. This in turn will enable a move toward establishing a better balance among economic, environmental, and social considerations in development. The Directive may help reduce the risk of shifting environmental problems among different media (that is, air, water, and soil), and therefore allow for better and more holistic environmental protection. It will also bring a wider range of industrial activities under the regulatory umbrella and offer a leverage point to force old and polluting technologies to change.

7. The IPPC Directive holds the potential to promote greater win-win opportunities. This can lead to resource productivity gains benefiting not only the environment but also the underlying profitability of industries. Energy efficiency and waste minimization are the main areas with proven win-win potential. In the specific case of cement, energy efficiency is an important area for resource productivity. Gains with respect to resource productivity at the regional and national levels could be realized through increased revalorization of waste materials as energy carriers in cement kilns. With stricter enforcement of waste management regulations, a considerable amount of waste-derived fuels could become available for the cement industry, providing both environmental and economic benefits. Combined with the incentive structures discussed above, the Ministry of Environment and Forestry could initiate stricter enforcement of waste regulations in areas where cement plants meet better environmental performance requirements. The IPPC Directive is also reported to provide a leverage point for more efficient technologies and new products with

better characteristics. Such developments can pave the way for welcomed innovations in the cement industry. In addition, IPPC permitting dynamics are highly instrumental in transforming the relations between the regulator and the regulated for the better, by creating a platform for dialogue and allowing room for negotiated compliance.

Recommendations

8. The EU IPPC Directive includes provisions for strengthening public policies and their implementation and for the use of BATs and BAT Reference Documents setting permit conditions. The note analyses how these apply to the specific sector aiming to develop recommendations with respect to the policy approaches that can be helpful for more efficient, effective, and equitable implementation of the IPPC Directive, thereby achieving the intended environmental gains while also assisting good performance in industry and sustaining competitiveness the sector. The following recommendations were identified following the key principles of the IPPC Directive:

9. *Adaptive Implementation*: The IPPC requirements, including the Best Available Techniques (BAT) requirements, Emission Limit values (ELVs), and time frame for compliance **need to be customized** to Turkey taking into consideration the technical, environmental, industrial, and institutional dynamics that prevail, or that are anticipated, in the country, and be based on appropriate cost-benefit analyses. Clear and **comprehensive guidelines concerning IPPC implementation**, targeting both the regulatory agencies and the industries, would help reduce the burden which companies may face to meet IPPC responsibilities with a short compliance deadline. A **clear and accountable set of rules and guidelines** need to be developed for the flexible areas of the Directive – such as completeness of BAT application, conditional permitting, permit reconsideration intervals and procedures, and sanctions for noncompliance – will be critical to maintain a level playing field during implementation and avoid inefficiencies, conflicts and a loss of credibility. Practice on BAT Guidance and the use of BAT Reference Documents (BREFs) varies across countries. Some countries adopted national guidance documents, through borrowing elements from the BREFs (for example, Belgium, Finland, Greece, Ireland, the Netherlands, Spain, and the United Kingdom), while others rely on the BREF material (for example, Portugal), and others intend to continue with national rules and guidance[2].

10. *Institutional Capacity*: Effective implementation depends critically on the **institutional delivery mechanism** for implementation and monitoring of the IPPC Directive. A major challenge in this regard will be to define the responsibilities for permit issuance, compliance control, corrective action and proper safeguards for fair treatment of industries. Success would also depend on the technical and local knowledge of responsible units and individuals involved in the permit process. Establishment of sector-specific expert groups with participation from different regions could make an important contribution to institutional capacity, capability and

[2] Institute for European Environmental Policy 2003

effectiveness. The majority of EU Member States opted for a single authority for permitting. This offers benefits such as consistency, ability to develop required competencies, and reducing administrative difficulties. Denmark and the United Kingdom have been highly successful in this regard. A Turkish Environmental Protection Agency, the establishment of which is under consideration, could provide a framework within which an effective and just IPPC implementation division can be housed.

11. *Economic Incentives and Stimuli*: Introduction of innovative market-based instruments (MBIs) could create **platforms for win-win outcomes**, thereby stimulating compliance and better environmental performance. To this end, the development of a pilot emission trading scheme (ETS) for the sector covering major emissions, like CO_2 or NO_x, could bring significant public benefits from improved environmental performance. Such an approach, if carefully crafted, could assist the sustainable long-term development of industry. Equally important, such an initiative will provide highly valuable experience to the country and help build capacity that will become increasingly important in light of the future needs to manage greenhouse gas emissions. The introduction of other MBIs, such as earmarked taxing systems for selected emissions, can also be considered. These tools can be developed based on holistic and rigorous analyses in order to avoid the promotion of unintended outcomes. Around the world the mechanism of trading permits which combines flexibility and predictability is used for reducing pollution, at lower cost. Following the example of the United States cap-and-trade program for Sulfur Oxide (SO_x) and Nitogen Oxide (NO_x) emission trading, Poland, Chile and United Kingdom are in a process of introducing tradable permit schemes. Several European countries have launched operational trading schemes such as Czech and Slovak Republics (for SO_x) and Netherlands (for NO_x).

12. *Flexibility, Participation and Transparency:* Providing flexibility in the permitting process, based on context-specific technical and environmental realities, is a key component in IPPC permitting. The IPPC Directive brings a totally new approach to the permitting process, where the industry has to carry out a self-assessment and needs to look into areas that are traditionally not regulated in most countries—such as energy efficiency, or having an environmental management system. In addition, the Directive itself has flexible elements that leave room for interpretation, making the work of both the regulator and the regulated more demanding. The socioeconomic and climatologic conditions of the different regions of Turkey are highly heterogeneous. This will entail a change in the permitting process in Turkey, where regulatory requirements will include context-specific conditions. Taking a flexible but no less strict approach is the use of **negotiated agreements** with industry to facilitate compliance. For example, more strict enforcement of waste regulations can be negotiated in return for higher emission reductions. This is likely to be warmly welcomed by the industry. **Informational tools**, such as awareness raising and education programs, dedicated research and development programs, recognition schemes, and support platforms to assist the industry in meeting environmental demands from their customers and consumers could stimulate innovation and competition. **Transparency and consultations** are essential elements of environmental decision making and accountability of environmental institutions. One of the findings of this report is that cement industry will benefit from expanding its understanding of the nature and implications of the

IPPC Directive. It might, therefore, be important to expand further the communication and outreach efforts with industry and provide a better-structured consultation and information-exchange platform in the coming stages of crafting the administrative details of the IPPC implementation. This will include engaging the industries from the early stage in the process by making the necessary contributions to the assessment of cost and benefits and discussion on policy options. The Ministry of Environment and Forestry has already communicated its willingness to take the future steps for strengthening the dialogue and cooperation with the industry. This will bring Turkey to an important point with regard to introducing policies and regulations which will stimulate compliance, innovation and competitiveness.

1. Introduction

1.1. Background, Objectives, and Audience

13. The World Bank is supporting the Government of Turkey in implementing its sustainable development agenda under the Environmental Sustainability and Energy Sector Development Policy Loan (ESES DPL) series. Specifically, the ESES DPL series supports actions that are among the most critical for Turkey's transposition[3] of its environmental legislation with the EU Environmental Acquis, such as the government's adoption of an EU Integrated Environmental Approximation Strategy (2007–2023). The Bank is providing further support to the government in harmonizing its legislation with that of the EU via non-lending technical assistance focusing on environmental sustainability. A programmatic approach is proposed to provide flexibility in delivering sound policy advice tailored to the Government of Turkey's needs.

14. The programmatic work includes two sector notes, one of which focuses on **Balancing Development, Sector Competitiveness, and Challenges of Complying with the EU Environmental Acquis**. Central to the analysis is the support to the Government of Turkey in meeting the EU Environmental Acquis requirements while sustaining economic development. The outputs of this technical assistance are (a) engagement of environmental regulators and the private sector in a dialogue about the challenges on the road to full compliance with the EU Acquis, and specifically issues related to the implementation of EU Directive (2008/1/EC) on Integrated Pollution Prevention and Control (IPPC); and (b) a Sector Note that examines industrial sector issues and the costs of compliance with the IPPC Directive in key manufacturing sectors. The latter specifically includes a review of technological and policy foundations for steady compliance while sustaining sector competitiveness and business decisions that contribute to meeting national development goals. This note aims to provide the public and private sector stakeholders with a set of policy options and incentives that will stimulate industrial compliance with the IPPC Directive, where the greatest costs of compliance will be borne by the industry.

15. While alternative manufacturing sectors were initially considered for the analysis, consultations with relevant public and private parties indicated that the **cement industry** would represent a good case study due to its structural profile and important place in the national economy, including high environmental awareness, its well-organized industrial structure, and good access to information. Thus, the current analysis aims to offer a *set of policy options and incentives that will assist compliance with the IPPC Directive in the Turkish cement industry.*

1.2. Methodology

16. The approach taken in the analysis covers three main areas:

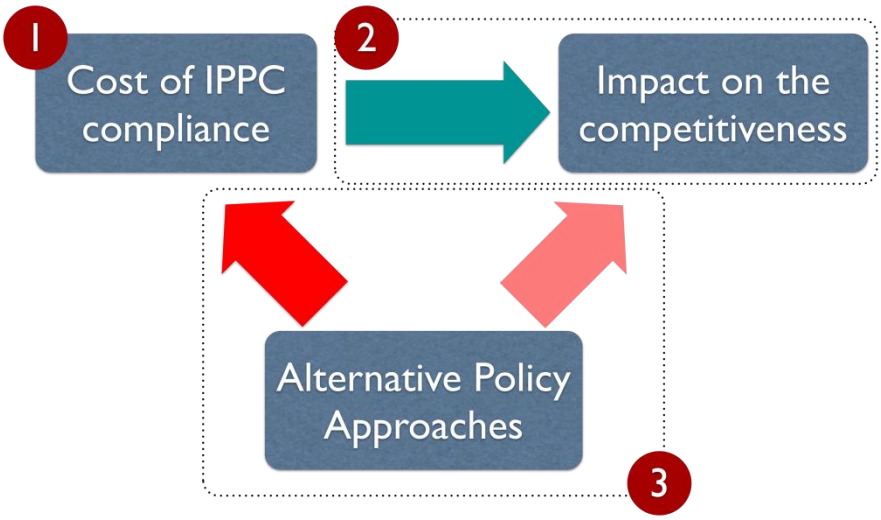
- Developing sufficiently accurate estimates of IPPC compliance costs for the Turkish cement industry

[3] Transposition is the aligning of country legislation with the EU Directive.

- Projecting probable impacts of compliance-related costs and benefits on the competitive position of the industry
- Identifying and assessing alternative policy approaches that support achieving compliance with minimal negative impact on the economic resilience and competitiveness of the sector

Figure 1 presents the main components of the study and their relation to each other.

Figure 1. Structure and Dynamics of the Methodological Approach

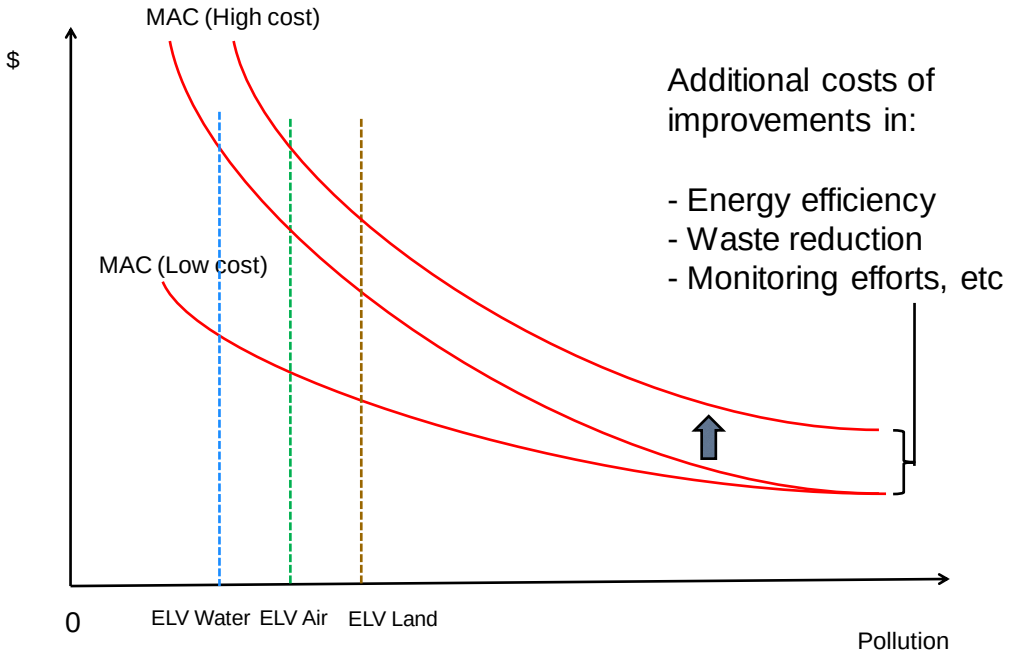


Source: Authors.

Developing sufficiently accurate estimations of IPPC compliance costs

17. Individual plants may possess very different compliance cost structures depending on the technologies employed, the operational characteristics of those technologies, and the managerial environment under which production takes place. There is also an issue of plant size and whether plants can leverage economies of scale in production. In terms of pollution control, firms with high per-unit abatement costs must spend more in order to meet the requirements of standards, such as the emission limit values (ELVs) mandated under the sector-specific guidance documents of the IPPC Directive (figure 2). However, IPPC compliance is broader than simply meeting ELV standards for air, water, and soil. Henceforth, compliance costs should be viewed as a cost "index" to meet a wide variety of compliance objectives, such as energy efficiency, waste reduction, emergency measures, and monitoring efforts. Taken together, plants face a significant degree of cost uncertainty based on the cumulative nature of these costs and a general lack of prior experience in taking on such investments.

Figure 2. Marginal Abatement Costs and Compliance



18. Properly assessing the cost of IPPC compliance to the industry is a vital element of the analysis that follows, and will form one of the major pillars for policy discussions. Consequently, it is essential to carry out the sector assessment systematically using an appropriate and transparent methodology. In order to obtain quality results, the following approach is taken:

- Industry requirements for IPPC compliance need to be identified
- An thorough understanding of the current state of cement plants with respect to their environmental performance and technical and managerial set-up relevant for compliance with the IPPC Directive
- The costs and benefits of reaching and maintaining a state of compliance needs to be calculated

19. With regard to **compliance requirements**, relevant elements of the IPPC Directive and related Best Available Techniques Reference (BREF) document(s) provide substantial guidance; the majority of the IPPC requirements covered in the remainder of this document are distilled from these references. Further input can be provided to this process by reviewing examples from countries where the IPPC Directive is already implemented and transferring relevant knowledge and experience. Inevitably, this is an iterative process since the complete identification of the compliance conditions requires emission limits to be set by the implementing authority—that is, the Ministry of Environment and Forestry (MoEF)[4]. These limits were among the key issues discussed at a multi-stakeholder workshop held on June 24, 2010, as part of the World Bank-supported technical assistance. Consequently, at the initial stages of the analysis, educated assumptions—based on Best Available

[4] A recast Directive 2010/75/EU on Industrial Emissions to replace IPPC and several other EU Directives was approved in December 2010. Depending on the content of the recast Directive, and implementation schedule the MoEF may have limited room to change the compliance conditions, including ELVs.

Techniques (BATs) performance data and/or average emission limits (AELs) used in implementing countries—were used for constructing a full set of requirements. Simulation of alternative compliance options is also thought to be instrumental for industry.

20. To identify the **existing compliance situation** in cement plants, representative data regarding specific technical, operational, and managerial realities is necessary. In compiling this data, areas that are likely to incur higher costs are normally prioritized. The prioritization shows that the following BAT requirements are associated with particularly high costs:

- Reducing the emissions of nitrogen oxide
- Reducing the emissions of particulate matter
- Introducing measures that improve energy efficiency
- Closing of the raw material and product storage areas
- Introducing systems for waste quality assurance, handling, and continual feeding (for plants using waste as supplementary fuel)

21. Among these, investments in energy efficiency measures are regarded to have relatively short payback periods.[5] Measures linked to closing storage areas and use of automated waste-handling systems are also beneficial, in the long run, and are already required by existing regulations in Turkey. Therefore, these are mostly excluded in the analysis. Accordingly, in making the intended categorization, information on nitrogen oxide and particulate matter emissions are used as prime proxies, while reference is made to other BAT options whenever relevant to provide guidance for future efforts to fine-tune cost assessments.

22. Once the existing state of the industry is identified with sufficient accuracy, the associated **costs of reaching and maintaining IPPC compliance** are calculated using cost figures from literature, from technology providers, from national and international references and benchmarks.

23. The results of the analysis are aggregated at the sector level rather than at the level of individual plants. Since plants can have significant variation in terms of their compliance readiness, initial assessments at the plant level are necessary. In the absence of plant level detail, it would be useful to develop a typology taking into consideration apparent environmental performance and environmental management practices, as well as the scale of investment. Categorizing plants in this manner also preserves the anonymity of individual plant performance. The proposed categorization is as follows:

- **Group 1:** Plants requiring minimal investments for compliance, X kilotons per year
- **Group 2:** Plants requiring modest amounts of investment for compliance, Y kilotons per year
- **Group 3:** Plants requiring substantial investments for compliance, Z kilotons per year

[5] Industry representatives state that investments in energy efficiency measures in Turkey generally have a payback time of less than one year.

24. The ability to produce quality assessment results greatly depends on plant-specific data relevant to compliance, associated costs, and competitiveness determinants. Cement plants themselves have the most reliable and representative data and are therefore the most important source of information. A data collection form (see Annex IV for an example) was developed by the project team and was instrumental for collecting the necessary data[6]. This form was used to gather information at the facility and kiln level, but allowing for providing data anonymously. Information not obtainable through this method was sourced from other organizations. Table 1 lists these sources and provides additional information about data use.

Table 1.Summary of Alternative Sources of Information

Source	Available Information	Additional Remarks
Turkish Cement Manufacturers Association (TCMA)	• Capacities and capacity utilization • Product types • Energy-efficiency-related info • Info regarding ISO 14001 implementation • Export shares • Employment figures • Generic compliance situation • Generic info on technical installations.	For many areas, does not have the information at the required level of detail. Some information can be shared only following the approval of member companies.
Environmental Impact Assessments (EIAs)	• Projected technical installations and their capacities. • Emission commitments.	Information in EIAs represents commitments and not necessarily operational realities. EIAs are available for only some facilities and only some of these are readily available.
Emission reports provided to the Ministry of Environment and Forestry (MoEF)	• Quantitative information on emissions on kiln and plant basis as well as on the ambient concentrations in surroundings. • Qualitative information about some of the technical installations that is of relevance.	Emission values reported based on spot measurements. Information is unorganized. Ministry cannot disclose this information without approval of the companies.
Consultants providing services to the industry	• Quantitative information about emissions. • Qualitative information about some of the technical installations that is of relevance.	These companies cannot provide such information because it would be a breach of client confidentiality.

Source: Authors

25. Once the **existing compliance situation** was measured with sufficient accuracy, the associated costs to reach and maintain compliance with the IPPC

[6] It future course of actions plant-specific data, and not the aggregated information that this study presents, will be necessary if there will be a need to negotiate prolonged compliance time allowances with the EC, which can only be done on a "plant-by-plant" basis. Although majority of the firms have been reported to have responded to the data collection effort initiated during this study, the collected data has not been shared with the project team, presumably on the basis of inadequate data quality. However, the MoEF would benefit from further collaboration with TCMA, that has been compiling the data from individual plants.

Directive was calculated using international and, preferably, national, references and benchmarks.[7]

Influence of compliance costs and benefits on competitiveness

26. To the extent that information can be gathered on the cost of the compliance structure of plants, and the sector at large, estimates of financial sustainability can be developed to measure plants' (sectors') ability to absorb greater costs of compliance. The purpose is to gauge the relative financial performance and competitiveness of the sector, from either a domestic or international standpoint.

27. Competitiveness is generally governed by a diverse range of factors and their complex interactions. In the case of the cement sector, some specific dynamics that need to be taken into account include:

- High fluctuations in demand and prices
- Significant variations in production and operating costs among plants
- A low price elasticity of the product[8]
- High investment and fixed costs
- Need for proximity to markets.

28. For the purpose of this analysis, the competitiveness implications of IPPC compliance costs were approximated using a simplified approach based on the following parameters[9]:

- Revenue (based on production and average price)
- Average rate of earnings before interest, tax, amortization, and depreciation (EBITAD) in the sector (profitability)
- New investment rate in the sector
- Investments in environmental monitoring and compliance
- Price elasticity of demand in the domestic market
- Price elasticity of demand in export markets.

29. Many of the IPPC-triggered investments can provide net benefits over their life cycle, which is particularly important for improved energy efficiency, process control, and automation. These benefits are not quantified in this study.

Identifying appropriate policy approaches

30. Given the above analyses, alternative policy approaches are proposed to facilitate IPPC compliance with minimal adverse impact on sector competitiveness. Some of the suggested approaches include:

[7] Relevant figures for high-cost BAT options are provided in Annex II of this note.

[8] Studies have shown that the own-price elasticity for cement is about -0.27. This means that a 1 percent increase in price would imply a 0.27 percent decrease in gross demand for the product (Ponssarda and Walker 2008). However, price elasticity for individual plants serving the same market are likely to be higher than this.

[9] See Annex III for detailed descriptions.

- Customization of the BAT requirements, in terms of emission limits and adaptation schedules
- Phased-in implementation (for example, starting with those facilities where highest returns can be achieved with minimal investment, or gradually increasing ELVs)
- Introducing market based policy instruments (for example, creating markets for emission trading or provision of tax benefits for compliant companies)
- Direct financial support, such as IPPC compliance credit funds for the most needy firms
- Informational tools (for example, compliance or research and development [R&D] support, recognition schemes).

