The Greek cement-industry sector and its potential towards sustainable development

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Sustainable Development

This work is framed under the term Sustainable Development, which can be defined in several ways.

Meeting the needs of the present without compromising the ability of future generations to meet their own needs

The simultaneous pursuit of the triple bottom line:

- Economic prosperity
- Environmental quality
- Social equity

A better quality of life for everyone now and for generations to come

Sustainable Business Strategies and Tools

The Natural Step principles define the end point of what is sustainable, which can be used to develop action plans.

How might we systematically decrease our economic dependence on...

Using fossil fuels and metals?	• Improve energy efficiency • Limit transportation impacts • Recycle metals
Using persistent synthetic materials produced by society?	• Eliminate/minimize toxic substances • Use biodegradable substitutes • Maintain synthetics in closed loop systems
Undermining the physical basis for the earth's productive cycles and biological diversity?	• Redevelop quarries - promote biodiversity • Minimize resource use • Reuse materials
How can we meet human needs efficiently and fairly?	• Invest in communities • Work with customers to identify ways to help ultimate customer be environmentally sound

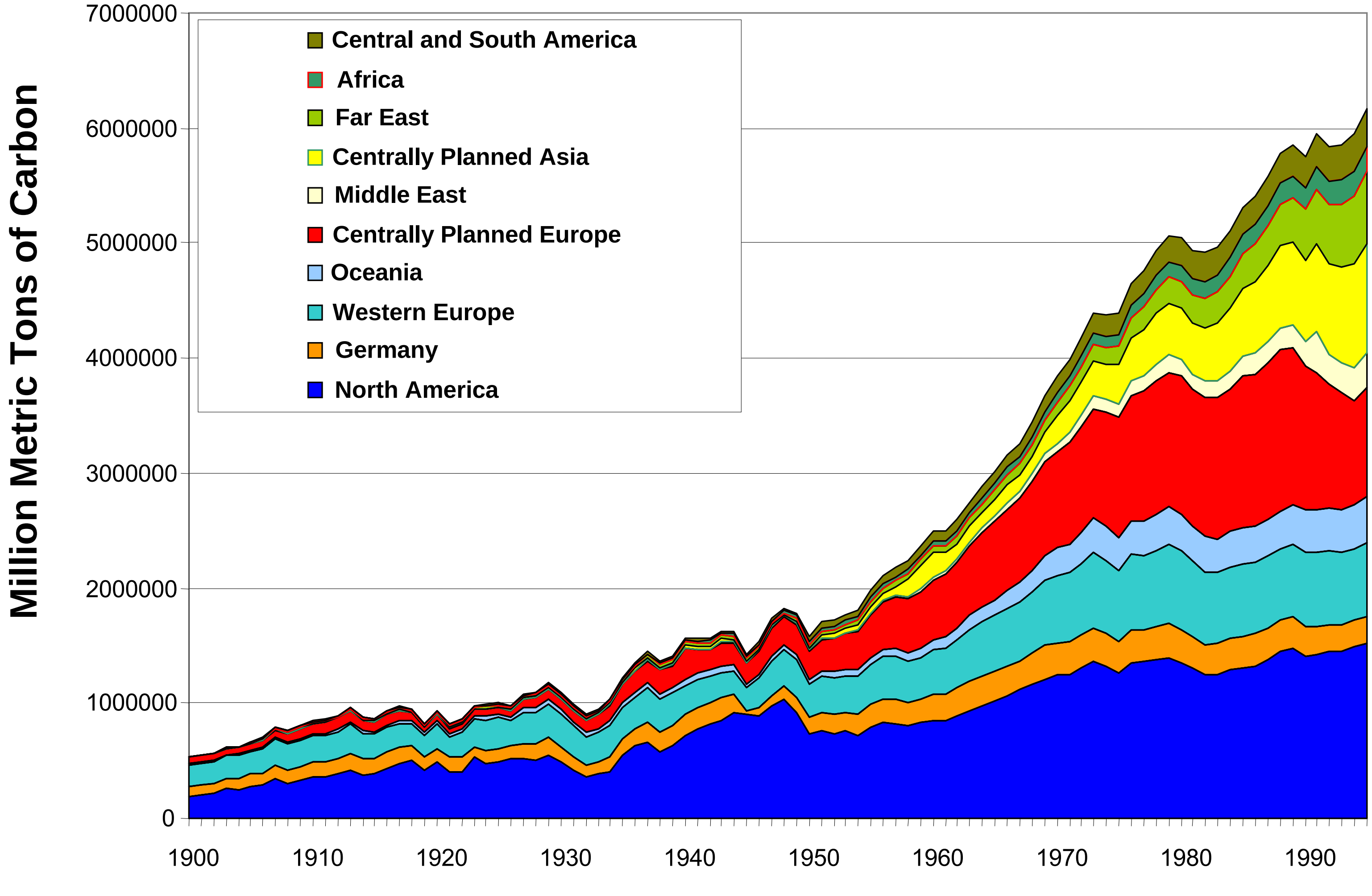
Climate Change Management

What could be sustainable strategies for climate change in the industry?