1.3. Limitations

31. While a considerable amount of quantitative and qualitative data was compiled for the preparation of the study, and enabling a better understanding of the development and business dynamics of the cement sector, some data required for the assessment of IPPC compliance costs were limited. For example, it is known that all cement plants have adequate environmental performance to comply with existing environmental regulations. It is also known that recently installed, or modernized, plants have high energy efficiency ratings and largely meet emissions levels, and a higher share of BAT requirements are in place—such as continual waste-handling systems, or closed storage areas. This level of understanding, however, is of less use for the purpose of analysis because it reveals little about the actual emission and energy efficiency performance, or the situation with regard to installations required by BATs, which vary among plants. Therefore, although basic plant-specific data were unavailable, the analysis produced compliance costs at the sector level estimated on informed assumptions from existing plant situations and requirements laid out by the BREFs. Although these estimates were cross-checked with the relevant and knowledgeable parties and adjusted accordingly, it should be understood that these assumptions are associated with varying uncertainty.

32. Similar gaps also existed with respect to information necessary for the assessment of competitive dynamics of the sector, such as information on earnings and investment rates. Similar to BAT adoption costs, the analysis regarding the competitiveness impacts are based on publicly available data and, whenever possible, on informed estimations, derived through consultations with relevant organizations and experts. Consequently, the quantitative outputs regarding BAT compliance costs and their impact on competitiveness are determined with some accuracy at this stage. This is not a major concern because there is consensus among relevant parties that IPPC compliance costs are not likely to be large enough to have a significant impact on sector competitiveness. Furthermore, the methodology introduced and demonstrated through this study can be re-iterated when the relevant data become available[10].

33. The policy recommendations, however, still carry high practical value for policy formulation. In addition, the approach taken here aims to be demonstrative and

[10] As noted earlier, although additional data that could have helped to further refine the findings was reportedly collected, it was not made available to the project team.

will have applicability to the compliance analysis of other sectors beyond cement manufacturing.

34. The authors factored into the analysis both the opinions and comments of representatives of the public and private sectors familiar with country-specific aspects of environmental regulations and industrial compliance gleaned during interviews, and reviews of international experience from available sources.

35. The remainder of this note is organized as follows. Section 2 reviews the cement manufacturing sector within the context of its global outlook and key environmental aspects; section 3 explores issues related to Turkey's cement manufacturing industry; section 4 presents an overview of the EU IPPC Directive and implementation experience, including benefits and drawbacks; section 5 presents compliance gap analysis and probable compliance costs for the Turkish cement manufacturing sector and an analyses of competitiveness impacts; section 6 provides an overview of environmental policy instruments and identifies the main sector policy and institutional issues to be addressed in detail in the process of application of the IPPC Directive specific to the sector; and section 7 offers concluding remarks.

2. Cement Industry and Environmental Aspects

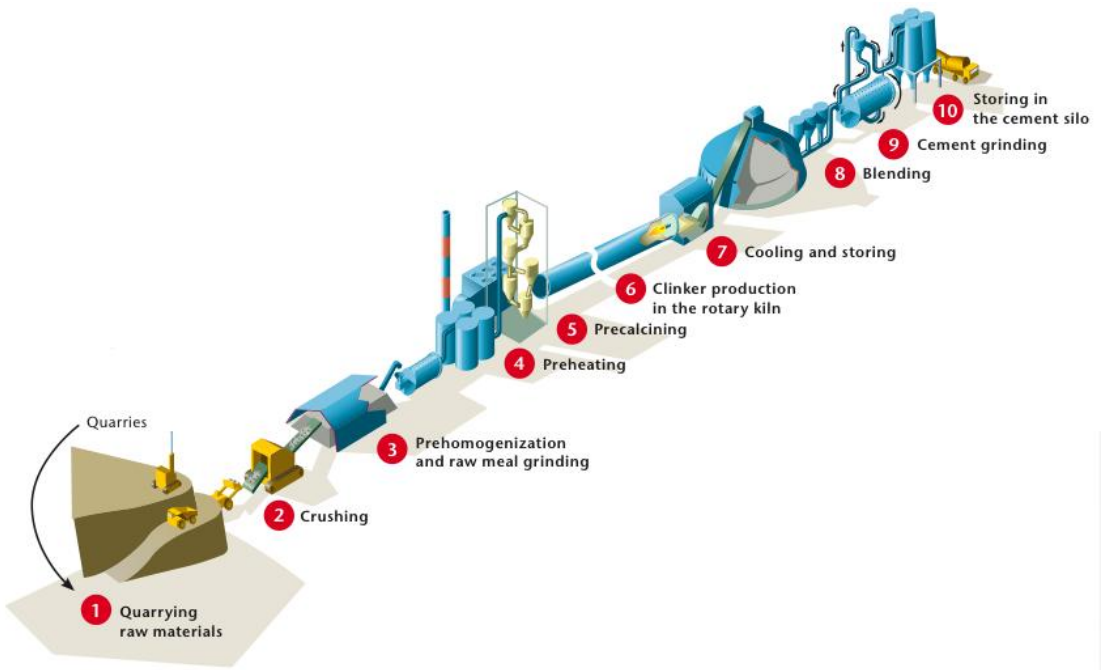
36. Cement is a substance that sets and hardens and can bind other materials together. It is a major input in the construction industry and its most important uses include the production of mortar and concrete.

37. In cement production, naturally occurring materials such as limestone, marl, or chalk, which are rich in calcium carbonate, form the main ingredients. These are mixed with small quantities of iron ore, bauxite, shale, clay, and sand to assure the right composition. These constituents are crushed and turned into a homogenous meal. In modern processes, this meal is passed through preheaters, where hot gases from the kiln are used to reduce the water content and increase the temperature of the material. In the next stages the material is fed into the precalcination unit (in modern plants) and a rotary kiln, where in the presence of temperatures in excess of 1,450 ^{o}C the meal melts into clinker.[11] The hot clinker emerging from the kiln is passed through a clinker cooling unit, where preheating of combustion air for the kiln also takes place. Clinker is a commonly traded intermediate product and is often stored on-site in dedicated storage areas.

38. For the production of cement, clinker is mixed with other substances such as gypsum, coal fly ash, limestone, pozzollana, or blast furnace slag. This mixture is then ground into a grey powder using either ball mills, or more efficient roller presses or vertical mills. Depending on the additives, different kinds of cement with varying characteristics are obtained. The final product is stored in silos. Figure 3 diagrams the cement production process of a modern cement plant using dry processes with precalcination.

Figure 3. Cement Production by Modern Dry Processes

[11] Calcination is a thermal treatment process applied to ores and other solid materials to bring about a thermal decomposition. Clinker is the solid material produced by the cement kiln stage that has sintered into lumps or nodules, typically 3 to 25 millimeters in diameter.



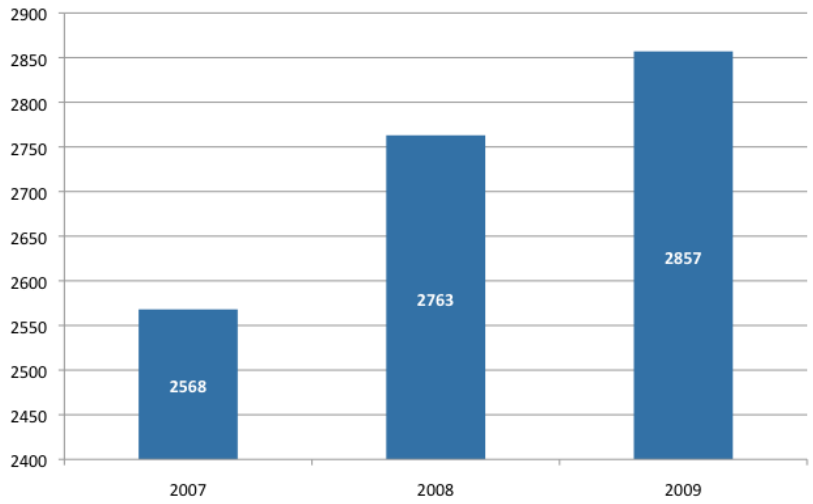
Sources: IEA/WBC 2009.

39. Wet, semi-dry, or dry processes are commonly used for clinker production. Despite their lower electricity demand (around 20 kilowatt-hours per ton [kWh/ton] of product) wet processes demand substantially more thermal energy (6,000 megajoules per ton [MJ/ton] to 7,000 MJ/ton compared to 750 MJ/ton to 3,000 MJ/ton) (Istanbul Chamber of Commerce 2003). This is the main reason why dry processing is dominant today.

2.1. Global Outlook of the Cement Industry

40. Demand for cement heavily depends on the construction sector and closely follows economic cycles. Housing, nonresidential building construction, and civil engineering works constitute the main consumer sectors. Paralleling the global economy, and in particular a booming construction sector, global cement production enjoyed exceptional growth rates of 9.9 percent and 7.6 percent in 2006 and 2007, respectively. The growth rate slowed drastically, falling to 3.4 percent in 2008. In the same year, global cement production peaked at 2,870 metric tons (Mt) (figure 4). According to the "Global Cement Report" (ICR 2008), in 2006 there were more than 2,020 integrated cement production facilities, up from 1,800 in 2006, and 380 dedicated grinding facilities.

Figure 4. Global Cement Production from 2007 to 2008 (Values in Mt)

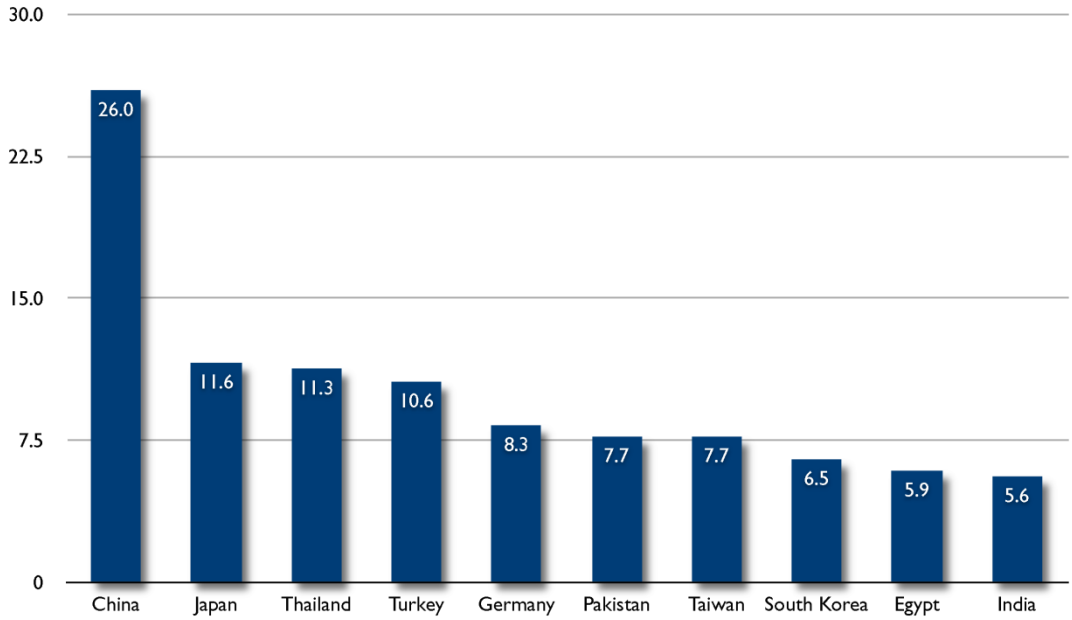


Source: Calculations based on ICR 2008 data.

41. Looking at the market in regional terms, North Asia, which includes China and Japan, with 1,500 Mt, accounted for 53 percent of global consumption in 2008. This is up from 44 percent a decade earlier. The consumption level in India accounted for 8 percent of global consumption, or 220 Mt, up from 7 percent a decade earlier. Share of global demand also increased over the last decade in the Middle East, Eastern Europe, and Central America. Western Europe consumed 266 Mt in 2008, making it the second-largest cement-consuming region in the world. Its share in global consumption, however, was down to 9 percent compared to 16 percent a decade earlier. Similarly, North America consumed 5 percent, down from 9 percent a decade earlier.

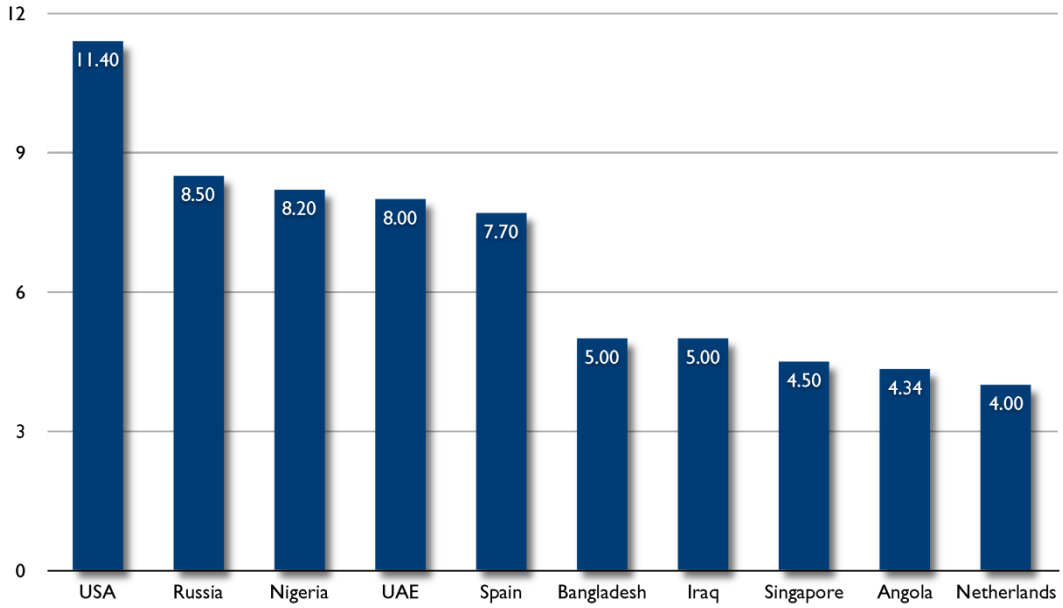
42. World trade in clinker and cement was 164 Mt in 2008, 70 Mt of which was clinker. This accounts for 6 percent of global production, down by 6 percent compared to the year before. Figure 5 displays the top 10 cement-exporting countries in 2008. Note that Turkey was the fourth-highest exporter globally, with exports reaching 10.6 Mt. Figure 6 presents the top 10 importers of cement in 2008.

Figure 5.Top 10 Cement Exporting Countries in 2008 (Values in Mt)



Source: Calculations based on ICR 2008 data.

Figure 6. Top 10 Cement Importing Countries (Values in Mt)



Source: Calculations based on ICR 2008 data.

43. The global market remains dominated by a limited number of traditionally major players, led by several large companies: Lafarge, Holcim, HeidelbergCement, Cemex, Italcimenti, and Buzzi Unicem (International Cement Review 2008) (Table 2).

Table 2.Main Global Players in Cement Sector

Company Name	Cement Capacity in 2008 (Mt)	Cement Sales in 2008 (Mt)
Lafarge	205	155
Holcim	194	143
HeidelbergCement	103	89
Cemex	96	87
Italcimenti	77	63
Buzzi Unicem	43	32

Source: ICR 2008.

44. The cement industry is among the leading capital-intensive manufacturing sectors and is therefore characterized by high fixed costs. Initial investment costs, expressed in terms of years of turnover is, for cement plants, given by a factor of 3.0. This compares to factors of 2.7 and 2.3, respectively, for paper and glass production plants. For a plant producing 1 Mt per year, about US$200 million is needed for capital equipment. In the cement sector, about 70 percent of variable costs are incurred by energy; therefore, more emphasis is given to energy efficiency measures (Wagner and Vassilopoulos 2000).

45. Labor productivity in the cement sector varies based on factors such as technology, size, product range, and capacity utilization. Owing to ongoing modernization efforts, labor productivity in the European cement sector has doubled over the last two decades (Wagner and Vassilopoulos 2000). Table 3 lists the costs of a European cement plant and the percentage of the unit and fixed costs in the production of cement.

Table 3.Rough Estimate of Factors Contributing to Unit Costs

Fixed Costs	% of Total Unit Cost	% of Fixed Cost
Depreciation & financing costs	40%	70%
Maintenance	8%	13%
Personnel, rents, rates	8%	15%%
Admin & overhead	1%	2%
Subtotal	**56%**	**100%**
Variable Costs	**% of Unit Costs**	**% of Variable Costs**
Fuel (thermal)	16%	36%
Electricity	15%	35%
Raw materials	11%	25%
Packaging, refractories, wear parts, lubricants, royalties	2%	4%
Subtotal	**44%**	**100%**

Source: Wagner and Vassilopoulos 2000.

46. Cement products commonly command a low unit-selling price. In the building industry the costs for cement amount to about 1 percent of the cost of construction (this value is around 4 percent for the Turkish sector[12]). A reduction or increase in

[12] Adnan İğnebekçili, chairman of the board of Turkish Cement Manufacturers Association, quoted in the *Web Hatti Haber Bulteni*, February 15, 2008. Accessed on June 21, 2010.

cement price hardly affects demand, although it may have important consequences for individual companies. Thus, demand for cement can be seen as highly inelastic. Moreover, cement prices have been decreasing in real terms (Wagner and Vassilopoulos 2000). While the overall consumer price index for Europe between 1982 and 1992 rose by 63 percent, the price of cement rose by only 30.6 percent, a relative price decrease of approximately 20 percent (European Cement Association 1995).

47. Since cement is a commodity with a low price-to-weight ratio, physical proximity to markets is important. Long-distance transport often requires the use of the sea, waterways, or railways to be competitive.

2.2. Environmental Aspects Related to Cement Production

48. Air emissions and energy use are the two main environmental aspects of cement manufacturing, and both are primarily linked to clinker production. Noise emissions and emissions to water and waste generation in smaller quantities are among secondary environmental impacts.

Air emissions

49. Dust, nitrogen oxides, sulphur oxides, and carbon dioxide are the main polluting substances emitted into the air. Carbon monoxide, metals, hydrogen fluoride, hydrogen chloride, dioxins, and furans are also emitted during production. The types and amounts of substances emitted vary among different plants depending on the raw materials, fuels, and production processes used.

Dust emissions

50. Channeled and diffused dust emissions are sources of concern. Channeled dust emissions arise mainly from the raw material preparation process (raw mills), grinding and drying units, the clinker burning process (kilns and clinker coolers), and the fuel preparation and cement grinding unit (mills). In addition, diffuse dust can be emitted from raw material and product storage areas and from conveyor belts. Electrostatic precipitators and fabric filters are commonly used in the industry to control channeled dust emissions. Emission values in the EU are reported to vary between 240 milligrams per normal cubic meter (mg/Nm^3) to less than 10 mg/Nm^3 depending on the process and pollution control technologies. Diffused dust emissions are usually controlled by containment in storage areas and conveyor belts, or by keeping the dust down.

Nitrogen oxides

51. Nitrogen oxides are formed in the high-temperature clinker burning process and are one of the major environmental concerns linked to cement production. The main part of nitrogen oxide (NO_x) emissions are formed through a mechanism where the nitrogen in the combustion air reacts with oxygen at elevated temperatures and is called thermal NO_x. The remainder of NO_x is formed when nitrogen chemically bound in fuels react with oxygen and is called fuel NO_x.

52. Yearly average NO_x emissions from European cement kilns are around 780 mg/Nm^3 (measured as nitrogen dioxide [NO_2]), with individual emission values varying from 145 mg/Nm^3 to 2,040 mg/Nm^3.

Sulphur oxides

53. Sulphur content of the fuel or raw materials can combine with oxygen and form sulphur oxides (SO_x). This is more of a problem in wet processes, since most of the SO_x is bound to calcium carbonate during the calcination process in dry processes. It can also be an issue for plants burning waste as supplementary fuel.

Carbon dioxide

54. The cement industry is among the chief emitters of carbon dioxide (CO_2), a potent greenhouse gas suspected of being a contributor to climate change and subject to considerable political and regulatory pressure. CO_2 emissions arise both during the transformation of raw materials (approximately 60 percent), due to combustion of fossil fuels in production (approximately 35 percent), and from the use of electricity (about 5 percent).

Other emissions

55. Emissions of other gaseous substances—including carbon monoxide (CO), heavy metals, hydrogen chloride (HCl), hydrogen fluoride (HF), total organic compounds (TOC) including volatile organic compounds (VOC), polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDDs and PCDFs)—can take place and are among the environmental concerns linked to the industry. Some of these emissions may become particularly significant for plants using waste materials and supplementary fuels.

Energy Use

56. Cement production is a highly energy-intensive process consuming large quantities of thermal and electrical energy. Depending on the production input and process set-up, between 3,000 MJ to more than 6,500 MJ of thermal energy can be used for producing 1 ton of clinker. In addition, between 90 kWh to 150 kWh of electricity are used—mostly in raw material and product mills, in exhaust fans, and conveyor belts—to produce 1 ton of cement (European Commission 2010). Various conventional fossil fuels and suitable waste materials are commonly used to provide the required thermal energy.

2.3. Environmental Demands on the Sector

57. Environmental demands on the sector vary depending on where the cement plant is located. However, in recent years, owing to its high CO_2 emissions, pressure on the sector has increased globally as part of discussions on the mitigation of climate

change impacts. Pressure is likely to increase commensurate with the growing interest in carbon footprints and carbon disclosure.

58. Use of waste materials, and in particular hazardous and special waste, as supplementary fuel, is another factor that has increased the environmental demands on the industry, particularly in Europe.

59. The sector is also a major link in the chain of construction products, which are subject to increasing environmental demands, ranging from the management of wastes to the adoption of environmental product declarations for materials used. So far, however, there are no known requirements for "extended producer responsibility" or for environmental product declarations for cement products.

3. The Turkish Cement Industry

60. The first cement manufacturing plant in Turkey was established in 1911 in Darıca with a 20,000-ton-per-year capacity. As of June 2010, there are 48 integrated clinker and cement plants and 17 milling and packaging facilities in Turkey, with a total installed capacity of more than 65 Mt per year of clinker and 103 Mt per year of cement. Figure 7 presents the geographic distribution of integrated plants in Turkey. In 2009, the sector represented 1 percent of the country's gross domestic product (GDP) and provided direct employment to 14,200 people. This figure rises to 25,000 when other sectors supporting the cement industry are included. Since 2008, the Turkish cement industry has been the leader in Europe in terms of production and export volumes. Globally, the Turkish cement industry is within the top ten producers and top four exporters. Foreign ownership in plants is around 35 percent.

Figure 7. Geographic Distribution of Integrated Cement Plants (using a map on administrative division of Republic of Turkey)

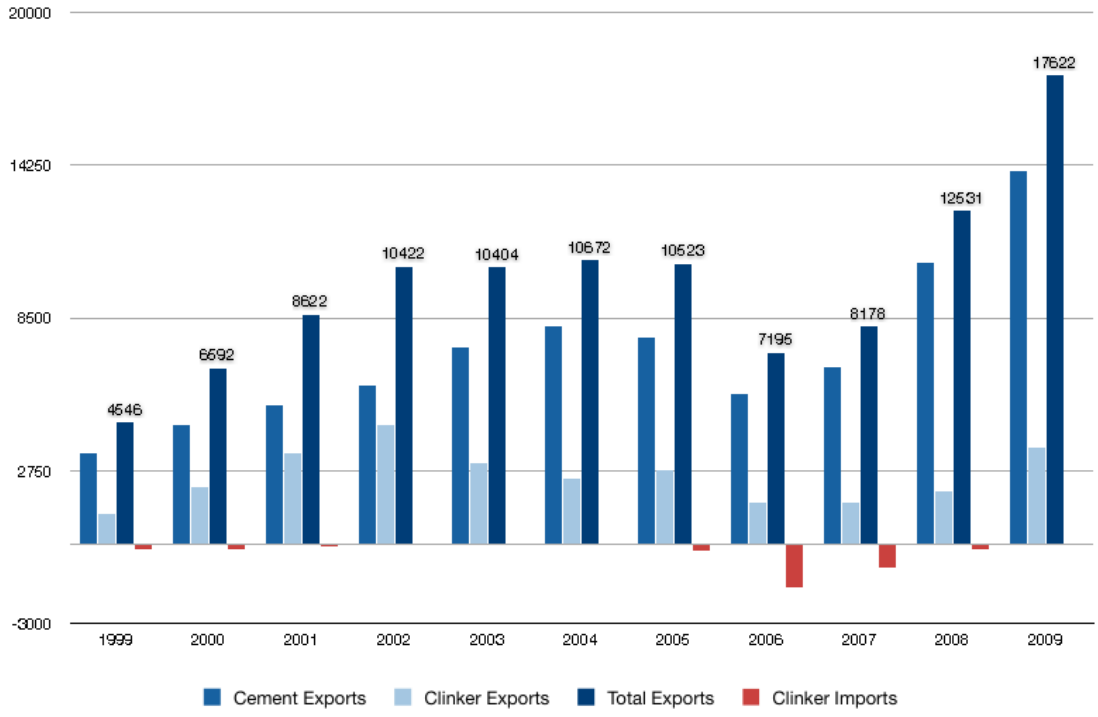
Source: TCMA.

From 2008 to 2009, clinker and cement production in Turkey increased by 4 percent and 9 percent, respectively[13]. In 2009, the construction sector, one of the worst affected by the global financial crises, experienced a 16.3 percent contraction. Despite this, domestic sales of cement in 2009 remained at about 2008 levels, mostly helped by public works projects. In response to the stagnation in the domestic market, the industry has concentrated more heavily on export markets. As a result, exports of

[13] Based on updated information provided by TCMA (Derinöz 2010, personal communication)

clinker have increased by 84.5 percent and of cement by 40 percent[14]. Russia and the Middle East and North African and Central Asian countries comprise the main export markets for the sector, with the share of European countries decreasing (TCMA 2010). Figure 8 displays the increase in the volume of Turkish cement exports from 1999 through 2009

Figure 8. Turkish Cement Industry and International Trade

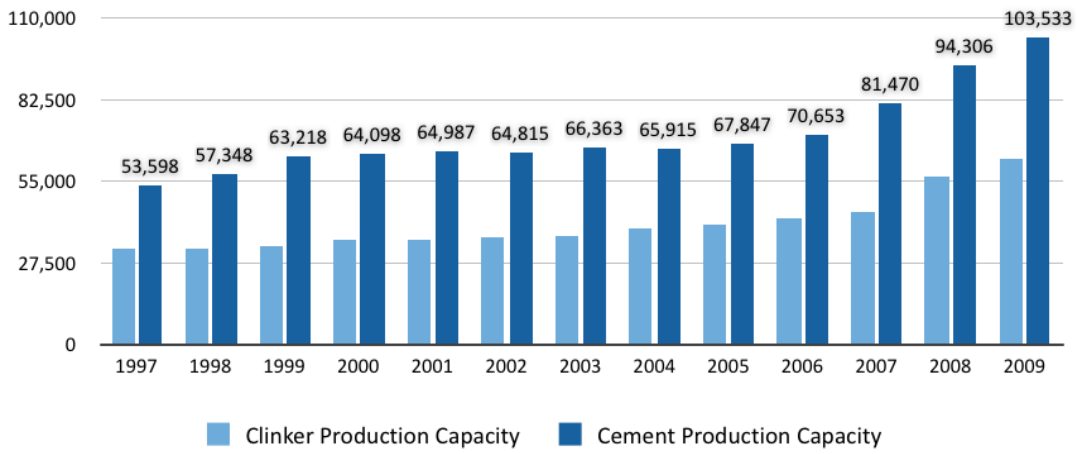


Source: TCMA 2010.

61. The Turkish cement industry has steadily increased its production capacity, with sharpened acceleration starting in 2005 (see figure 9). The substantial increase in capacity combined with the impacts of the 2008–09 global financial crises on the Turkish construction sector has pushed the price of cement down (Ministry of Industry and Trade 2010).

Figure 9. Clinker and Cement Production Capacity in Turkish Plants (Values in ktons)

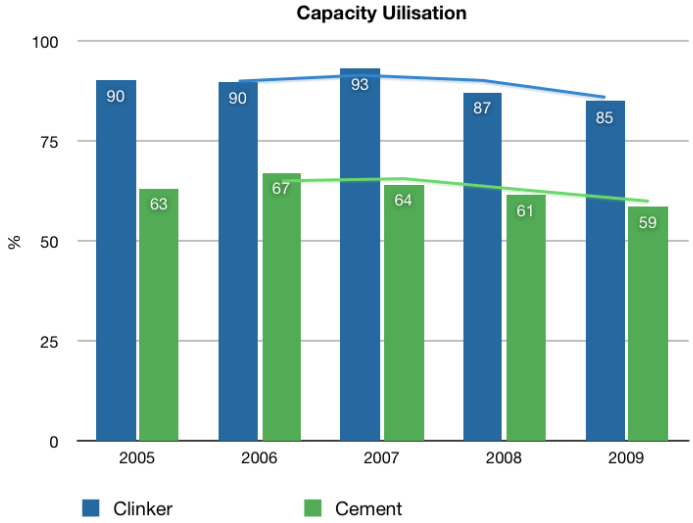
[14] Ibid



Source: Based on data provided by the Turkish Cement Manufacturers Association.

62. Due to these depressed prices, earnings in the sector declined by 20 percent in 2009, although larger firms focusing on export markets have seen their earnings increase (*Property News* 2010). There are differing views about the impact of production capacity expansion on the sector. On one hand, there is concern that there are declining capacity utilization rates (figure 10) while there are a number[15] of new large-scale plants in the planning stage. On the other hand, national development projections indicate the need for an additional 60 percent[16] production capacity until 2020. TCMA's official letter to the Ministry of Environment and Forestry (TCMA 2009) regarding greenhouse gas emissions potential supports the emission reduction targets established in the context of the national climate change commitments while ensuring sustainable sector growth.

Figure 10. Capacity Utilization Rates in Clinker and Cement Industry in Turkey



Source: TCMA 2009.

[15] More than seven new projects have submitted Environmental Impact Assessments.

[16] There are different opinions regarding this percent. Per capita cement consumption in 2009 was around 590 kg/capita. Some members of the industry (for example, Şahinoğlu Atalay, Director of Nuh Çimento [as quoted by the İstanbul Chamber of Commerce, http://www.ito.org.tr/]) state that consumption values of around 900 kg/capita will be reached by 2020. Others (for example, TCMA staff) gave a figure of around 700 kg/capita to 750 kg/capita based on a graph showing the relationship between per capita GDP and per capita cement consumption in different countries that is used by the industry for demand projections.

63. Table 4 presents the average cost structure of Turkish cement plants. Energy costs account for around 60 percent of the production costs—high compared to 40 percent in the EU. Coal, petrocoke, and fuel oil are the main fossil fuels used. Many of the wet processes were converted to dry ones during the capacity increase that occurred between 1965 and 1973, with the objective of saving energy after 1974. In addition, more than 50 percent of the integrated plants were either established or retrofitted after 2000. Therefore, these plants have modern technical infrastructures and are highly efficient.

Table 4. Cost Structure in the Turkish Cement Industry

Industrial Cost Items	Average Cost (%)
Raw and auxiliary materials	9.6
Electricity	21.1
Fuel	38
Labor	9.4
Amortization	7
Other fixed costs	13.1
Other costs	1.8
Total:	**100**

Source: Ministry of Industry and Trade 2010.

3.1 Environmental Profile of Turkish Cement Plants

64. In Turkey, the cement sector is regarded as a pioneer in terms of responsiveness to environmental demands, demonstrating a good record of compliance with relevant environmental regulations. It was the first sector to sign an Environmental Declaration—in 1993—and the second one in 2004—and is regarded as living up to its commitments. Item 14 of the Second Cement Sector Environmental Declaration mandates a commitment to work with the Ministry of Environment and Forestry in adopting Best Available Techniques (BATs) promulgated by the IPPC for the cement sector.[17]

65. In 2009, 44 of 47 plants acquired emission permits and are considered to be in full compliance with applicable regulations, while three plants are in the process of acquiring permits. This implies that sector plants meet the emission limits listed in table 5.

Table 5. Emission Limits for Air Pollutants Applicable to the Turkish Cement Industry

Pollutant	Emission Limits		
Dust (mg/Nm^3)	**120** – for electrostatic precipitators installed before 1993	**75** – for fabric filters installed prior to 1993	**50** – for plants installed or retrofitted after 1993
NO_x (mg/Nm^3- as NO_2)	**1,300** – for plants installed before July 2009	**800** – for plants installed after July 2009	
SO_2 (mg/Nm^3)	**300**		

Source: Based on the "Regulation on the Control of Industry-induced Air Pollution" ("Sanayi Kaynaklı hava kirliliğinin Kontrolü Yönetmeliği"), Ministry of Environment and Forestry, as published in the Official Gazette of July 3, 2009, No. 27277.

66. However, there is considerable difference between the regulatory limits and the values that are achievable with the use of BATs—<10 mg/Nm^3 to 20 mg/Nm^3 for dust and 200 mg/Nm^3 to 450 mg/Nm^3 for NO_x. Consequently, solely knowing that the companies are in compliance does not provide sufficient information to assess their distance from potential IPPC-induced performance targets. Representative

[17] Second Cement Sector Environmental Declaration (2004).

information regarding actual plant performance levels is currently not available. Furthermore, a majority of the plants have modern installations, particularly with regard to energy efficiency. Preheating is employed in almost all of the kilns and precalcination is employed in around 35 percent. Kiln types and their geographic distribution are provided in table 6.

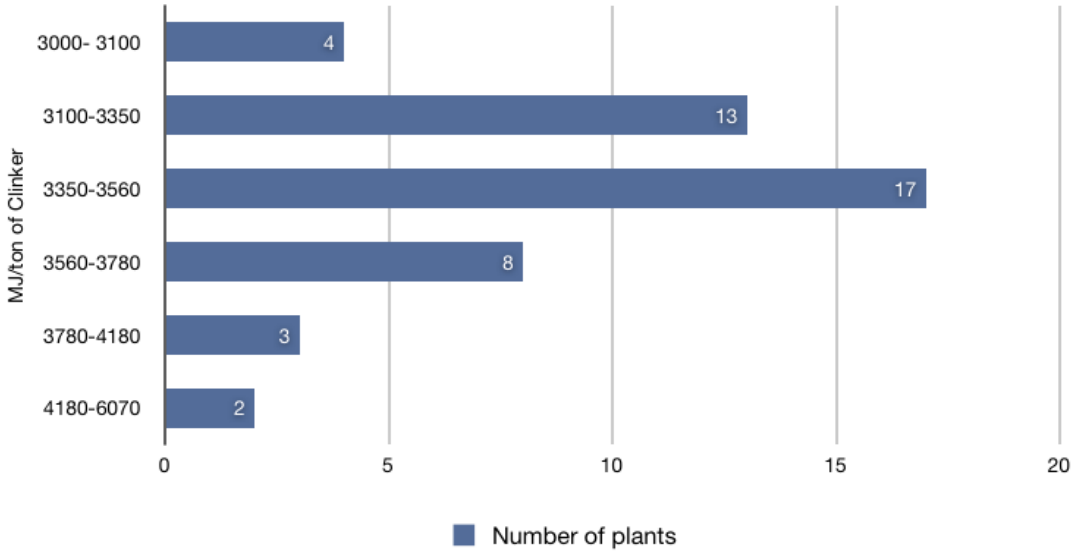
Table 6. Kiln Types and their Geographic Distribution

	Number of Kilns		
Regions	Dry with Precalcination and Preheater	Dry with only Preheater	Wet Processes
Marmara region	8	6	0
Agean region	4	3	1
Mediterranean	3	9	0
Black Sea region	3	3	0
Central Anatolia region	4	10	2
Eastern Anatolia region	1	3	0
Southeast Anatolia region	1	6	0
Total	**24**	**40**	**3**

Source: Based on information from the TCMA.

As figure 11 shows, the thermal energy consumption in more than 35 percent of the plants is within the BAT targets, given as 2,900 MJ/ton to 3,300 MJ/ton of clinker, and more than 50 percent of all plants are either BAT compliant or within a 10 percent deviation from the BAT values concerning thermal energy use.

Figure 11. Thermal Energy Use in Turkish Cement Industry



67. In cement production, increasing the use of alternative additives, thereby reducing the clinker demand, is a desirable approach to reduce environmental impacts. This is among the BAT recommendations for the sector. In Turkey, the use of alternative additives is also a common practice; in 2004, 60 percent of the cement sold in the domestic market had additives (State Planning Organization 2006).

68. An increasing number of plants are using waste materials as a supplementary fuel, and 30 of 48 plants have a waste combustion license (MoEF 2010). The recently enacted *regulation concerning the combustion of waste* will be applicable to these

plants and will impose much stricter emission levels. According to this regulation, the conditions outlined in table 7 are now applicable to cement plants burning waste.

Table 7. Requirements of Regulation Concerning Combution of Waste.

Requirement	Earlıer Requirement	New Requirement
Dust emissions (mg/Nm^3)	50–120	30
NO_x emissions (mg/Nm^3)	800–1,300	800 existing plants 500 new plants
SO_x emissions (mg/Nm^3)	300	50

Source: Regulation concerning the combustion of Waste (2010)

69. According to the Regulation, for the purposes of the enforcement of NO_x emission limit values, cement kilns in operation and holding emission permit are not regarded as new plants.[18] In addition, this regulation brought renewed monitoring demands for substances such as hydrogen fluoride and hydrogen chloride.

70. A major issue that currently has no legally binding implication but that could soon become a key concern is the CO_2 emissions of the sector. With 16.7 million tons of CO_2 emissions, the cement industry was responsible for 7 percent of CO_2 emissions in the country in 2004 (UNFCCC 2007). CO_2 emissions result from processes used in the production of cement and clinker (for example, calcinations of raw meal, burning of fuel in rotary kilns, and burning of fuel in thermal power plants producing electricity for clinker production and cement grinding). Given that significant capacity increases have been realized in the sector since then, using available technology, it is likely that the sector's share in the country's emissions has increased. Turkey recently signed the Kyoto Protocol, but it has not specified sector reduction targets. The cement industry has already taken steps to reduce existing levels of emissions and has indicated the possibility of further reducing levels by 9 percent (Tezmen 2010).

71. The carbon credits and emission trading schemes (ETS) implemented in the EU have had an impact on the competitive position of the cement industry in Europe. As a result, plants in Europe had to reduce their production and increase clinker imports, impacting the cost of production. Increasing pressure on Turkish producers to comply with comparable emission obligations is likely to become a future challenge. The cement industry in Europe is keenly aware of the implications of the Kyoto Protocol and of emission trading schemes and has responded to the anticipated developments by exploring the possibilities for improving energy efficiency and making necessary investments.

[18] According to the subject regulation, exemptions are provided to combustion plants for various parameters. For kilns that burn less than 3 ton/h of waste as supplementary fuel an exemption is provided until 31 December 2014 for NOx, if it can be documented that total emission limit value for NOx is not higher than 1,200 mg/m^3 during test combustions. A similar exemption is provided for wet-process kilns using less than 3 ton/h waste as supplementary fuel until 31 December 2014 for dust emissions, if it can be documented that total emissions for dust do not exceed than 50 mg/m^3 during trial combustion.

4. The Integrated Pollution Prevention and Control (IPPC) Directive and its Implementation

4.1 IPPC and its Requirements

72. First enacted in 1996, IPPC Directive 96/61/EC adopts an integrated approach to pollution prevention and control. It addresses emissions into the air, water, and soil, and addresses waste management, requiring industrial and agricultural activities with a high pollution potential to acquire operating permits. The original IPPC Directive has been amended four times since it entered into force and a codified version compiling all amendments was issued in 2008 (2008/1/EC).

73. The IPPC Directive covers new or existing industrial and agricultural activities. These are defined in Annex I of the Directive and include, among others, energy, production and processing of metals, the mineral industry, the chemical industry, waste management, and livestock farming. The Directive contains measures designed to prevent or, where that is not practicable, to reduce, emissions into the air, water, and soil from the installations it covers, including measures concerning waste, promoting energy efficiency, and ensuring accident prevention and damage limitation, in order to achieve a high level of protection of the environment. Permits are issued only when such measures are implemented. In accordance with the "polluter pays" and "pollution prevention" principles,[19] the companies themselves bear the responsibility for implementing all necessary IPPC measures.

74. In the EU, about 52,000 installations are covered by the IPPC Directive (Commission of the European Communities 2007). In accordance with Section 3.1 of Annex I, entities required to obtain a permit include:

> "…installations for the production of cement clinker in rotary kilns with a production capacity that exceeds 500 tons per day or lime in rotary kilns with a production capacity exceeding 50 tons per day or in other furnaces with a production capacity exceeding 50 tons per day…"

75. The IPPC Directive was to be applied to new installations, and to existing installations undergoing "substantial changes," from October 30, 1999, which was also the deadline for transposition by Member States. For existing installations, the deadline to achieve full compliance with the Directive was October 30, 2007.

76. The Directive is based on the following key principles:

[19] Organization for Economic Co-operation and Development recommendations adopted on November 14, 1974, state that the Polluter-Pays Principle, as defined by the Guiding Principles concerning International Economic Aspects of Environmental Policies, means that the polluter should bear the expenses of carrying out the measures such as allocating costs of pollution prevention and control measures introduced by the public authorities to ensure that the environment is in an acceptable state. In other words, the cost of these measures should be reflected in the cost of goods and services that cause pollution in production and/or consumption.

- **Integrated approach:** The aim of this approach is to ensure a high level of protection of the environment as whole. Thus, the entire environmental performance of the plant covering, for example, emissions into air, water, and soil, the generation of waste, the use of raw materials, energy efficiency, noise, prevention of accidents, and restoration of the site upon closure, must be taken into account in the issuance of permits by the responsible authority.
- **Best Available Techniques (BATs):** Both permit conditions and emission limit values (ELVs) must be based on BATs. Guidance for industries and licensing authorities is provided in BAT Reference Documents (BREFs) adopted and published by the EU Commission and is based on information exchanged among experts, industry, and environmental organizations.
- **Flexibility:** Provides the licensing authorities with flexibility in determining permit conditions, considering:
  - Technical characteristics of the installation
  - Geographic location of the installation
  - Local environmental conditions.

- **Public participation:** The IPPC Directive ensures that the public has the right to participate in the decision-making process and to be informed of its consequences. This is enabled through access to:

  - Permit applications in order to give opinions
  - Permit results of the monitoring of releases
  - The European Pollutant Release and Transfer Register (E-PRTR) (Regulation No.166 Commission of the European Communities of January 18, 2006).

Compliance requirements

77. To obtain a permit, operators must show that they have systematically developed proposals to apply the BATs and meet certain other requirements, taking relevant local factors into account. These requirements are related to:

- Use of all appropriate pollution-prevention measures, namely the BATs (which produce the least amount of waste, which use less hazardous substances, and so forth)
- Enabling the substances generated to be recovered and recycled
- Preventing all large-scale pollution
- Preventing, recycling, or disposing of waste in the least polluting way possible
- Using energy efficiently
- Ensuring accident prevention and damage limitation
- Returning sites to their original state when the activity is over.

Factors influencing the permitting process

78. In addition, the decision to issue a permit must contain a number of specific requirements, including:

- Emission limit values for polluting substances (with the exception of greenhouse gases if the emission trading scheme applies)
- Any air, water, and soil protection measures required
- Waste management measures
- Measures to be taken in exceptional circumstances (for example, leaks, malfunctions, temporary or permanent stoppages, and so forth)
- Minimization of long-distance or transboundary pollution
- Release of monitoring results
- All other appropriate measures.

Permit application

79. All permit applications must be sent to the relevant authority issuing the permit, which will then decide whether or not to authorize the activity. Applications must include the following information:

- A description of the installation and the nature and scale of its activities and its site conditions
- The materials, substances, and energy used or generated
- The sources of emissions from the installation, and the nature and quantities of foreseeable emissions into each medium and their effects on the environment
- The proposed technology and other techniques for preventing or reducing emissions from the installation
- Measures for the prevention and recovery of waste
- Measures planned to monitor emissions
- Possible alternative solutions (European Parliament and of the Council 2008).

80. Recently, the European Commission approved a proposal for a Directive on Industrial Emissions, which recasts seven existing Directives related to industrial emissions into a single, clear, coherent legislative instrument. The recast includes the IPPC Directive, the Large Combustion Plants Directive, the Waste Incineration Directive, the Solvents Emissions Directive, and three Directives on Titanium Dioxide. Currently, the second draft of the proposed Directive is awaiting Commission approval. Anticipated implications of the recast Directive are described below.

4.2 IPPC in Practice, Implementation, and Relevant Experiences

81. Since the introduction of original IPPC Directive 96/61/EC, various assessments have been performed concerning its implementation and resulting impacts at both the community and National States levels[20]. The summary presented in this section is mostly based on a literature review. Although some of these assessments date back to 2007 or 2005, they are relevant for this study because they provide an overview of the early years of the IPPC Directive's implementation. Information was also gathered through interviews with relevant professionals.

[20] As many of the assessments were performed prior to the introduction of codified version of IPPC (2008/1/EC), the Directive's title is often quoted in its original form – i.e. 96/61/EC – in these assessments.

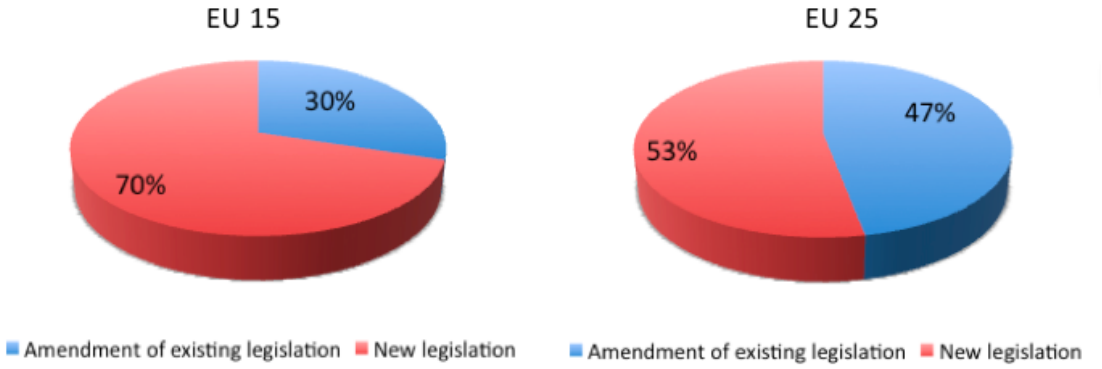
82. The implementation of IPPC Directive 96/61/EC differs across the EU member countries. This is partly due to the different starting positions and preexisting regulatory systems of the member states, and partly due to the flexibility built into the Directive.

Transposition of the Directive

83. Significant delays have been observed in the transposition of the Directive by Member States. EU-15[21] Member States did not transpose the Directive until the end of 2004, and there are still certain gaps. Transposition by most new Member States is ongoing.

84. Different approaches were used by Member States (MS) during transposition. Generally, most countries already had an integrated permit system, and some (France and Sweden) had to transpose the Directive only by making relatively small changes in existing legislation. Other MSs (Portugal and Spain) and the majority of new MSs, usually drafted new legislation, along with creating new permit systems and procedures to follow the provisions of the Directive more closely (Commission of the European Communities 2005). Figure 12 displays the approaches adopted by the EU-15 and EU-25[22] Member States for transposition.

Figure 12. Approaches to Transposition



Source: Based on information from the Industrial Emissions Reporting Information System. http://iris.eionet.europa.eu.

Progress with permitting

85. Until the end of 2002, the Member States appeared to have made inadequate progress with permitting, raising concerns for meeting the October 30, 2007, deadline, by which all eligible facilities were expected to comply with Directive requirements (Commission of the European Communities 2005). This led to a Commission-level communication to accelerate progress with permitting. Information provided for 2005–07 demonstrated more progress being made, although the number of facilities

[21] The EU-15 comprises Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom.

[22] The EU-25 comprises Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom.

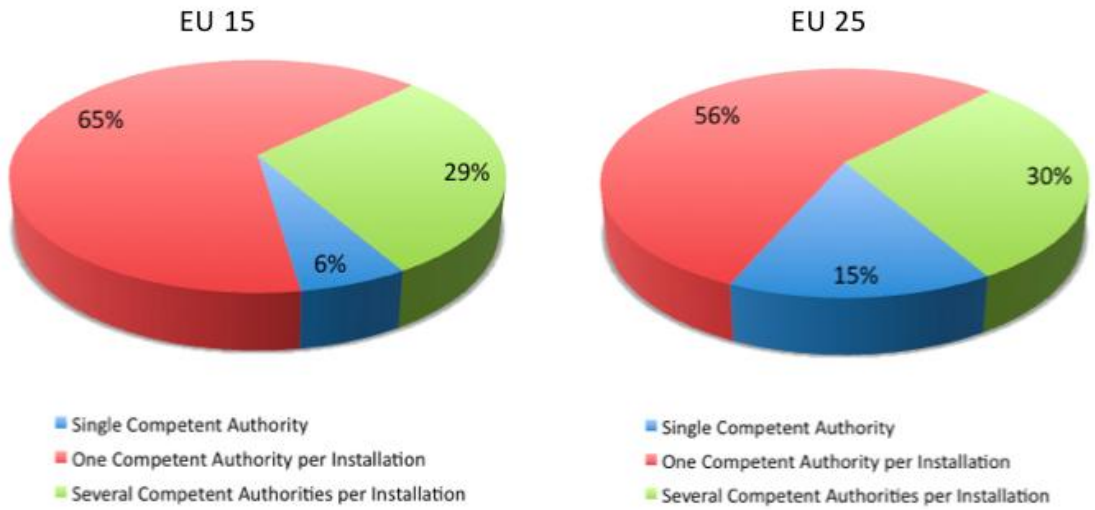
covered by the Directive was reduced to 36,000 (from an original of 52,000) by this date (Commission of the European Communities 2005). A considerable number of IPPC permits were issued based on existing regulations, but are periodically reconsidered as plant updates become necessary to comply with the latest IPPC requirements.

86. To date, countries show significant variations in their permitting progress with Belgium, Denmark, Germany, and Hungry leading the way, and Greece, Malta, Poland, Portugal, Slovenia, and Spain making little progress.

Competent authority

87. Member States developed different approaches with respect to competent authorities responsible for permitting. While some states had a single authority responsible for all aspects of the permitting process, others have distributed the responsibilities among different authorities. Different levels of sophistication regarding the coordination among these Member States have been observed. Figure 13 shows the distribution of different approaches with regard to competent authorities involved in permitting.

Figure 13. Authorities Involved in the Permitting Process



Source: Based on information from Industrial Emissions Reporting Information System. http://iris.eionet.europa.eu.

88. The majority of Member States opted to establish a single authority for permitting, which offers various benefits such as assisting consistency, ability to develop required competencies, and reducing administrative difficulties. Such an approach, however, places an excessive load on a single authority and can slow the implementation process. Whereas allocation of responsibilities between a central authority and local agencies during permit issuance and follow-up is desirable, in practice such an approach has been challenging. Local authorities often lack the necessary capacity to assess relatively complex issues, like BATs, and the permit process involving specific arrangements between the regulator and the regulated is

considered among the main difficulties (Morra 2010 personal communication; Pisco 2010 personal communication).

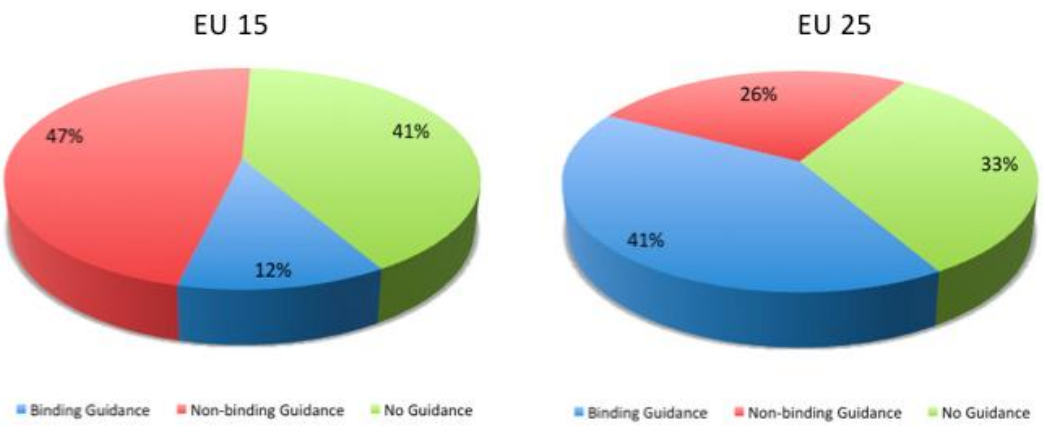
Specific guidance for implementation

89. Depending on the characteristics of the legal framework and permitting, the introduction of the IPPC Directive can imply significant changes in approaches taken in the permitting process. In addition, there has been confusion regarding elements of the Directive, such as threshold criteria to be used for determining covered installations, interpretation of "substantial change," deriving BAT-based ELVs, monitoring and inspection, and returning sites to their original states. In an effort to help the regulators, certain countries have produced specific guidance documents detailing the requirements of the IPPC permitting process.

90. The Directive may require industries to consider a significantly different set of issues, namely BATs, during their permit application. Practice on BATs Guidance and the use of BAT References Documents (BREFs) varies across countries. Some countries adopted national guidance documents, though borrowing elements from the BREFs (for example, Belgium, Finland, Greece, Ireland, the Netherlands, Spain, and the United Kingdom), while others rely on the BREF material (for example, Portugal), and others intend to continue with national rules and guidance (Institute for European Environmental Policy 2003).

91. In addition, the inherent flexibility of the Directive leaves considerable room for the competent authorities to determine the final permit conditions. The consideration of BATs in the permitting process has shown significant variations, and has been a key concern – this was among the key reasons for proposing a recast Directive on Industrial Emissions, about which more information is provided further in the report. In an attempt to emphasize the industry's responsibility, 41 percent of Member States developed guidance documents for BATs determination for different industries. To better regulate the permitting process, and to reduce disputes, such guidance documents are legally binding. The nature of guiding documents is presented in figure 14.

Figure 14. Guidance for Industry Regarding BATs Determination



Source: Based on information from Industrial Emissions Reporting Information System. ***http://iris.eionet.europa.eu***.

Compliance with permit conditions

92. Procedures for checking compliance with permit conditions were established by most Member States (MSs), generally through on-site inspections. The frequency of such inspections, as well as the use of self-monitoring carried out by the operators or by non-administrative bodies (for example, accredited laboratories), varies among MSs. The requirement for operators to regularly inform the competent authorities of the results of the monitoring of releases into the environment has also been introduced in most states. As of 2003, some MSs were still in the process of defining procedures for regular inspections.

Permit reconsideration

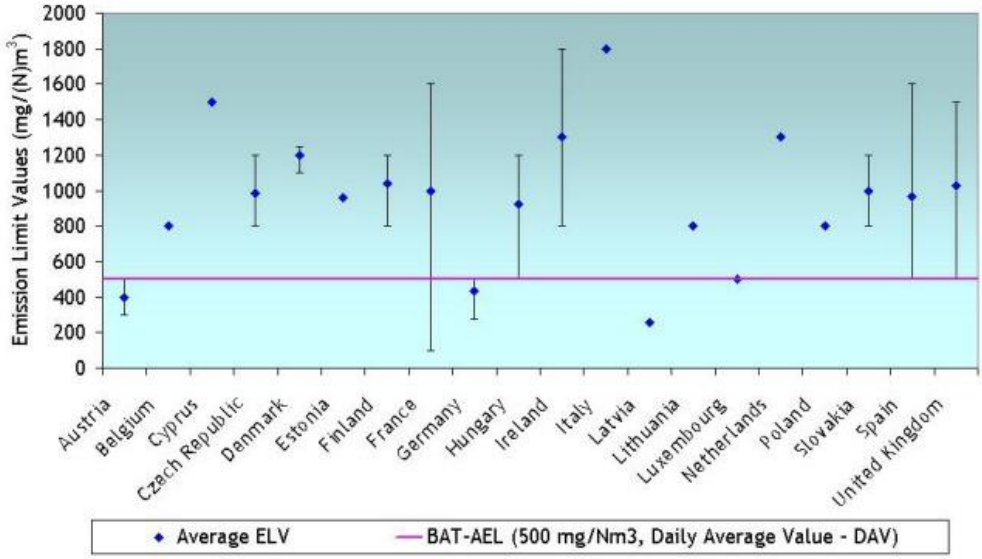
93. The IPPC permits are subject to reconsideration, during which time considerable new changes can be demanded. MSs adopted different approaches to permit consideration. Some MSs have set minimum reconsideration schedules applicable across the board, whereas others set the reconsideration times on a case-by-case basis. For instance, in Sweden, each installation is inspected on average every two years; in France inspections are done annually; and in Spain, inspections are carried out at the initiative of the competent authorities (Commission of the European Communities 2005).

Emission limit values

94. As mentioned, the IPPC permitting process requires ELVs to be based on performance achievable through the use of BATs and to be adjusted according to local environmental conditions. As of end-2002, there has been little use of local environmental quality standards among Member States. The use of Generally Binding Rules (GBRs), which establish standard conditions for specified activities at the national level and which have a longer history of being implemented by Member States, are regarded from an administrative perspective as being easier to implement, and are more widely used during the permitting process. Only in limited cases have ELVs been developed based on BAT references.

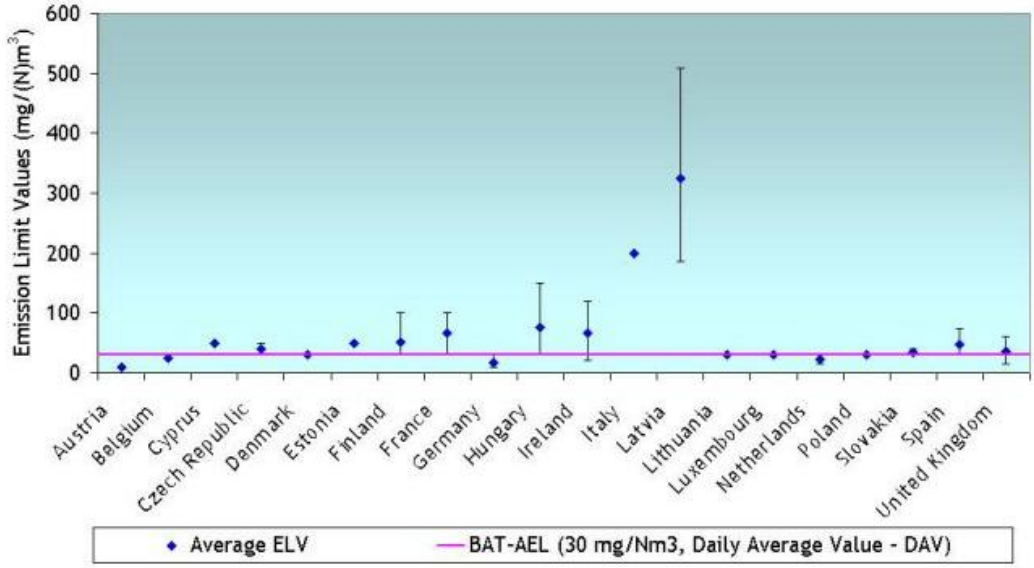
95. Variations across Member States were not limited to the approaches taken to determine ELVs, and were also observed for the applicable ELVs themselves. Figures 15 and 16 show high variations in ELVs applied specifically for clinker and cement production.

Figure 15. ELVs for Nitrous Oxide in the EU-25



Source: Industrial Emissions Reporting Information System. http://iris.eionet.europa.eu.

Figure 16. ELVs for Particulate Matter in the EU-25



Source: Industrial Emissions Reporting Information System. http://iris.eionet.europa.eu.

96. High variations in approaches taken for determining ELVs and the substantial differences among the resulting ELVs have been a major concern, leading to suboptimal environmental protection and distortions of the internal market.

4.3 Benefits and Drawbacks of the IPPC Directive

Public benefits and drawbacks

97. Although implementation of the IPPC Directive has been slower than planned, and variations in the application stimulate different levels of performance

improvement in industry, the IPPC Directive has been instrumental in bringing about various positive impacts.

98. From an environmental perspective, the IPPC Directive has enabled a reduction of emissions from industrial activities. It has also strengthened waste management through enhancing waste reduction, reuse, and recycling (DEFRA 2007), and has helped to reduce the risk of shifting problems from one medium to another. Its elements focusing on inefficiencies in the use of energy and material resources have contributed to the institutionalization of "preventive measures" in industry and have helped improve the overall resource productivity of industrial activities.

99. The IPPC stimulated ecological modernization of the industry. It has also increased the uptake of environmental technologies in regulated industries and had a positive spin-off effect on the producers of environmental technologies (DEFRA 2007).

100. The Directive also brought a larger share of industrial activities under the regulatory umbrella—particularly those plants that are old and inefficient and therefore form hotspots with regard to environmental protection (Dalhammar 2010). In addition, the features of the Directive that facilitate public participation in permitting and public disclosure of environmental performance information have been useful in raising public awareness and empowering the public to become an active stakeholder in industrial conduct.

101. Finally, the Directive and associated permitting procedures have made a significant contribution to improving the capacities and capabilities of public authorities. Personnel in such agencies have improved their knowledge about state-of-the-art approaches in different industrial sectors and have enhanced their abilities to perform their regulatory responsibilities through improved dialogue with industries.

102. However, as mentioned, implementation of the Directive is also associated with certain drawbacks. In cases where permit issuance and monitoring are badly organized, the Directive has led to an increased regulatory burden. More important, in cases where the relevant BATs and associated ELVs are inadequately enforced, implementation of the Directive produced suboptimal results.

103. It should also be noted that the introduction of the IPPC Directive to the Member States in the EU has been a difficult and slower than expected process. Considerable pressure has been placed on those member states that were found to be lagging behind, during intermediate evaluations, by the EU parliament. Alongside, a number of initiatives have been launched in order to assist the work of public authorities responsible for IPPC implementation, such as developing a specific group under the "European Union Network for the Implementation and Enforcement of Environmental Law" (IMPEL).

Private implications, benefits, and drawbacks of the IPPC Directive

104. From the perspective of private companies, the IPPC Directive means more emphasis on environmental performance issues and a need for financial resources. Although this is commonly perceived to be a factor for rising production costs, many industries have realized positive effects while adhering to the provisions of the Directive.

105. As mentioned, the Directive has propelled companies to focus on the inherent inefficiencies in processes and management control systems. As a result, companies pay more attention to important areas such as energy efficiency, environmental management systems, and good practices for waste management. This has led to improvements in resource productivity, thereby reducing costs linked to production and waste and emission management. In some cases, certain provisions of the Directive have helped the companies gain access to new markets (Kuisma 2010). The Directive also increased industry monitoring efforts, which, in light of the "what gets measured gets managed" philosophy, provided additional benefits.

106. Little information is available about the costs and additional burdens engendered by the IPPC Directive on industry. Studies conducted in the United Kingdom indicate that considerable costs can be incurred for permit application and maintenance. Murfin (2005) estimated the costs to be about €24,000 per year[23]. Another survey conducted by DEFRA estimated the cost of permit application to be in the range of €75,000, although reported costs showed high variations and more than 50 percent of respondents stated a cost below €44,000. It is worth noting that the costs required for external consultants had a high share for the first application, but internal staff costs became the major cost element for subsequent permit maintenance and renewal.

107. In a majority of cases, the companies engage consultants to assist with the permit application process, or to be fully responsible. At the same time, the quality of the consultants has a major impact on the quality of the permit application and, consequently, on the cost and duration of the permitting process (Morra 2010).

108. Regarding the costs of measures taken for compliance, the above mentioned study of DEFRA estimated the median value of one-off compliance costs linked to the improvements required by the permit to be around €46,000 – including capital costs, management time, monitoring and reporting – with the highest recorded costs being in the range of €7.3 million. The annual average ongoing costs of IPPC, on the other hand, was estimated to be in the range of €63,000 – again including capital, management time, monitoring and reporting costs[24]. (DEFRA, 2007). These costs are often regarded as negligible for larger organizations, but they can be significant for smaller facilities.

109. More detailed studies concentrating on the competitiveness impacts of the IPCC Directive on selected industrial sectors have also been performed (for example, by Carl Bro Group [2006] on the iron, steel, and glass industries; and by Wagner and

[23] In this study costs assessments were provided for a three-year valid permit for a low-risk, strategic technology unit plant, based on values in 2005. The breakdown of the cost is provided as: Environment Agency cost: 20 percent; application fees: 13 percent; maintenance fees: 20 percent; surrender fees: 20 percent; consultancy fees: 27 percent.

[24] The break-down of different cost items can be obtained from the referred study.

Triebswetter [2001] on the cement industry), with no conclusive results indicating negative impacts due to the requirements of the Directive. The Carl Bro Group study, however, highlights potential competitiveness impacts linked to the institutional context of implementation:

> *"Various potential economic impacts on competitiveness have been found in the analysis of the institutional context of IPPC implementation. There is reason to believe, given the lack of assessment methodologies, that many competent authorities assess economic viability at the level of individual companies rather than at the sector level as the Directive requires. It has also been found that competitive distortions can result from different levels of stringencies and regulatory quality, e.g., more stringent regulations typically negatively affect competitiveness of those companies immediately affected by them. Furthermore, the analysis of the institutional context shows that competitiveness impacts may arise in countries where the previous permitting regime displayed a low degree of similarity to the IPPC regime and where the regime therefore needed to be fundamentally restructured to implement the Directive. Moreover, competitive distortions can be due to differences in the frequency, regularity, consistency and quality of inspections across countries. Available evidence suggests that these differences are in- deed present. This is even clearer in the comparison with some non-EU countries (e.g., Russia). Other differences in IPPC implementation that have been found relate to variations in permitting fees, different schemes of financing permit-related activities of competent authorities and variations in the length of permitting. These latter differences may be relatively unimportant quantitatively, so that one may speak about irregularities rather than competitive distortions"* (pp. 11).

110. More relevant to this analysis is the work performed on the cement industry by Wagner and Triebswetter (2001). These authors report that the primary measures induced on the cement industry by the IPPC Directive are often not associated with a cost burden, but instead offer net savings. The authors state that secondary measures for the reduction of particulate matter, nitrogen oxide (NO_x), and sulphur oxide (SO_x) reductions entailed additional costs, but these are seen as having virtually no negative impact on the competitiveness of the industry. Similar to the Carl Bro Group study, the Wagner and Triebswetter study on the cement industry also concludes that *"most managers were not concerned about the impact of IPPC on competition among EU member and adjacent states but about imports by ship from countries further away… that lower prices in the EU*" (p. 16).

Key elements for successful implementation

111. A study conducted by three British experts (Gray, James, and Dickson 2007) has identified several elements as playing a key role for successful implementation of the IPPC Directive in the United Kingdom. Although their findings pertain to the specific circumstances of their country, they are considered to be applicable to other countries. The findings are:

- Phasing the introduction of the regime by the industrial sector over the period 2001–07 was essential in order to spread the workload.
- Having a single institution (the Environment Agency for most installations in England and Wales) responsible for the implementation of the integrated regulations has been crucial to its success.
- It is important to provide guidance that clearly describes the information required from applicants and that defines technical requirements for industry, regulators, and the public. Regulatory packages tailored to each sector were produced containing all the guidance and application tools necessary to apply.
- It is important to involve the industry and trade bodies early in the formulation of guidance, establishing BATs, and identifying sector-specific issues.
- A risk-based scoring system, called the Environmental Protection Operator and Pollution Risk Appraisal (EP OPRA), which takes site-specific characteristics into account, was introduced in 2002. The application and submission fees are based on the EP OPRA score.
- National permitting groups were established and this improved the consistency of permits. Training has also become faster and more cost-effective.
- Once the permit is issued, compliance and enforcement assessments are carried out. This assessment is based on the EP OPRA score.

112. As part of their study concentrating on the cement sector, Wagner and Triebswetter (2001) also emphasize that *"A sufficient time frame for planning investments is important as early and clear information on future environmental legislation will help companies to take into account upcoming regulations in their investment projects and to choose an optimal solution"* (p. 129).

113. This view is supported by industry. According to a representative from a European cement company, in the specific case of the cement sector, implementation of the IPCC Directive has been relatively problem-free. The industry has been involved in the development of the Directive from the early stages. Therefore, not only the requirements on the sector have been influenced, but also the sector was aware of what to expect. These advantages, combined with sufficiently long time frames for implementation, allowed the industry to make necessary changes and achieve compliance relatively smoothly (Abreu 2010).

The recast directives on industrial emissions

114. Following a detailed analysis regarding IPPC permit application, significant shortcomings were identified regarding:

- Implementation of best available techniques due to vague provisions on BATs in the current legislation
- A large degree of flexibility left for competent authorities to deviate from BATs requirements in the permitting process
- The unclear role of the BREFs.

115. Accordingly, it was found that permits issued for implementing the IPPC Directive often include conditions that are not based on BATs as described in the BREFs and included little if any justification for such deviation. These shortcomings

led to a failure to deliver the originally intended environmental goals and caused significant distortions in the internal market. These are the chief reasons for proposing a recast Directive on Industrial Emissions.

116. The proposed recast Directive includes provisions to strengthen and clarify the use of BATs and requires that BATs Reference Documents are used for setting permit conditions. It also demands that ELVs do not exceed the emission levels associated with the best available techniques as described in the BATs reference documents.

117. In addressing the issue of flexible treatment of installations based on context-specific circumstances, the proposal continues to enable competent authorities to grant exceptions to allow ELVs to exceed the emission levels associated with the BATs as described in the BREF documents. However, such exceptions are now required to be based on well-defined criteria and should not exceed the ELVs applicable to all Member States. In addition, such exceptions and their justification are required to be made publicly available.

118. The vague provisions of the IPPC on compliance reporting, inspections, and permit reviews are thought to be resulting in large variations in the application of legislation in Member States, and consequently suboptimal levels of environmental protection and distortion of the internal market. This situation makes clear the need for more specific provisions that will require operators to regularly report to the competent authority on compliance with permit conditions.

119. The proposal also requires the permit conditions to be reconsidered and, if necessary, updated, following the adoption of a new or updated BATs Reference Document, in order to take account of developments in the BATs or other changes regarding the operation of an installation. Furthermore, the proposal demands that Member States provide for a system of environmental inspections with minimum criteria. The proposed changes are expected to help secure and, in certain cases, speed up, implementation of BATs, thereby contributing to the achievement of the objectives of the Thematic Strategies and reducing distortion of competition.

120. Furthermore, the proposal suggests implementing powers for the European Commission, in particular to establish criteria for granting exceptions from the emission levels associated with the BATs as described in the BATs Reference Documents and to adapt the nonessential minimum requirements set out in its Annexes (Commission of the European Union 2007).

121. The proposed recast Directive is expected to provide significant benefits to the environment and human health by reducing harmful industrial emissions across the EU, in particular through better application of BATs. For the large combustion plants alone, net benefits could be €7 billion to €28 billion per year, and include the expected reduction of premature deaths and years of life lost by 13,000 and 125,000, respectively.

122. The streamlining of permitting, reporting, and monitoring requirements, and renewed cooperation with Member States to simplify implementation, are expected to

lead to a reduction in unnecessary administrative burdens of between €105 million and €255 million per year.[25]

[25] http://ec.europa.eu/environment/air/pollutants/stationary/ippc/proposal.htm.

5. Compliance GAP Analysis and Probable Costs for the Turkish Cement Industry

123. Determining Integrated Pollution Prevention and Control (IPPC) compliance requirements with accuracy requires knowledge of the details of implementation, and in particular, of the extent to which Best Available Techniques (BAT) guidelines will be followed and the emission limit values (ELVs) imposed. Approximations can, however, be attempted based on upcoming BAT requirements and on existing, or anticipated, regulatory demands.

124. Consultations with relevant experts indicate a rather high application of BATs in Turkish operators. Many of the plants are reported to have already switched over to dry processes with preheating, and some also use precalcination. As mentioned, the industry demonstrates good performance with respect to energy efficiency, with more than 35 percent of the plants is within the BAT targets, and more than 50 percent of all plants are either BAT compliant or within a 10 percent deviation from the BAT values concerning thermal energy use.

125. With regard to electricity consumption, the Turkish plants operate with the specific consumption of 105 kWh/ton of clinker, which is at a level comparable to European plants (TCMA 2009). Operational automation and control is common in plants, and substantial work on energy efficiency measures has already been done. Particularly in those plants that use large amounts of waste, automated waste-monitoring and feeding systems are already in place. The remaining waste-burning plants are already required to install such units. As part of the ”industrial air pollutants” Directive requirements, the plants are also obliged to cover their raw material and product storage areas by 2014.[26] The situation regarding emission control measures for nitrogen oxide (NO_x), and particulate matter is, however, unclear. This is an important shortfall because these are among the high cost BAT requirements prioritized in this study. Due to the domination of dry processes, the sulphur oxide (SO_x) emissions are not regarded as an issue for the Turkish plants for the moment. This situation is changing, however, particularly for waste-burning facilities, in light of tighter ELVs, and needs to be further investigated. Demands for new installations for waste monitoring and feeding can also arise for smaller or new users of waste as fuel.

126. The information made available for the sector regarding NO_x, dust, and SO_x emissions was too generic to allow reliable gap analysis. Based on the available information, most plants are known to be in compliance with ELVs. However, it is likely that differences could occur because the values they need to comply with, and actual emission values, could differ substantially. The fact that 15 of 67 operational kilns have fabric filters already installed to control their emissions is indicative in that respect. However, due to the lack of facility-specific data, exact performance levels cannot be determined at this stage. Therefore, based on an educated assumption around 30 percent of the clinker production capacity can be considered to have particulate matter (PM) emission values of 30 mg/Nm^3 or lower.

[26] This demand is a source of concern for some industries. The issue is revisited in coming sections.

127. Furthermore, understandably the Ministry of Environment and Forestry (MoEF) will be continuing the work of finalizing IPPC and determining the ELVs to be applied on the basis of the final form of the recast Directive on Industrial Emissions. Due to such uncertainties, it was not possible to determine exact requirements of the state of compliance. For the purposes of this study, which includes the demonstration of a methodology, another set of educated assumptions were made regarding the future ELVs, and following two scenarios were developed based on these:

- **Scenario A,** developed assuming that the emission values imposed by the regulation concerning the combustion of waste will be generally applicable to all cement industries
- **Scenario B,** developed assuming that ELVs will be based on BAT reference performances. In addition, under Scenario B it is assumed that the companies will be forced to take energy efficiency measures.

Existing ELVs and those that can prevail under these two scenarios are summarized in table 8.

Table 8. Emission Limit Values in Current Situation and under Different Scenarios Related to Introduction of New ELVs

Parameter & Unit	Current Situation	Scenario A	Scenario B
Dust (mg/Nm^3)	50–120* (30 for waste burning plants)	30	<20
NO_x (mg/Nm^3)	800–1,300 (500 for new plants burning waste)	800 (500 for new installations)	500
SO_x	300 (50 for new plants burning waste)	50	~200
Thermal energy consumption (MJ/t clinker)	No requirement	No requirement	700

Source: Author.
Note: *Depending on age of plant and type of control equipment

128. It is safe to conclude that companies will need to implement additional measures to meet tighter requirements for dust and NO_x emissions. Additional investments will also be necessary for energy efficiency measures under Scenario B. However, since such measures are often associated with a relatively short payback time, these are not taken into consideration at this stage. Another BAT requirement concerning the coverage of raw material storage areas, that can potentially bring in high costs, is on the other hand is not included in these assessments mainly due to

lack of information availability, and partially due to the fact that such requirements are already enforced within the existing legislative framework.

5.1 Cost of IPPC Compliance

129. In practice, compliance costs will be linked to two areas:

- Installation and operation of hardware
- Managerial and administrative changes.

130. The share of such costs in individual plants will vary depending on the technical installations and operational routines. As mentioned, at this stage, the focus is on costs linked to hardware installation and operation, since they are usually substantially higher.

131. Because accurate performance data for the facility level do not exist, analyses are based on relatively educated assumptions[27] that include the following:

132. Out of the 65 Mt of installed clinker production capacity:

- Approximately 60 percent already has NO_x emissions just below 800 mg/Nm^3 and the remaining 40 percent have emissions around 1,100 mg/Nm^3
- Approximately 60 percent can already meet 50 mg/Nm^3 for dust emissions. Only 30 percent of the capacity can meet 30 mg/Nm^3 level.[28] The remaining capacity has dust emissions of around 120 mg/Nm^3.

133. Next, some cost assumptions are made, primarily using the cost figures provided in the literature (see Annex II), and whenever possible, making necessary adjustments to these based on feedback received from national parties. These assumptions include the following:

- The reduction of NO_x emissions from 1,100 mg/Nm^3 to 800 mg/Nm^3 will require the installation of selective non-catalytic reduction (SNCR) technology and a moderately high performance for NO_x reduction. The total cost (including investment and operation) of such an operation is estimated to be €1/ton of clinker.
- The reduction of NO_x emissions from 1,100 mg/Nm^3 to 500 mg/Nm^3 will also include the adoption of SNCR technology, but NO_x reduction performance will have to be higher. Therefore, a total cost of €1.2/ton of clinker is assumed to be applicable.

[27] These assumptions have already been cross-checked with industry representatives, who regard their level of uncertainty as acceptable. The representatives also communicated their commitment to provide necessary data to fine tune these assumptions in the near future.

[28] As stated earlier, the costs linked to energy efficiency measures or the closing of the storage areas are not included in calculations at this stage. However, in future efforts to improve these assessments, the following assumptions can be made: for more than 30 percent of the production capacity, considerable investments for improving energy efficiency will be needed; for more than 70 percent of the production capacity, investments will be needed to close raw material and product storage areas.

- The reduction of NO_x emissions from 800 mg/Nm^3 to 500 mg/Nm^3 will require the use of SNCR technology and will have a total cost of €1/ton of clinker.
- 40 percent of the currently installed capacity has high PM emissions. These plants will have to invest in new bag-filter units to achieve levels of 30 mg/Nm^3 and less than 20 mg/Nm^3. The total cost to achieve these values is estimated to be €1.2 and €1.3/ton of clinker.
- 60 percent of the plants will have to make moderate investments to reach 30 mg/Nm^3 and less than 20 mg/Nm^3 levels. The total cost of such improvements is assumed to be €0.3/ton of clinker.
- 30 percent of the plants will need to reduce their PM emissions from 30 mg/Nm^3 to less than 20 mg/Nm^3 under scenario B. The total cost of this action is assumed to be €0.1/ton of clinker.

134. Accordingly, the following compliance costs can be obtained:

For Scenario A

For NO_x emissions:

Compliance cost = 65 Mt clinker x 0.40 x €1/ton clinker = €**26 million per year (M/y)**

For PM emissions:

Compliance cost = 65 Mt clinker x ((0.6 x €0.3/ton) + (0.4 x €1.2/ton)) = **~€43 M/y**

Consequently, the total cost of compliance under Scenario A will be:

(€26 + €43) M/y = €**69 M/y.**

For Scenario B

For NO_x emissions:

Compliance cost = 65 Mt clinker x ((0.60 x €0.5/ton) + (0.4 x €1.2/ton)) = €**50.7 M/y**

For PM emissions:

Compliance cost = 65 Mt clinker x ((0.6 x €0.3/ton) + (0.4 x €1.3/ton)+ (0.3 x €0.1/ton)) = **€47.5 M/y**

Consequently, the total cost of compliance under Scenario B will be:

(€50.7 + €47.5) M/y = €**98.2 M/y.**

5.2 Competitiveness Impacts

135. As mentioned, the cement industry has certain specific characteristics that make competitiveness analyses rather difficult. These include:

- High fluctuation of product price over relatively short time periods (a range of US$60 to US$120 was recently observed)
- Substantial differences in production costs (US$20 to US$35/ton cement have been reported for Turkey)
- Extremely low price elasticity of overall demand.

136. Moreover, it has already been confirmed by relevant stakeholders that the IPPC-induced costs are not likely to adversely impact the competitiveness of the sector, provided that enough time is allowed for compliance.

137. Still, some competitiveness impact approximations are performed here, primarily to provide a demonstrative example. For these assessments the following assumptions are made:

- Average price of the product: €60/ton cement
- Earnings are only linked to the earning rate and sales volumes
- Average earning rate: €20/ton cement
- Price elasticity of gross demand = -0.27
- Price elasticity of demand in the domestic market (for individual plants that share a regional market with at least one more producer) = -4
- Price elasticity of demand in export markets = -5.

138. The competitiveness assessment is focused on a plant that has initial NO_x emissions of around 1,100 mg/Nm^3 and PM emissions of around 120 mg/Nm^3. For such a plant the total cost of IPPC compliance will be in the range of €2.5/ton cement under scenario B.

139. If this cost is fully absorbed, the earning rate will drop from €20 to €17.5/ton, which will translate into a 12.5 percent reduction in overall earnings.

140. If the cost is partially absorbed, and partially reflected in the price as a 2 percent (€1.2) increase, the sales volume will decrease by 8 percent and the earning rates will go down to €18.7/ton. This will translate into a 14 percent reduction in overall earnings.

141. If similar assessments are performed for Scenario B at the sectoral level, assuming that all costs are shared equally among all production plants, this will result in a decrease in earnings of 7.5 percent (€98.2 M/65 Mt = €1.5/ton clinker; (18.5/20) x 100 = 7.5 percent).

142. If part of the extra costs is reflected almost completely in the price to realize a 4 percent increase, total sales will go down by around 1.12 percent, but the earnings rate will only go down to €19.9/ton clinker. Accordingly, only a 2 percent reduction in overall earnings will be realized.

6. Policy Considerations

6.1. General Overview of Environmental Policy Instruments

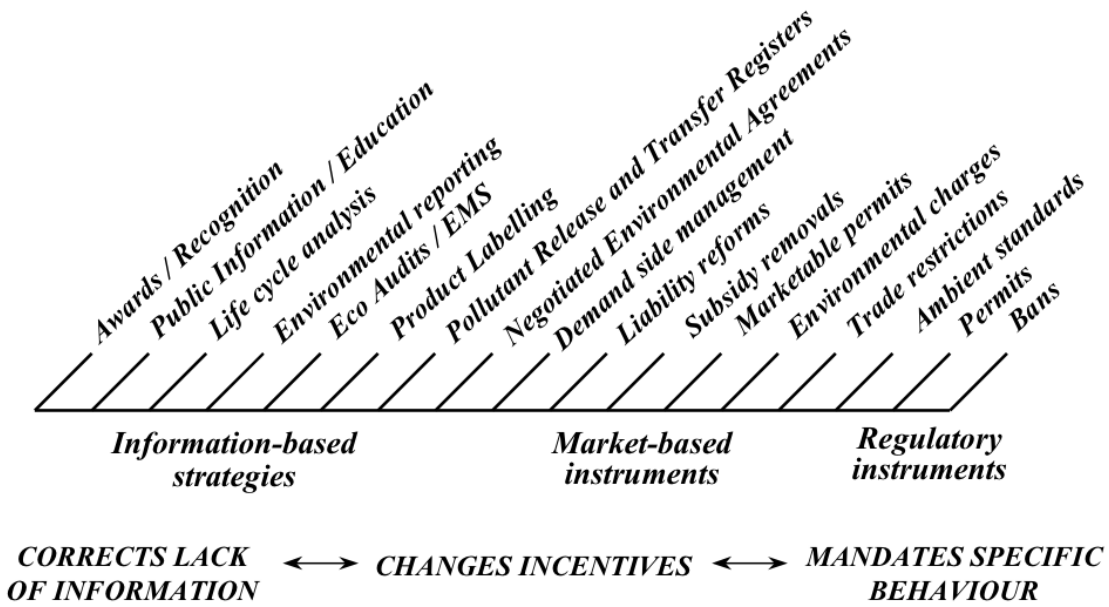
143. It can be argued that industry and consumers are the ones that will ultimately determine the response to compliance requirements. However, the role of government is to create an enabling environment that will encourage better environmental performance and widespread adoption of practices that can lead to compliance.

144. There is a wide range of instruments and these can be used in combination to stimulate better environmental performance—performance that could ultimately lead to a better environmental quality. These instruments can be categorized into three groups:

- **Regulatory instruments** that mandate specific behavior
- **Market-based instruments** that act as incentives for particular activities
- **Information-based instruments** that seek to change behavior through the provision of information.

145. Examples of different instruments are provided in figure 17.

Figure 17. Examples of Different Environmental Policy Instruments



Source: Lindhqvist 2000.

146. Further categorization of these policy instruments can be made based on the nature of the interaction between government and industry, and the level of obligation of the policy instrument. With such an approach a distinction will be necessary among the following:

- **Specified compliance,** where government imposes obligatory standards on the regulated party
- **Negotiated compliance,** where the regulators and the regulated interact in setting the obligatory standards
- **Co-regulation,** where there is a high level of interaction among the parties, but the agreed standards are not mandatory
- **Self-regulation,** where industry acts unilaterally in setting standards that are not legally enforceable.

147. Different policy instruments are usually not used in isolation from each other: regulatory instruments typically operate in conjunction with the threat of an economic penalty, economic instruments need an appropriate legal framework, and the provision of information is a necessary element in the implementation of most types of policy instruments. For example, the IPPC Directive is a typical regulatory instrument, but its implementation can benefit from parallel approaches like negotiated compliance, market-based instruments, and informational tools.

Regulatory instruments

148. Regulation has been the predominant strategy for pollution control and one in which a public authority sets standards and then carries out inspection, monitoring, and enforcement of compliance with these standards, as well as punishing transgressions with formal legal sanctions. These regulations may, for example, specify an environmental goal—such as the reduction of NO_x emissions by a specified date—or they may mandate the use of a particular technology or process.

149. Such an approach gives the regulator maximum authority to control where and how resources will be allocated to achieve environmental objectives, and it provides the regulator with a reasonable degree of predictability as to how much the pollution levels will be reduced. There are certain specific situations where regulatory instruments might be seen as the most appropriate and effective means of achieving a desired environmental outcome, an example being the control of hazardous substance releases through restrictions or bans.

150. Environmental quality in the majority of the industrialized countries is based on programs for direct regulation. The efficiency of regulations depends on the instruments used to influence the behavior of the polluter. The majority of the programs for direct regulation rely on ***specified compliance***, where precise and specific demands are imposed on the regulated entity or industrial community and little bargaining and few exceptions are allowed. Although generally successful, this arguably authoritarian style has drawbacks in that the regulated entity can become alienated and might unite in opposition against the rule makers.

151. Some of the drawbacks can be offset with the use of a ***negotiated compliance*** approach, where setting and enforcing standards are performed more cooperatively. This "shared responsibility" between government and industry enhances the likelihood of a more open exchange of information between the parties, and allows greater flexibility regarding the means of meeting the standard. In a number of countries, so-called ***non-prescriptive regulations*** exist. With these, attainment of

certain targets (for example, recycling targets) is required but concrete means of achieving such targets are left to the industries. Such approaches hold the potential to improve the economic efficiency of the regulation, and may stimulate the emergence and adoption of innovative, preventive approaches.

Market-based instruments (MBIs)

152. Instead of banning unwanted activities or dictating acceptable ones, MBIs seek to address market failure of "environmental externalities" either by incorporating the external cost of a firm's polluting activities within the firm's private cost (for example, through taxation), or by creating property rights and facilitating the establishment of a proxy market (for example, by using tradable pollution permits).

153. MBIs can be economically more efficient than regulatory standards in achieving a desired reduction in pollution because they act as *incentives* for the development of more cost-effective pollution control and prevention technologies and provide greater *flexibility* in the choice of technology or prevention strategy. In addition, they may provide government with a source of *revenue* that may be used to support environmental and/or social initiatives. Introduction of MBIs, however, is often faced with significant constraints. It is advisable to identify and evaluate already existing economic incentives that have a direct or indirect link to the targeted performance—such as subsidies encouraging overuse of resources—prior to introducing new economic incentives. ***Taxes, charges, and fees*** are among the commonly used MBIs. For example, France introduced water charges, and emission taxes on sulfur, volatile organic compounds and NO_x which are earmarked for pollution abatement investments by the polluting industries (Thomas Sterner, 2003). Setting high-enough levels for these to achieve desired goals, however, is often politically infeasible. Furthermore, successful implementation of such initiatives requires a system of monitoring, revenue collection, and enforcement. These are also prone to fueling corruption.

154. ***Liability rules,*** holding firms responsible for all the environmental damage they cause, even if they have fulfilled their legal obligations and have exercised "due diligence," can be another example of effective MBIs, provided that an appropriate enforcement mechanism and legal system exist. ***Subsidies*** that can be provided in the form of, for example, ***low-interest loans***, ***direct grants***, or ***preferential tax treatment*** are also among MBIs that are proven to be effective in stimulating desired environmental performance. In line with earlier arguments, these need to be carefully assessed prior to their introduction in order to avoid hidden incentives for counterproductive behavior.

155. ***Emission trading schemes*** (ETSs) is another MBI that, if applied properly, could be highly effective. In the case of an ETS, the right to emit a certain unit is certified and the total amount of emissions is set at a maximum level (cap) for a specified group of controlled entities (for example, countries, companies). If the emissions cap is below the business-as-usual level, the emission certificates become valuable and incentivizing tools for emissions reductions. As such, the ETS would lead to a more cost-effective allocation, since emitters with abatement costs above the market price of the certificate can refrain from taking costly emission reduction

measures and buy lower-cost certificates instead. These certificates are supplied by emitters with lower abatement costs, who realize additional emission reductions and sell their surplus certificates. Contrary to a tax on emissions, an ETS ensures reaching the environmental target (which is equal to the emission cap), and uses the market to determine the price associated with reaching that target.

Information-based instruments

156. Information-based instruments that apply directly to the product are used as an alternative to direct control and to provide incentives to reduce pollution. For example this could be through requiring ***public disclosure of environmental information***—or through building capacity in the regulated community—such as providing ***training*** in specific issues. ***Eco-labeling*** or ***environmental product declaration*** measures that aim to influence consumer behavior, issuing ***high-profile awards*** for desired performers, and promoting ***R&D and demonstration programs*** are other examples of information-based instruments. Eco-labeling has been most successful in the Nordic countries because eco-labels had turned out to be popular with consumers and most large producers voluntarily followed suit.

6.2 Approaches for Consideration

157. The IPPC Directive offers an important leverage point for Turkey, not only for improving the environmental condition of the country, but also to facilitate productivity improvements in the industry, to strengthen the institutional capacity for ecological modernization, and to better engage the general public in the sustainability discussion.

158. From an environmental perspective, the introduction of the IPPC Directive will present an opportunity for (further) factoring in the costs of pollution in areas where public costs are known or likely to be high and an overall benefit is likely. This in turn will enable a move toward balancing economic, environmental, and social considerations in development. The Directive may help reduce the risk of shifting environmental problems among different media (that is, air, water, and soil), and therefore allow for better and more holistic environmental protection. The permitting requirements and applications will also bring a wider range of areas that can be influenced by the industry under the regulatory umbrella and will certainly offer a leverage point to force old and polluting technologies to change.

159. For industrial operations, the IPPC Directive holds the potential to promote greater win-win opportunities. This can lead to resource productivity gains benefiting not only the environment but also the underlying profitability of industries. Energy efficiency and waste minimization are the main areas with proven win-win potential. In the specific case of cement, energy efficiency is an important area for resource productivity. Gains with respect to resource productivity at the regional and national levels could be realized through increased revalorization of waste materials as energy carriers in cement kilns. The IPPC Directive is also reported to provide a leverage point for more efficient technologies and new products with better characteristics. Such developments can pave the way for welcomed innovations in the cement industry. In addition, IPPC permitting dynamics are highly instrumental in

transforming the relations between the regulator and the regulated for the better, by creating a platform for dialogue and allowing room for negotiated compliance.

160. The IPCC Directive can also make important contributions to institutional capacity, capabilities, and effectiveness. For the implementing authorities in Turkey—the MoEF and its regional and local representations—the benefits would be most obvious. Relevant personnel from such institutions will be better informed about technical and operational possibilities that can assist ecological modernization of the industry, which will advance their capabilities for engaging and assisting industry in making environmental progress. Increased demand for improved energy and resource efficiency may stimulate innovative outputs from R&D organizations, universities, and other public and private bodies working in the field of environmental technology and environmental management.

161. Finally, adoption of the IPPC Directive will create a platform for engaging the general public more closely in issues related to industrial sustainability. Industrial openness toward the public and public participation in the country remains limited, partly because public reaction to environmental issues is often considered to be driven by "emotions" rather than by "rational judgment." Rational judgment capabilities, however, can be developed through enhancing the awareness and knowledge level of the public. Constructive, reasoned public input to relevant decisions could be a major pillar supporting good environmental performance in many countries and could help induce more openness in the current systems.

162. The IPPC Directive might also have drawbacks. There is a consensus among relevant parties that the IPPC-induced costs will not have an adverse impact on the competitiveness of the cement sector, provided that reasonable time is allowed for compliance. That is, there is a risk of placing excessive demands with a short compliance deadline on industry to the extent of threatening sectoral competitiveness. There are also other issues linked to IPPC implementation that could lead to suboptimal results, such as fueling additional bureaucracy in the public sector and increasing the compliance burden for industry, giving rise to unjust permitting demands among different facilities, thereby introducing competitiveness distortions and increasing the communication and cooperation gap between the public and private sector. The challenge, therefore, lies in adopting the right policy approaches so that the benefits of the Directive can be realized while avoiding potential drawbacks to the extent possible. With this understanding, the following issues are considered.

Transposition of the Directive

163. Turkey, like EU Member States, will also be faced with a decision regarding how best to transpose the IPPC Directive. The options are either to amend existing legislation or to introduce new legislation. These options have different benefits and drawbacks, based on, among others factors, the maturity of the existing environmental legislation and the nature of the prevailing permitting process. Generalizing from experiences in Europe, it can be stated that transposition through amendment is preferred in countries where environmental legislation is well developed, and more holistic permitting routines are already in place. Drafting new legislation is often preferred by countries with an underdeveloped environmental legislative framework,

where the main weakness is fragmented and inadequate permitting and inspection routines. The choice will also depend on the complexity and cost of drafting necessary amendments and approving new legislation.

164. Turkey has an environmental law and numerous regulations aimed at reducing the impact from anthropogenic activities on the environment. These regulations include generally binding rules that form a foundation for ELVs and that are comparable to those applied in European countries. The environmental law mandates sanctions for cases of noncompliance.

165. A single environmental permit and license system was introduced in Turkey on April 1, 2010, within the framework of an integrated and progressive approach in lieu of different practices for permits and licenses for polluting activities [29]. Under the new system, the environmental permit/ environmental permit and license procedures are carried out electronically through a software program developed under the "Online Environmental Permits Project".

166. The possibility of filing applications for all environmental permits at a single point will help prevent enterprises from operating without obtaining the required permits due to lack of knowledge about the legislation and help reduce the potential negative impacts that may be caused on the environment. There are, however, significant differences between the single permitting system and the integrated permitting approach put forward by the IPPC Directive.

167. While the single permitting system aims to reduce the administrative burden, it differs from IPPC permitting in the following ways:

- There are no cross-media considerations
- There is no flexible treatment based on locality-specific conditions
- Evaluations are based on emissions at the discharge points, without any consideration of changes that can be made at the source of emissions
- No consideration is given to BATs[30]
- No attention is given to energy efficiency
- There is no consideration of responsibilities following decommissioning
- There are no reporting requirements.

168. Thus, although the single permitting scheme can be seen as a step in the right direction, its current structure is different from what will be needed to comply with the IPPC Directive.

169. For the specific case of the cement industry in Turkey, transposition through amendments to the existing framework appears to be a good alternative. With the upcoming waste incineration legislation this framework will become even more complete. Consequently, a set of Generally Binding Rules that are comparable to

[29] The legal basis for this system is established by the *Regulation on Permits and Licenses Required to be Obtained Pursuant to the Environment Law*, which was published in the Official Gazette no. 27214 dated 29 Apr. 2009

[30] The "industrial regulations" for new plants require the planners to use "Best Available Techniques." In addition, in recent years the MoEF has been encouraging the new developers to design their plants to become IPPC compliant. Thus, this statement is more valid for existing installations.

those of the EU already exist. Moreover, the existing permitting process and relevant regulations for air quality standards already includes IPPC-aligned elements. For example, a description of activities that are related to emissions is covered by the permit, and the regulations already require the plants to take action to cover storage areas, which is also among the IPCC requirements.

170. In the transposition through amendments the single permitting system can have a pivotal role, if necessary adjustments are made. Since the environmental aspects of this industry are primarily linked to a singular medium—that is, air emissions—the sector does not offer a good context to make a judgment for an integrated approach that addresses pollution arising from different media sources. Thus, prior to a final decision, studying the implications on another sector with significant interactions with multiple environmental media would be helpful.

Provision of guidelines for sectors and regulators

171. In many ways, the IPPC Directive brings a totally new approach to the permitting process, where the industry has to carry out a self-assessment and needs to look into areas that are traditionally not regulated in most countries—such as energy efficiency, or having an environmental management system. In addition, the Directive itself has flexible elements that leave room for interpretation, making the work of both the regulator and the regulated more demanding.

172. Consequently, development of national guidelines—if necessary with supplementary material on sector-specific issues—will make a significant contribution to easing the implementation process for both regulators and regulated. These can be seen as part of informational policy instruments. The MoEF has already taken steps in the right direction by translating the BREF documents into Turkish. Once the administrative details for implementation are determined, it would be highly useful to compile these into a concise, coherent guidance document to be used by parties involved in the permitting process. Although such guidelines will bring additional initial costs, the benefits they can produce over the course of implementation are likely to outweigh the costs. Some of the issues discussed below should be part of the guidelines, once finalized.

Determination of BATs and ELVs

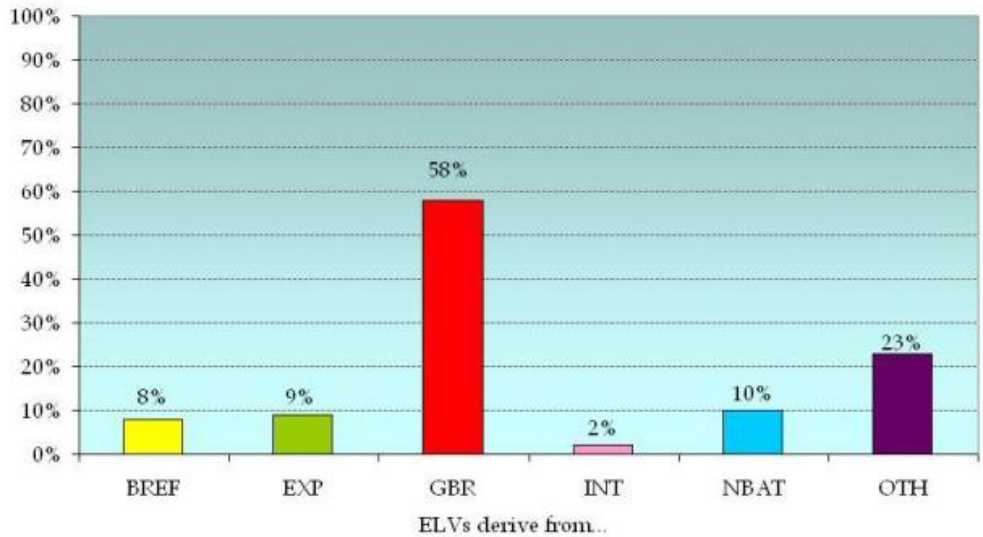
173. BREF documents are the primary source for BAT determination and are prepared for the European context with the contributions of European industry representatives. Thus, caution is needed for the Turkish context because this process does not necessarily fit prevailing conditions in Turkey. For example, Turkish industrialists did not have the opportunity to influence the preparation of BREF documents. While the number of wet processing plants is low in Turkey, there are still such plants in considerable numbers. In addition, certain assessments, particularly those related to technology applicability and costs, may not apply well to Turkish conditions because, for example, electricity prices are considerably higher in Turkey than in Europe and the skills base of average workers is likely to be lower in Turkey.

174. It will therefore be useful to customize BAT requirements for Turkey with respect to both technologies and performance levels. This will allow the prioritizing of those that are of higher importance in light of the national interest and capabilities, and may help achieve an appropriate balance for costs and benefits for a typical, well-performing installation in the sector. The MoEF is well aware of these concerns and will be working on establishing ELVs that are customized to the national context as part of the on-going IPPC transposition work (Tok 2010). It is, however, not clear what factors are considered in determining such emission values. It will therefore be advisable that the industry contribute to the decision process.

175. Furthermore, a number of the BAT proposals have the potential to result in win-win outcomes—specifically those related to energy efficiency, process optimization, use of alternative materials and fuels, establishing an Environmental Management System, and some of the monitoring and control systems. A customized BAT determination will allow for raising the profile of such alternatives. Some BAT proposals may lack a legally binding foundation, however, and could result in disputes over BAT adaptation that leads to long and costly legal action. Once finalized, issues pertaining to BAT selection should be communicated as part of the above-mentioned guidance document.

176. The IPPC permitting process requires ELVs to be based on performances achievable through the use of BATs and adjusted to the local environmental conditions. The use of Generally Binding Rules (GBRs) – that establish standard conditions for specified activities at national level have a longer history of being implemented by EU Member States. From an administrative perspective they are more widely used during the permitting process. Only in limited case ELVs been developed based on BAT references. Figure 18 provides an overview of the bases for determining ELVs in different EU Member States.

Figure 18: Determination of ELVs in EU 25.



Source: Industrial Emissions Reporting Information System. http://iris.eionet.europa.eu.

177. ELVs play a significant role in determining the compliance effort and, consequently, its costs. Although the Directive calls for the adoption of ELVs based

on figures given in BREF documents, this is seldom practiced in Europe, where only 8 percent of ELVs are based on BREF values. There are also significant variations in ELVs adopted by different countries (see figures 15 and 16).

178. ELVs currently used for NO_x and PM are slightly higher than the average figures used in the EU, but they are not the highest. For NO_x, a significant change was already introduced for new plants installed after 2009, lowering this limit from 1,300 mg/Nm^3 to 800 mg/Nm^3. This new limit will be applicable to more than 60 percent of the cement plants in Turkey, with the introduction of the waste incineration directive. Since the current emission levels are not known, it is difficult to provide accurate guidance. However, if the sector performance levels are such that the industries will need to invest in SNCR technology, then further reduction of the NO_x limits to BAT suggestions (that is, 500 mg/Nm^3) can be considered because the marginal cost of achieving higher performance will be relatively lower. However, such a reduction will need to be justified on the basis of the benefit it will provide to the environment and society. For this, local vulnerability to acidification, cumulative NO_x emissions in the impact area, and transboundary transport issues need to be taken into consideration. Environmental regulators are often criticized for copying the strictest ELVs without providing justification for their choice. Just because it is possible to do so does not mean it is justified.

179. With regard to PM, an argument similar to that of NO_x holds. Existing limit values (50 mg/Nm^3) are comparable to most EU countries. In addition, levels can be reduced to 30 mg/Nm^3 with waste incineration regulation, which is the BAT value. In any case, stricter PM requirements for this parameter should also be justified based on a healthy cost-benefit analysis. To this end, it should be noted that PM reduction has a different nature because the captured fraction has commercial value. Therefore, there can be better economic incentives for stricter ELVs.

180. In addition, with the introduction of the recast Directive on industrial emissions, a more harmonized set of ELVs can become applicable in all Member States. This will bring Turkey to an important decision point with regard to reformulating its demands on industry.

Scheduling of permits and temporal requirements

181. The temporal dimension of compliance is very important for the industry. The industry has even communicated its willingness to meet any environmental demands, provided that it is given a reasonable time frame (five years is suggested) in which to do so.

182. Although crude, the compliance cost figures developed in this study further raise the importance of allowing sufficient time for the industry to absorb such costs. In addition, there are technical limitations to compliance since, in the case of SNCR, for example, a time frame of three years may be needed from the moment of taking a decision for action until the plants can become fully operational.

183. The importance of a carefully crafted, phased approach cannot be overemphasized. Clear signals with stricter future requirements combined with

realistically long compliance times could stimulate innovation in industries and enhance competitiveness. Box 1 presents such an example.

Box 1. Competitiveness through Environmental Regulations-induced Innovation

In the 1970s, in both the United States and Scandinavia, stricter regulations were promulgated for the pulp and paper industry. The United States introduced strict emission standards and demanded compliance in a relatively short time, so most companies had to revert to proven but costly end-of-pipe solutions.

Scandinavia, however, took a more flexible, but no less strict, approach. The regulators set out with relatively loose emission standards but clearly communicated that these were going to get stricter over time. This provided enough time for companies to review their production systems and continually incorporate innovative environmental technologies into their normal cycles of capacity replacement and innovation.

As a result, Scandinavian companies developed innovative pulping and bleaching technologies that not only met emission requirements but also lowered operating costs. This approach produced the side effect of raising the competitiveness of the local equipment industry. Spurred by Scandinavian demand for sophisticated process improvements, local pulp-and-paper-equipment suppliers made major international gains in selling innovative pulping and bleaching equipment.

Eventually, the Scandinavian pulp-and-paper industry was able to reap innovation offsets that went beyond those directly stemming from regulatory pressures. By the early 1990s, producers realized that growing public awareness of the environmental problems associated with pulp-mill effluents were creating a niche market. For a time, Scandinavian companies with totally chlorine-free paper were able to command significant price premiums and serve a rapidly growing market segment of environmentally informed customers.

Source: Porter and van der Linde 1995.

Competent authority and responsibilities

184. A key issue in IPPC implementation relates to the responsibilities regarding issuing and reviewing permits. The MoEF is reportedly about to start a project to define the administrative dynamics linked to permitting. Consequently, the ideas presented here are timely and of practical value.

185. In the case of the cement industry in Turkey, environmental permits are currently issued centrally, while the monitoring and inspection of the permit, however, are the responsibility of the local environmental Directorates. Applying the same implementation arrangements for IPPC permits may be problematic due to the following reasons:

- IPPC permits allow for flexibility based on local conditions. Responsible officers in central and local agencies need to acquire skills and knowledge to properly take that context specificity into consideration.

- IPPC permits are often issued conditionally. During the process, representatives from the permitting authority engage in a lengthy dialogue and agree on a number of changes to be implemented, then draft a plan including these changes. Although such conditions and their time frames need to be

included in the permit document, it is often difficult for a third party that has not been part of the permitting process to fully understand the specific local conditions. This can lead to considerable confusion with the inspecting body and can also be a source of conflict with industry.

- During the permitting process, good relationships are commonly established between the regulator and the regulated. It is, however, preferable for the industry to have access to and contact with the local regulator.

186. A promising approach could be to give the permitting responsibility to regional and local entities. However, as in most other countries personnel at such levels in Turkey may have limited capacity and capabilities so significant capacity-building may be needed in order to make sure that regional and local personnel can review permit applications properly and drive the permitting process in an informed, professional way. This, however, is a resource- and time-consuming activity. Concentrating the decision power on the regional bodies may have the additional disadvantage of bringing large differences in the way permits are issued, possibly giving rise to commercial tensions.

187. The MoEF is working on the establishment of a Turkish Environmental Protection Agency (TEPA) which, among other things, will bear the responsibility for IPPC implementation. The TEPA is projected to have an organizational structure including headquarters in Ankara and 26 regional agencies covering the entire country. If realized, such a structure could provide a good foundation for efficient and effective implementation of the IPPC Directive. Here a phased development approach could be considered. In the early stages, it is important that the core of the TEPA is staffed by competent individuals with solid knowledge of the sector and of applicable BATs who can thoroughly assess the permit applications.[31] Representatives from regional divisions of the TEPA and from local administrative authorities can be gradually involved in the process, thereby not only acquiring relevant sector-specific BAT knowledge, but also learning about the details for case-specific agreements.

188. When the capacity of the personnel reaches the desired level, a designated IPPC permitting and inspection committee could be considered. This committee would be formed by representatives of the central and regional units of the TEPA, and could develop sector-specific expert groups for dominant sectors that could bear the full responsibility for negotiating permit conditions, issuing permits, and overseeing their regular inspection. The committee would include local personnel having routine inspection and monitoring duties in the communications taking part during the permitting process. While assuring equitable treatment, such an approach would allow for granting exceptions for valid reasons. In addition, this approach could be instrumental in building local and regional capacity and capabilities for industrial ecological modernization. The committee could be financed by permit application and annual administration fees.

189. The majority of EU Member States opted for a single authority for permitting. This offers benefits such as consistency, ability to develop required competencies, and

[31] Further strengthening could be accomplished by attracting retired operations managers from companies to this unit on an as-needed basis.

reducing administrative difficulties. Further guidance on how to run the process with a single authority can be obtained from countries like Denmark or the United Kingdom, which have been highly successful in this regard.

Flexibility and transparency

190. Providing flexibility in the permitting process, based on context-specific technical and environmental realities, is a key component in IPPC permitting. This will entail a major change in the permitting process in Turkey, where regulatory requirements are imposed on industry without consideration to context-specific conditions. The socioeconomic and climatologic conditions of the different regions of Turkey are highly heterogeneous. Consequently, the existing practice of uniform imposition of regulations could lead to unfair treatment, with possible competitiveness implications.[32] Flexibility in permitting would therefore be welcomed.

191. Flexibility, however, can be problematic, because it can also lead to unfair treatment of different players. It is, therefore, fundamental that decisions making less strict or stricter demands on the industry are based on a transparent and accountable approach that is followed for each applicant. Guidance can be obtained from countries having such approaches (such as the *Environmental Protection Operator and Pollution Risk Appraisal* system used in the United Kingdom). Guidelines for granting exceptional permit conditions are highlighted in the draft recast Directive on industrial emissions.

Noncompliance actions

192. Actions that can be taken in the case of noncompliance should also be developed and clearly communicated to both the regulators and regulated. It would be sensible to formulate these sanctions at the right level to ensure realistic performance improvements.

Establishing an early dialogue with industry

193. The IPPC Directive is structured to be an "industry-led" regulatory instrument. It will be the industry that will bear the ultimate responsibility for investigating the applicability of improvement options and proposing implementation plans. Consequently, it would be highly advisable to fine-tune the details of the mechanics of the IPPC Directive in country implementation while maintaining a dialogue with industry.

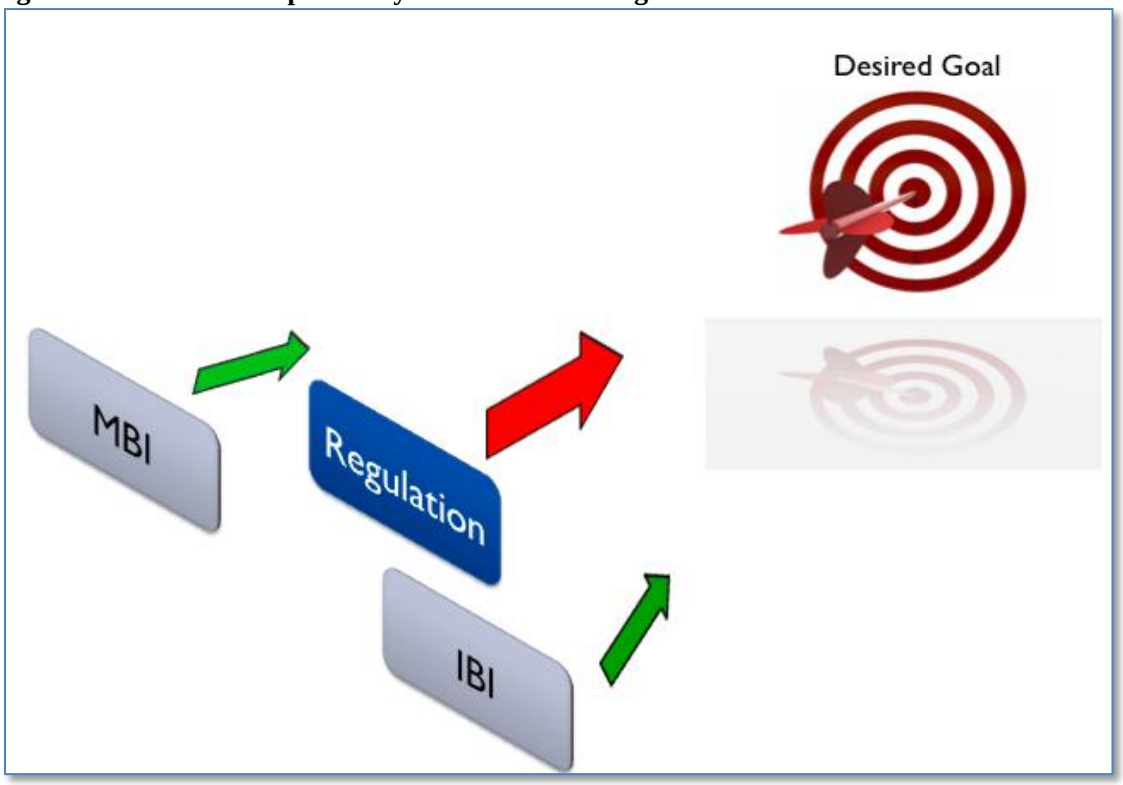
[32] Examples of this were presented by industry representatives during the project workshop. For example, as part of the Air Quality Regulations, all cement plants are required to close all storage areas for raw materials and products and have until 2013 to comply with this requirement. For plants that are in Eastern Anatolia and in eastern parts of Central Anatolia, where the construction season is considerably shorter due to tough winters, and therefore where the plants have to store a larger share of their annual production on site, this entails making much larger investments than their counterparts in the Western and South Eastern parts of the country.

194. The MoEF has already openly communicated its willingness to strengthen the dialogue with the industry in the process of fine-tuning the implementation details of the IPPC Directive. It has also invited industry representatives to review the translated BREF documents. It is, however, one of the findings of this report that there is inadequate understanding in the industry regarding the nature and implications of the IPPC Directive. It might, therefore, be a good idea for the Ministry to foster continued dialogue with the industry during the coming phases where the administrative details of the Directive will be determined. Development of a better-structured consultation and information-exchange platform and the establishment of a committee with both industry and TCMA representation could be beneficial to this end.

Market-based instruments

195. A mixture of policy tools is, as mentioned, often used in combination to reach desired goals. This is also valid in the case of Turkey and IPPC implementation (figure 18).

Figure 19. Use of Multiple Policy Tools in Achieving Desired Results



Turkey could benefit from the use of market-based instruments (MBIs) in stimulating compliance and better environmental performance. There are several options.

Emission cap and permit trading systems

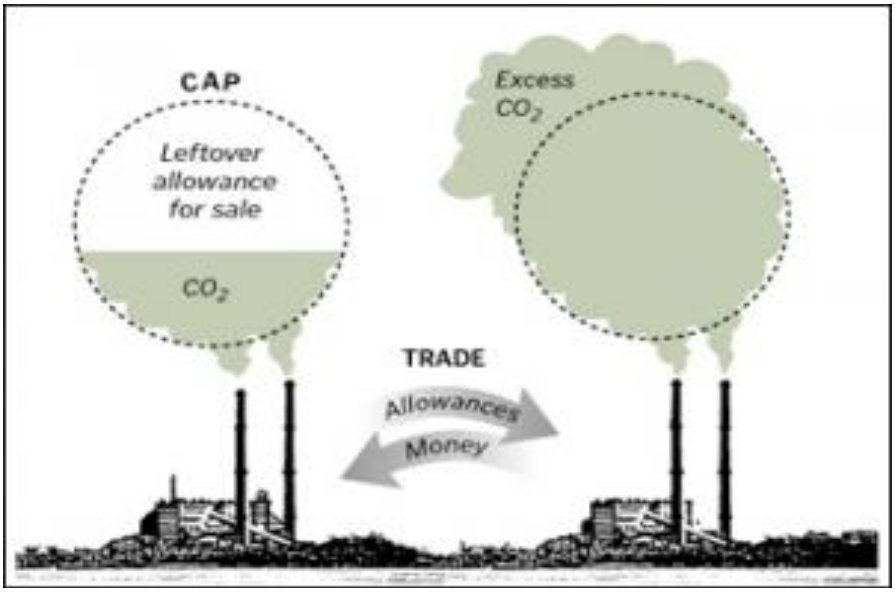
196. Emission trading schemes (ETSs) are among the tools that try to achieve a desirable reduction in emissions by creating financial incentives. In the EU, Phase II of an ETS concerning greenhouse gas emissions is already in place.

197. The IPPC Directive does not include specific requirements regarding greenhouse gas emissions; instead it refers to the Council Directive specifically set up for such emissions (Directive on Greenhouse Gas Emission Allowance Trading Scheme – Directive 2009/29/EC). However, given the fact that Turkey signed the Kyoto Protocol and is in the process of formulating its commitment to greenhouse gas reductions, and the fact that ETSs will sooner or later be part of the efforts to comply with the EU's Environmental Acquis, it may be worth considering paying more attention to the benefits of ETSs. More important, a carefully crafted ETS can be instrumental in assisting compliance with IPPC Directive requirements and achieving emissions reductions in the sector.

198. Around the world the concept of trading permits is used for reducing pollution. Following the United States' cap-and-trade program for Sulfur oxide (SO_x) and Nitogen Oxide (NO_x) emission trading, countries like Poland, Chile and United Kingdom are in a process of introducing tradable permit schemes. Several European countries have operational trading schemes such as Czech and Slovak Republics (for SO_x) and Netherlands (for NO_x). These schemes are proven to be effective in reducing emission values cost effectively (see among others Convery (2001) and Smeets *et al.*

199. Turkey could benefit greatly from gaining experience and developing capacity related to ETS implementation. In this regard, the cement industry appears to be a suitable choice for a pilot initiative. Naturally, prior to its launch such a test will require detailed analyses and a carefully developed set of rules. Based on our understanding of the sector and the application of the ETS approach elsewhere, the following can be shared as preliminary guidance for potential action.

Figure 20. Logic of Cap and Trade



Source: Image originally from the *Washington Post*.
http://legalplanet.wordpress.com/2009/06/23/waxman-markey-may-lower-household-costs/.

200. An ETS test can start with a focus on the CO_2 emissions of clinker production. An emissions cap can be established using a specific CO_2 emission value that is less than the national average to provide the impetus for reduction. Specific energy consumption indicators for clinker production can be used as a proxy. For example, in Turkey the average specific energy consumption is given as 860 kilocalorie per kilogram (kcal/kg) of clinker (TCMA 2009); in determining the cap, a value of around 820 kcal/kg of clinker could serve as the starting point. CO_2 emissions corresponding to an average plant operating with such specific energy consumption (S_{CO2}) could then be determined and could form the main unit for detailing the system. The cap can then be determined using a relation, such as

$$C_{CO2} = S_{CO2} \, x \, C_{Capacity} + S_{CO2} \, x \, N_{Capacity},$$

where:

C_{CO2} = cap value for CO_2 emissions from clinker production (t/year)
S_{CO2} = specific CO_2 emissions from a reference plant (t/ton clinker-year)
$C_{Capacity}$ = current installed clinker production capacity (t clinker/year)
$N_{Capacity}$ = new capacity (t clinker/year).

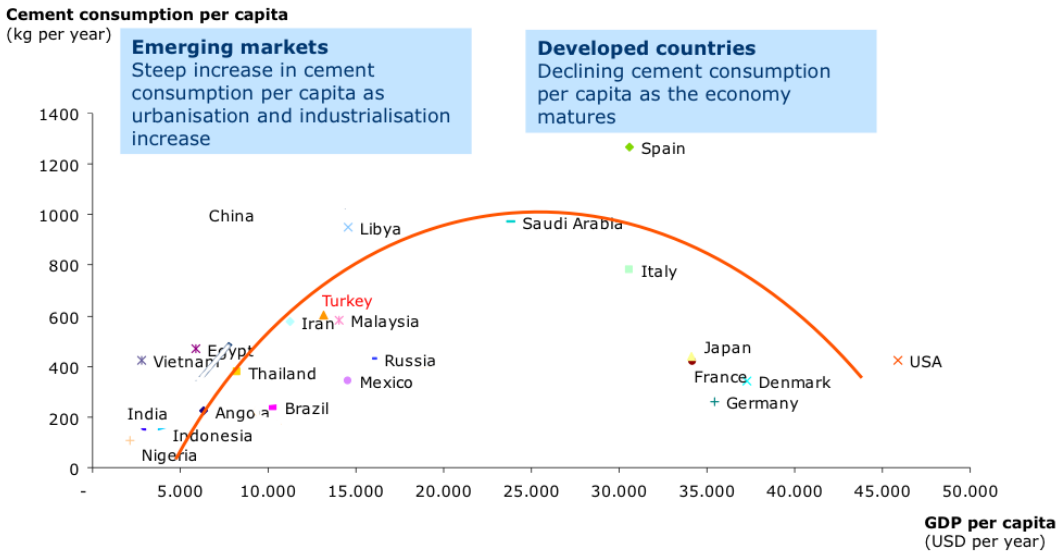
201. The next step would be to distribute emissions allowances for the existing installations and to set a price of emissions that are beyond the allowed levels. Allowances can be distributed to individual plants based on their installed clinker production capacity and using the specific emission value (S_{CO2}) discussed earlier. To account for incomplete capacity use and to provide a stimulus for emissions reduction, 90 to 95 percent of the calculated emissions allowances can be allocated for free. If appropriate, a gradual reduction of the share of freely allocated allowances over the years can also be considered. In addition, a price for emissions that are in excess of allowed limits needs to be set. It is of utmost importance that the overall cap is set at the right level and the initial allocation of emission allowances is made properly. The determination of the initial price[33] for excess emissions will also need to be set rightly.

202. In this framework, the determination of emissions allocated for new capacity deserves particular attention. By using different approaches, projections of future demand can be developed. For example, a graph showing the relation between per capita cement consumption and per capita GDP from different countries is often used for this purpose by the industry (see figure 20).[34] Alternatively, growth projections provided by the State Planning Organization for the cement sector could be used.[35] Once an agreed future demand is determined, the corresponding CO_2 emissions can

[33] This is not the trading price of emission rights, which should be set by the market.
[34] The TCMA, which is the voice of the cement industry in Turkey, uses this graph and predicts that per capita cement consumption will rise from its current levels of 590 kg to around 900 kg in 2020, where it will stabilize (Derinöz 2010, personal communication).
[35] Although the share of domestic use and exports does not match the reality very well, the overall production projections for 2009, performed in 2006 (State Planning Organization 2006), are within a 10 percent range of what is actually realized. Thus, such projections can provide a good basis for our purposes here.

be included in the overall cap for future installations. While assisting the adoption of best practices with regard to CO_2 emissions, such an approach could also be instrumental in establishing a more sustainable development path for the sector.

Figure 21. Per Capita Cement Consumption and GDP



Source: Modified from Rasmussen 2010.

203. Following a similar logic, an ETS related to NO_x emissions could also be considered.

204. Other MBIs could also be considered. For example, emissions taxes could be imposed for those emissions whose reduction is desired (here, NO_x, CO_2, and PM). However, rather than turning this into another burden on the industry, innovative approaches providing additional incentives for change could be incorporated. For example, a fixed tax applicable to all plants, for instance, for NO_x, could be introduced. At the end of the year, however, the emissions from individual plants could be evaluated to define a threshold level. Those operators whose emissions are below the threshold limit could receive a tax refund in proportion to their distance from the threshold.

205. Even simpler approaches could be considered, where operators below a determined threshold would benefit—such as through tax reductions, less-strict controls, or compliance support grants—while those above the limits would not be eligible. The MoEF and the industry have experience with similar negotiated provisions,[36] and these can be used as a foundation to trigger innovative approaches to compliance.

206. For this type of approach the MoEF could also use proper enforcement of waste management regulations as an award system. Despite the fact that using waste materials in cement kilns has been practiced for several years, the level of waste

[36] Plants that monitor their emissions continuously are allowed to use fuels with higher sulphur content (from 5 to 8 percent higher).

burning as supplementary fuel has not increased and is much below levels in Europe (while levels as high as 25 percent are achieved in Europe, in Turkey, waste-derived fuels account for only 1 percent of energy demand).

207. The main reason for this is the insufficient enforcement of waste management regulations at the municipal level, making the land filling or open dumping of waste less costly. With the proper enforcement of waste management regulations, a considerable amount of waste-derived fuels could become available for the cement industry, providing both environmental and economic benefits. Combined with the incentive structures discussed above, the MoEF could initiate stricter enforcement of waste regulations in areas where cement plants meet better environmental performance requirements.

208. As raised and discussed by key stakeholders during the final workshop of this study, important and inter-related technical and legislative gaps will have to be filled prior to introducing and piloting market based instruments. Technical challenges include inter alia calibration of the continuous monitoring equipment and establishing the infrastructure and protocols for processing of the generated monitoring data; establishing accredited laboratories for calibration of continuous monitoring equipment Finalization and enforcement of the legislation to regulate these areas – which is under preparation – will be a key step in the right direction. Moreover, a binding legislative framework will have to be established for an emission ceiling, and accounting and taxation details associated with emission trading. Furthermore, details of any market based instrument needs to determined based on sound cost benefit analysis and with a view of potential implementation bottlenecks. It will be important to determine these details in dialogue with the industry. It is an encouraging fact that the cement sector will be prepared to discuss the details of a market based approach, provided that the technical and legal foundation is set properly, rather than discussing whether or not it should be implemented.

Informational approaches

209. A number of information-based approaches could also be instrumental in assisting better environmental performance and IPPC compliance in the cement sector. These can be in the form of raising industry awareness regarding the dynamics of the IPPC permitting scheme and of relevant BATs. Since other parties, such as consultants or universities, can also be involved in the process, the target audience of such capacity-raising efforts should be expanded to cover them, as well.

210. Information-based tools, however, can go further and could have a longer-term and longer-lasting orientation. For example, besides placing stricter demands on industry, funds could be allocated for research and development that could concentrate on innovations that assist compliance with demands. For example, if and when CO_2 reductions are demanded from industries, research funds could be provided to relevant universities, to The Scientific and Technological Research Council of Turkey (TÜBİTAK), and the Technology Development Foundation of Turkey (TTGV) to explore possibilities for alternative additives or fuels that could be used by the sector.

211. Producers of building materials, including cement producers, have been trying to respond to customer demands regarding disclosing environmental information—through the use of environmental product declarations (EPDs)—about their products and eventually delivering products with better environmental performance. Such customer demands are often highly effective in stimulating improved environmental performance in industry. An uptake of such a dynamic offers a unique opportunity for policy makers. By assisting the industry in their efforts to respond to customer demand, policy makers can indirectly support better environmental performance. Establishing eco-labeling centers, or assisting the development of product category rules (PCRs) for those producers that currently feel the heat, could be instrumental to achieving this end.

Concluding Remarks

212. Recent efforts by the Government of Turkey to strengthen environmental management and national, regional, and local policies, and to integrate environmental considerations into economic development decisions and align national environmental legislation with the EU Environmental Acquis, are essential steps toward achieving sustainable economic development. These efforts, however, need to attend to the national development goals and help sustain competitiveness of important industrial sectors. As an important policy tool the IPPC Directive is instrumental in reducing industries' impact on the environment and in catalyzing resource productivity gains. Turkey, like EU member States will be faced with a decision regarding how best to transpose the provisions of EU IPPC Directive. The challenge lies in adopting policy approaches that help realize the benefits of the Directive while avoiding potential drawbacks to the extent possible. .

213. The cement industry is an important and rapidly developing sector in Turkey with high environmental awareness. The companies in the sector are generally characterized as producing high-quality products in modern facilities using state-of-the-art processes. With regard to industrial environmental approaches and performance, the sector has a leading position within the manufacturing industry, with all plants in compliance with applicable environmental regulations.

214. From an environmental management perspective, the introduction of the IPPC Directive present an opportunity for (further) factoring in the costs of pollution in areas where public costs are known or likely to be high and an overall benefit is likely. This in turn will enable a move toward establishing a better balance among economic, environmental, and social considerations in development. The Directive may help reduce the risk of shifting environmental problems among different media (that is, air, water, and soil), and therefore allow for better and more holistic environmental protection. It will also bring a wider range of industrial activities under the regulatory umbrella and offer a leverage point to force old and polluting technologies to change.

215. The Directive requires industrial installations to obtain a permit, the issuance of which depends on a range of prevention, control, and efficiency measures and the use of Best Available Techniques (BATs), and on locality-specific conditions.

Experience of European countries, which have been working on implementing the Directive for a long time, shows that the policy tool is instrumental in reducing industries' impact on the environment and in catalyzing resource productivity gains. Implementation, however, also poses challenges for both the regulator and the regulated. These challenges are primarily linked to the flexible nature of the Directive, which leaves much room for interpretation; to the use of BATs; and to the case-specific implementation procedures that require continual dialogue between the regulated and the regulator allocation of responsibilities among various public agencies, and inadequate capacities and capabilities in public organizations.

216. Although a precise assessment is yet to be concluded, many of the BAT requirements put forward for IPPC Directive compliance in the cement sector appear to already be in place in the majority of Turkish plants. This is partly owing to the fact that the win-win nature of some of the proposed BATs has been understood by the industry and thus were adopted in new developments or during expansions. In addition, the MoEF has been advising the industry to pay attention to IPPC requirements while making new investments. To become IPPC compliant, however, new investments will be necessary, particularly with regard to the reduction of nitrogen oxide (NO_x) and particulate matter (PM) emissions, and regarding energy efficiency. While the energy efficiency investments are likely to have reasonable payback times and can have a positive net economic effect, NO_x and PM control will bring a net cost.

217. The precise cost of IPPC compliance will greatly depend on the emission limit values (ELVs) that will be imposed and the current performance level of the industry. Since there are uncertainties related to both areas, cost estimations were derived using well-educated scenarios. These result in an estimated cost increase per unit production of around €1.3/ton of clinker (for the whole sector), which appears unlikely to impact competitiveness in the sector. This, however, holds true provided that the industry is given sufficient time to plan for and incorporate these additional costs into their investments.

218. There are a number of approaches that can be helpful for more efficient, effective, and equitable implementation of the IPPC, thereby achieving the intended environmental gains while also assisting good performance in industry and sustaining competitiveness. For regulating the public sector, these can be summarized as follows:

- The IPPC requirements, including the BAT requirements, ELVs, and time frames for compliance need to be customized to Turkey taking into consideration the technical, environmental, industrial, and institutional dynamics that prevail, or that are anticipated, in the country, and be based on appropriate cost-benefit analyses. Clear and comprehensive guidelines concerning IPPC implementation, targeting both the regulatory agencies and the industries, would help reduce the burden which companies may face to meet IPPC responsibilities with a short compliance deadline. A clear and accountable set of rules and guidelines need to be developed for the flexible areas of the Directive -- such as completeness of BAT application, conditional permitting, permit reconsideration intervals and procedures, and sanctions for noncompliance will be critical to maintain a level playing field during

implementation and avoid inefficiencies, conflicts and a loss of credibility. Practice on BATs Guidance and the use of BAT References Documents (BREFs) varies across countries.

- Effective implementation depends critically on the institutional delivery mechanism for implementation and monitoring of the IPPC Directive. A major challenge in this regard will be to define the responsibilities for permit issuance, compliance control, corrective action and proper safeguards for fair treatment of industries. Success would also depend on the technical and local knowledge of responsible units and individuals involved in the permit process. Establishment of sector-specific expert groups with participation from different regions could make an important contribution to institutional capacity, capability and effectiveness. The majority of EU Member States opted for a single authority for permitting. This offers benefits such as consistency, ability to develop required competencies, and reducing administrative difficulties. Denmark and the United Kingdom have been highly successful in this regard. A Turkish Environmental Protection Agency, the establishment of which is under consideration, could provide a framework within which an effective and just IPPC implementation division can be housed.

- Introduction of innovative market-based instruments (MBIs) could create platforms for win-win outcomes, thereby stimulating compliance and better environmental performance. To this end, the development of a pilot emission trading scheme (ETS) for the sector covering major emissions, like CO2 or NO_x, could bring significant public benefits from improved environmental performance. Such an approach, if carefully crafted, could assist the sustainable long-term development of industry. Equally important, such an initiative will provide highly valuable experiences to the country and help build capacity that will become increasingly important in light of the future needs to manage greenhouse gas emissions. Introduction of other MBIs, such as earmarked taxing systems for selected emissions can also be considered. These tools can be developed based on holistic and rigorous analyses of the legal and technical requirements in order to avoid the promotion of unintended outcomes.

- Use of negotiated agreements could potentially facilitate compliance. Providing flexibility in the permitting process, based on context-specific technical and environmental realities, is a key component in IPPC permitting. The IPPC Directive brings a totally new approach to the permitting process, where the industry has to carry out a self-assessment and needs to look into areas that are traditionally not regulated in most countries—such as energy efficiency, or having an environmental management system. In addition, the Directive itself has flexible elements that leave room for interpretation, making the work of both the regulator and the regulated more demanding. The socioeconomic and climatologic conditions of the different regions of Turkey are highly heterogeneous. This will entail a change in the permitting process in Turkey, where regulatory requirements will include context-specific conditions. For example, more strict enforcement of waste regulations can be

negotiated in return for higher emission reductions. This is likely to be warmly welcomed by the industry. Taking a flexible but no less strict approach is the use of negotiated agreements with industry to facilitate compliance. For example, more strict enforcement of waste regulations can be negotiated in return for higher emission reductions. This is likely to be warmly welcomed by the industry.

- Informational tools, such as awareness raising and education programs, dedicated research and development programs, recognition schemes, and support platforms to assist the industry in meeting environmental demands from their customers and consumers could stimulate innovation and competition. Transparency and consultations are essential elements of environmental decision making and accountability of environmental institutions.

219. The Ministry of Environment and Forestry has already communicated its willingness to take the future steps for strengthening the dialogue and cooperation with the industry. This will bring Turkey to an important point with regard to introducing policies and regulations which will stimulate compliance, innovation and competitiveness.

Annex I
BAT Requirements for Cement Industry

BAT #	Application Area and BAT Description
	Environmental Management Systems
1	To implement and adhere to an Environmental Management System (EMS) that incorporates a set of defined features.
	General Primary Measures/Techniques
2	**To achieve a smooth and stable kiln process, operating close to the process parameter set points, that is beneficial for all kiln emissions and for energy use by applying the following measures/techniques:** • Process control optimization, including computer-based automatic control • Using modern, gravimetric solid-fuel-feed systems.
3	**To carry out a careful selection and control of all substances entering the kiln to avoid and/or reduce emissions**
4	**To carry out monitoring and measurements of process parameters and emissions on a regular basis, such as:** • Continuous measurements of process parameters demonstrating the process stability, such as temperature, O_2 content, pressure, flow rate, and of NH3 emissions when using elective non-catalytic reduction (SNCR) • Monitoring and stabilizing critical process parameters, i.e., homogenous raw material mix and fuel feed, regular dosage, and excess oxygen • Continuous measurements of dust, NO_x, SO_x, and CO emissions • Periodic measurements of polychlorinated dibenzodioxin and dibenzofuran (PCDD/F), metals emissions • Continuous or periodic measurements of HCl, HF, and TOC emissions.
	Energy Consumption and Process Selection
5	**For new plants and major upgrades, BAT is to apply a dry-process kiln with multistage preheating and precalcination. Under regular and optimized operational conditions, the associated BAT heat balance value is 2900–3300 MJ/ton clinker**
	Energy Consumption

6	**To reduce/minimize thermal energy consumption by applying a combination of the following measures/techniques:**
	• Applying improved and optimized kiln systems and a smooth and stable kiln process, operating close to the process parameter set points by applying:
	  ○ Process control optimization, including computer-based automatic control systems
	  ○ Modern, gravimetric solid-fuel-feed systems
	  ○ Preheating and precalcination to the extent possible, considering the existing kiln system configuration.
	• Recovering excess heat from kilns, especially from their cooling zone
	• Applying the appropriate number of cyclone stages related to the characteristics and properties of raw material and fuels used
	• Using fuels with characteristics that have a positive influence on thermal energy consumption
	• When replacing conventional fuels by waste fuels, using optimized and

	suitable cement kiln systems for burning wastes • Minimizing bypass flows.
7	**To reduce primary energy consumption by considering the reduction of the clinker content of cement and cement products**
8	**To reduce primary energy consumption by considering cogeneration/combined heat and power plants if possible, on the basis of useful heat demand, within energy regulatory schemes where economically viable**
9	**BAT is to minimize electrical energy consumption by applying the following measures/techniques individually or in combination:** • Using power management systems • Using grinding equipment and other electricity-based equipment with high energy efficiency.
	Use of Waste
10	**BAT is:** • **To apply quality assurance systems to guarantee the characteristics of wastes and to analyze any waste that is to be used as raw material and/or fuel in a cement kiln for:** • Constant quality • Physical criteria, e.g., emissions formation, coarseness, reactivity, burnability calorific value • Chemical criteria, e.g., chlorine, sulphur, alkali, and phosphate content and relevant metals content. • **To control the amount of relevant parameters for any waste that is to be used as raw material and/or fuel in a cement kiln, such as chlorine, relevant metals (e.g., cadmium, mercury, thallium), sulphur, total halogen content** • **To apply quality assurance systems for each waste load.**
	Waste Feeding to the Kilns
11	**(a) To use the appropriate feed points to the kiln in terms of temperature and residence time depending on kiln design and kiln operation** **(b) To feed waste materials containing organic components that can be volatilized before the calcining zone into the adequately high temperature zones of the kiln system** **(c) To operate in such a way that the gas resulting from the co-incineration of waste is raised in a controlled and homogeneous fashion, even under the most unfavorable conditions, to a temperature of 850 °C for 2 seconds** **(d) To operate in such a way that the gas resulting from the co-incineration of waste is raised in a controlled and homogeneous fashion, even under the most unfavorable conditions, to a temperature of 850 °C for 2 seconds** **(e) To raise the temperature to 1,100 °C, if hazardous waste with a content of more than 1% of halogenated organic substances, expressed as chlorine, is co-incinerated** **(f) To feed wastes continuously and constantly** **(g) To stop co-incinerating waste for operations such as start-ups and/or shutdowns when appropriate temperatures and residence times cannot be reached, as noted in (a) to (d).**
	Safety Management for the Use of Hazardous Waste Materials
12	**To apply safety management for the handling, e.g., storage, and/or feeding of hazardous waste materials such as using a risk-based approach according to the source and type of waste, for the labeling, checking, sampling, and testing of waste to be handled.**

	DUST – Diffuse Sources
13	**To minimize/prevent diffuse dust emissions by applying the following measures/techniques individually or in combination:** • Measures/techniques for dusty operations. In this context, see section 1.4.4.1, where several different measures/techniques are presented, which can be applied individually or in combination • Bulk storage area measures/techniques. In this context, see section 1.4.4.2, where several measures/techniques are presented, which can be applied individually or in combination.
	Channeled Dust Emissions from Dusty Operations
14	**To apply a maintenance management system that especially addresses the performance of filters of these sources. Taking this management system into account, BAT is to reduce channeled dust emissions from dusty operations to less than 10 mg/Nm3 (BAT-AEL), as the average over the sampling period (spot measurement, for at least half an hour), by applying dry exhaust gas cleaning with a filter.**
	Dust Emissions from Kiln Firing Processes
15	**To reduce dust (particulate matter) emissions from flue gases of kiln firing processes by applying dry exhaust gas cleaning with a filter. The BAT-AEL is <10 – 20 mg/Nm3, as the daily average value. When applying fabric filters or new or upgraded ESPs, the lower level is achieved.**
	Dust Emissions from Cooling and Milling Processes
16	**To reduce dust (particulate matter) emissions from flue gases of cooling and milling processes by applying dry exhaust gas cleaning with a filter. The BAT-AEL is <10 – 20 mg/Nm3, as the daily average value or average over the sampling period (spot measurements for at least half an hour). When applying fabric filters or new or upgraded ESPs, the lower level is achieved.**
	NO_x Emissions
17	**To reduce the emissions of NO_x from the flue gases of kiln firing processes by applying the following measures/techniques individually or in combination (see wection 1.4.5.1):**
	(a) Primary measures/techniques, such as: • Flame cooling • Low NO_x burners • Mid-kiln firing • Addition of mineralizers to improve the burnability of the raw meal (mineralized clinker) • Process optimization • Staged combustion (conventional or waste fuels), also in combination with a precalciner and the use of optimized fuel mix. (b) SNCR (c) Selective catalytic conversion (SCR), subject to appropriate catalyst and process development in the cement industry.
18	**By applying SNCR, BAT is:**
	(a) To apply an appropriate and sufficient NO_x reduction efficiency along with a stable operating process (b) To apply a good stoichiometric distribution of ammonia in order to achieve the highest efficiency of NO_x reduction and to reduce the ammonia slip

	(c) To keep the emissions of NH3 slip from the flue gases as low as possible, but below 30 mg/Nm3, as the daily average value. The correlation between the NO_x abatement efficiency and the NH3 slip has to be considered (see section 1.4.5.1.7). Depending on the initial NO_x level and on the NO_x abatement efficiency, the NH3 slip may be higher up to 50 mg/Nm3. For Lepol and long rotary kilns, the level may be even higher.
	SO_x Emissions
19	**To keep the emissions of SO_x low or to reduce the emissions of SO_x from the flue gases of kiln firing and/or preheating/precalcining processes by applying one of the following measures/techniques (see section 1.4.5.2):** (a) Absorbent addition (b) Wet scrubber.
20	**To optimize the raw milling processes (for the dry process) which act as SO_2 abatement for the kiln, as described in section 1.3.4.3.**
21	**When applying electrostatic precipitators (ESPs) or hybrid filters, BAT is to minimize the frequency of CO trips and to keep their total duration to below 30 minutes annually, by applying the following measures/techniques in combination:** (a) Reducing the ESP downtime. In this context, where several different measures/techniques are presented, which can be applied individually or in combination (b) Taking continuous automatic CO measurements (c) using fast measuring (c) Control equipment including a CO monitoring system with short response time and which is situated close to the CO source.
	Total Organic Carbon Emissions (TOC)
22	**To keep the emissions of TOC from the flue gases of the kiln firing processes low by applying the following measure/technique:** Avoid feeding raw materials with a high content of volatile organic compounds into the kiln system via the raw material feeding route.
	Hydrogen Chloride (HCl) and Hydrogen Fluoride (HF) Emissions
23	**To keep the emissions of HCl below 10 mg/Nm^3 (BAT-AEL), as the daily average value or average over the sampling period (spot measurements, for at least half an hour), by applying the following primary measures/techniques individually or in combination:** • Using raw materials and fuels containing a low chlorine content • Limiting the amount of chlorine content for any waste that is to be used as raw material and/or fuel in a cement kiln.
24	**To keep the emissions of HF below 1 mg/Nm^3 (BAT-AEL) expressed as HF, as the daily average value or average over the sampling period (spot measurements, for at least half an hour), by applying the following primary measures/techniques individually or in combination:** • Using raw materials and fuels containing low fluorine • Limiting the amount of fluorine content for any waste that is to be used as raw material and/or fuel in a cement kiln.
	PCDD/F Emissions
25	**To avoid emissions of PCDD/F or to keep the emissions of PCDD/F from the flue gases of the kiln firing processes low by applying the following measures/ techniques individually or in combination:** • Carefully selecting and controlling of kiln inputs (raw materials), i.e., chlorine, copper, and volatile organic compounds

	• Carefully selecting and controlling of kiln inputs (fuels), i.e., chlorine and copper • Limiting/avoiding the use of wastes that contain chlorinated organic materials • Avoid feeding fuels with a high content of halogens (e.g., chlorine) in secondary firing • Quick cooling of kiln exhaust gases to lower than 200 °C and minimizing residence time of flue gases and oxygen content in zones where the temperatures range between 300 °C and 450 °C • Stop co-incinerating waste for operations such as start-ups and/or shutdowns • Limiting/avoiding the use of wastes that contain chlorinated organic materials. **The BATs-AELs are <0.05–0.1 ng PCDD/F I-TEQ/Nm3, as the average over the sampling period (6 to 8 hours).**
	Metal Emissions
26	**To minimize the emissions of metals from the flue gases of the kiln firing processes by applying the following measures/techniques individually or in combination:** • Selecting materials with a low content of relevant metals and limiting the content of relevant metals in materials, especially mercury • Using a quality assurance system to guarantee the characteristics of the waste materials used • Using effective dust removal measures/techniques. In this context, where different measures/techniques for dust removal are presented, which can be applied individually or in combination.
	Process Losses/Waste
27	**To reuse collected particulate matter in the process, wherever practicable, or to use these dusts in other commercial products, when possible.**
	Noise
28	**To reduce/minimize noise emissions during the cement manufacturing processes by applying a combination of the following measures/techniques enclosing the noisy operations/units:** (a) Vibration insulation of operations/units (b) Using internal and external lining made of impact-absorbent material (c) Soundproofing buildings to shelter any noisy operations involving material transformation equipment (d) Building up noise protection walls, e.g., construction of buildings or natural barriers, such as growing trees and bushes between the protected area and the noisy activity) (e) Applying outlet silencers to exhaust stacks (f) Lagging ducts and final blowers, which are situated in soundproofed buildings (g) Closing doors and windows of covered areas.

Source: European Commission 2010.

Annex II
Costs of Different BAT Options

BAT Item	Cost	Remarks
Process control optimization	Up to €5 million.	Highly variable depending on the measures and techniques used.
NO_x-based expert burning control systems	€300,000.	Additional investments may be necessary for measurement and dosing systems.
Dust Emissions		
ESP – kilns (3,000 t/d capacity)	Investment: €1.5 million–€3.8 million (2000 data) Investment: €4.5–€6 million (2006 data). Operation: €0.1–€0.2/ton.	Additional €600,000 to €800,000 if a conditioning tower and filter fan is needed. Investment costs greatly depend on local erection costs. Operational costs greatly depend on local electricity costs.
ESP – clinker cooler (3,000 t/day capacity) or ball cement mill (160 t cement/h)	Investment: €0.8 million–€1.2 million. Operation: €0.09–€0.18/ton clinker.	
Fabric Filters – kilns (3,000 t/d capacity)	Investment: €1.5 million–€6 million. €4 million–€8 million for separation efficiencies ≥ 99.9%. Operation: 0.1–0.35/ton of clinker.	Additional €600,000 to €800,000 if a conditioning tower and filter fan is needed. The type of fabric selected has a big influence on the investment cost, plant performance, and plant life.
Fabric filter – grate clinker cooler (3,000 t/d capacity)	Investment: €1 million–€1.4 million. Operation: €0.1–€0.15/ton clinker.	With a pulse jet cleaning system.
Fabric filter – ball cement mill (160 t/h capacity)	Investment: €0.3 million–€0.5 million. Operational: €0.03–€0.04/ton clinker.	
NO_x reduction		Figures based on a kiln capacity of 3,000 t/day clinker and initial NO_x emissions of up to 2,000 mg/m^3.
Flame cooling	Investment: Up to €0.2 million. Operation: Up to €0.5/ton clinker.	Reduction efficiency: 0–35%.
Low NO_x burner	Investment: €0.15 million–€0.45 million for new installations and up to €0.6	Reduction efficiency: 0–35%.

	million for replacing existing burners (additional €0.6 million to €0.8 million can be needed if original burner uses direct burning). Operation: €0.07/ton clinker.	
Mid-kiln firing	Investment: €0.8 million–€1.7 million.	Only applicable to long kilns.
Staged combustion – for kilns with precalciner	Investment: €0.1 million–€2 million	Reduction efficiency: 10–50%.
Staged combustion – kilns with preheater	Investment: €1 million–€4 million	Can only be feasible during capacity increases. Reduction efficiency: 10–50%.
SNCR – kilns with suspension preheater and precalciner	Investment: €0.5 million–€1.2 million. Operational: €0.3–€ 0.7/t clinker. Total (Investment + Operation): €0.5–€1.2/ton clinker.	Storage of NH3 a major cost item and can make up to 50% of the investment. Reduction efficiency: 30–90%.
SNCR – kilns with grate preheater	Investment: €0.5 million. Operation: €0.84/t clinker.	Only 35% reduction efficiency.
SCR	Investment: €2.2 million–€4.5 million. Operation: €0.33–€3.0/t clinker.	Limited application so far. Reduction efficiency can vary from 43 to 95%.
Activated carbon	Investment: €15 million. Operational: No exact figure available, but likely to be high.	Only installed in one plant in Europe. May be necessary if emissions of dioxins and metals increase due to waste combustion, particularly sewage sludge.
SO_x Reduction		
Absorbent addition	Investment: €0.2 million–€0.3 million. Operation: €0.1–€0.4/ton clinker.	For a kiln with 3,000 t/d capacity and slaked lime cost of €85/ton.
Wet scrubber	Investment: Values €6 million to €30 million are reported. Operation: Values from €0.5 to €2/ton of clinker are reported.	Values are based on a kiln with 3,000 t/d capacity and initial SO_2 concentration of 3,000 mg/Nm3.

Source: Unless stated otherwise, the costs are extracted from European Commission (2010).

Annex III
Detailed Description of Indicators to Measure Financial Performance and Competitiveness

The average EBITAD rate (earnings before interest, taxes, amortization, and depreciation): the ratio between the EBITAD and value added. EBITAD is used to compare the profitability among industries and eliminates the effects of financing and accounting decisions.

The average net investment rate: the ratio between the amount of net investment and value added. This parameter depends mainly on the capital intensiveness and the growth of production (for example, capital-intensive sectors, such as iron and steel, normally require more investment).

In addition to the above financial indicators, it is also useful to know the relative price responsiveness of the sector. The following are a set of suggested price-based indicators (elasticity) that would expand the understanding of sector sensitivity to price changes:

$$\text{Production elasticity} = \frac{\text{annual change of the volume of production (period) in percent}}{\text{annual change of representative price of sector (period) in percent.}}$$

The representative price is calculated by dividing the turnover (including value-added tax [VAT]) in nominal currency by the volume of production.

$$\text{Export elasticity} = \frac{\text{annual change of the volume of exports (period) in percent}}{\text{annual change of representative export price (period) in percent.}}$$

The representative export price is calculated by dividing the amount of exports, converted in nominal currency, by the volume of exports.

$$\text{Import elasticity} = \frac{\text{annual change of the volume of imports (period) in percent}}{\text{annual change of representative import price (period) in percent.}}$$

The representative import price is calculated by dividing the amount of imports, converted in nominal currency, by the volume of imports.

Appendix IV
Data Collection Form for the Determination of Competitiveness Impacts of IPPC Costs

Geographic region where the plant is located:_____
Plant code: _____ (Generate a six character code of your choice)

Plant Level:

General			
Establishment year:			
Capacity increases:			
# of employees:			
# of kilns:	_____ *(Please use the next page for kiln-specific info)*		
	Clinker (kton/y)	Cement (kton/yıl)	
Installed capacity:			
Annual Production:			
Export volume:			

Mills						
	#	Mill Type	PM Emissions (mg/Nm3)	Dust Collect System Used	Costs	
					Investment (TL/unit)	Operation (TL/y)
Farin Mills						
Cement Mills						

Electricity Use:			
Annual electricity consumption:	_____ kWh/y	Investment Cost (TL/unit)	Operation Cost (TL/unit)
Electricity saving measures:	☐ Power management system;		
	☐ Use of frequency convertors for fans, motors, and compressors		
	☐ High-efficiency motors		
	☐ Use of variable speed fans		
	☐ High-pressure grinding rolls for clinker		
	☐ Use of vertical grinders		
	☐ Replacing pneumatic systems with mechanical for material transport		

Diffused Dust Emissions			
	Measures	Investment (TL)	Operation (TL/y)
Raw material storage areas			
Product storage areas			
Conveyor belts			

Environmental Management System
☐ Plant is ISO 14001 certified

Economic Indicators
Average sales prices of products: Clinker_____ TL/t Cement: _____TL/t
Annual average investment rates: _____ TL/y

Kilns *Please fill a separate sheet for every kiln*

Kiln number: *Please give a number to the kiln*

Kiln capacity:	kton/day		
Production type:	☐ Rotary kiln ☐ With preheater (# of stages:) ☐ With precalcination		
Installation year:z		Last retrofit year:	
Type of retrofit:		Cost of retrofit:	
Process Control	☐ Raw material use and kiln operations are controlled automatically		
NOx Emissions		Costs	
		Investment (TL)	Operation (TL/t clinker)
NOx reduction measures	☐ Flame cooling		
	☐ Low-NOx burners		
	☐ Mid-kiln firing		
	☐ Staged combustion		
	☐ Selective Non-catalytic Reduction		
Dust Emissions:		Costs	
		Investment (TL)	Operation (TL/t clinker)
Control systems	☐ Electrostatic precipitators used Efficiency:_____ %		
	☐ Torbalı filtre kullanılıyor Efficiency:_____ %		
SO_x Emissions	☐ SO_x abatement is present Measure: _____	Costs	
		Investment (TL)	Operation (TL/t clinker)
Thermal Energy	Specific energy consumption for clinker production: _____ (MJ/ton)		
	Type of fuel used:		
Waste Combustion:			
Waste is used	☐Yes ☐ No		
Type of waste		Costs	
Amount of waste:	_____ton/y	Investment(TL)	Operation (TL/t clinker)
	☐ Waste quality monitoring system		
	☐ Automatic waste feeding system		

Emission Values:

Parameter	**Average Emission values (mg/Nm^3)**	**Monitoring Type**
NO_x		☐ Continuous ☐ Periodic; Frequency:___
PM		☐ Continuous ☐ Periodic; Frequency:___
SO_x		☐ Continuous ☐ Periodic; Frequency:___
Total karbon		☐ Continuous ☐ Periodic; Frequency:___
HF		☐ Continuous ☐ Periodic; Frequency:___
HCl		☐ Continuous ☐ Periodic; Frequency:___
Heavy metals		☐ Continuous ☐ Periodic;

		Frequency:___
Dioxins		☐ Continuous ☐ Periodic; Frequency:___
Furans		☐ Continuous ☐ Periodic; Frequency:___

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