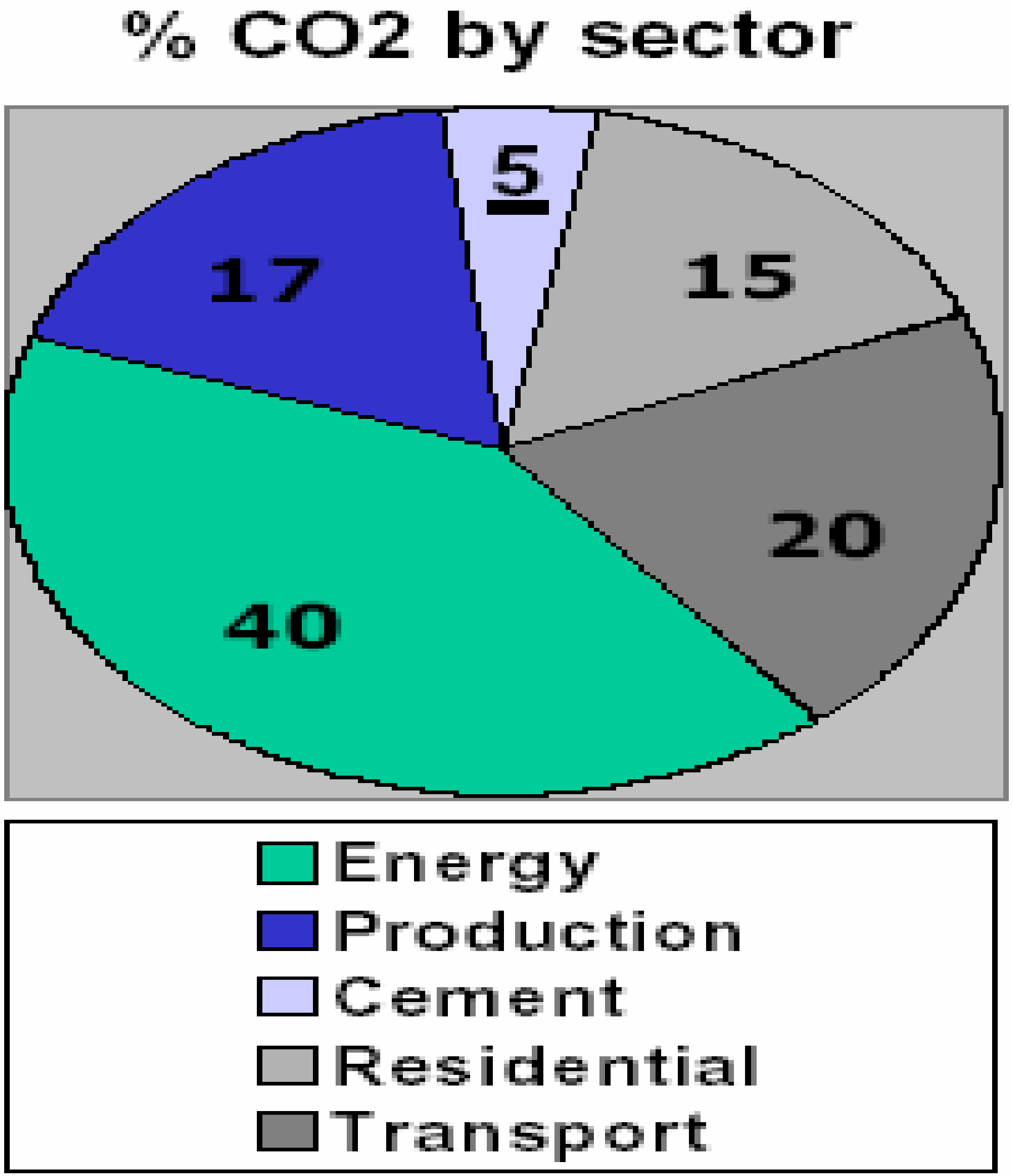
- Ultimately, atmospheric CO_2 concentrations must be stabilized, and Kyoto-like targets were only the beginning
- Serious reductions may be required by all industries
- Taking early action may be a good hedge against financial uncertainty
- Companies adopting incremental approaches may face serious economic consequences.

Atmospheric carbon dioxide (CO_2) emissions are rising

Global Carbon Emissions from Fossil Fuel and Cement



Source: CDIAC



% CO2 by sector
5
17
15
20
40
Energy
Production
Cement
Residential
Transport

Resource Stewardship by the Cement Industry

According to World Business Council of Sustainable Development **(WBCSD) …**

"The earth holds a limited supply of primary resources for meeting the needs of humanity and other living creatures. Resource Stewardship involves acceptance by the cement industry of their responsibility to ensure that fuels and raw materials are used wisely and efficiently and that the services of earth's ecosystems are not diminished."

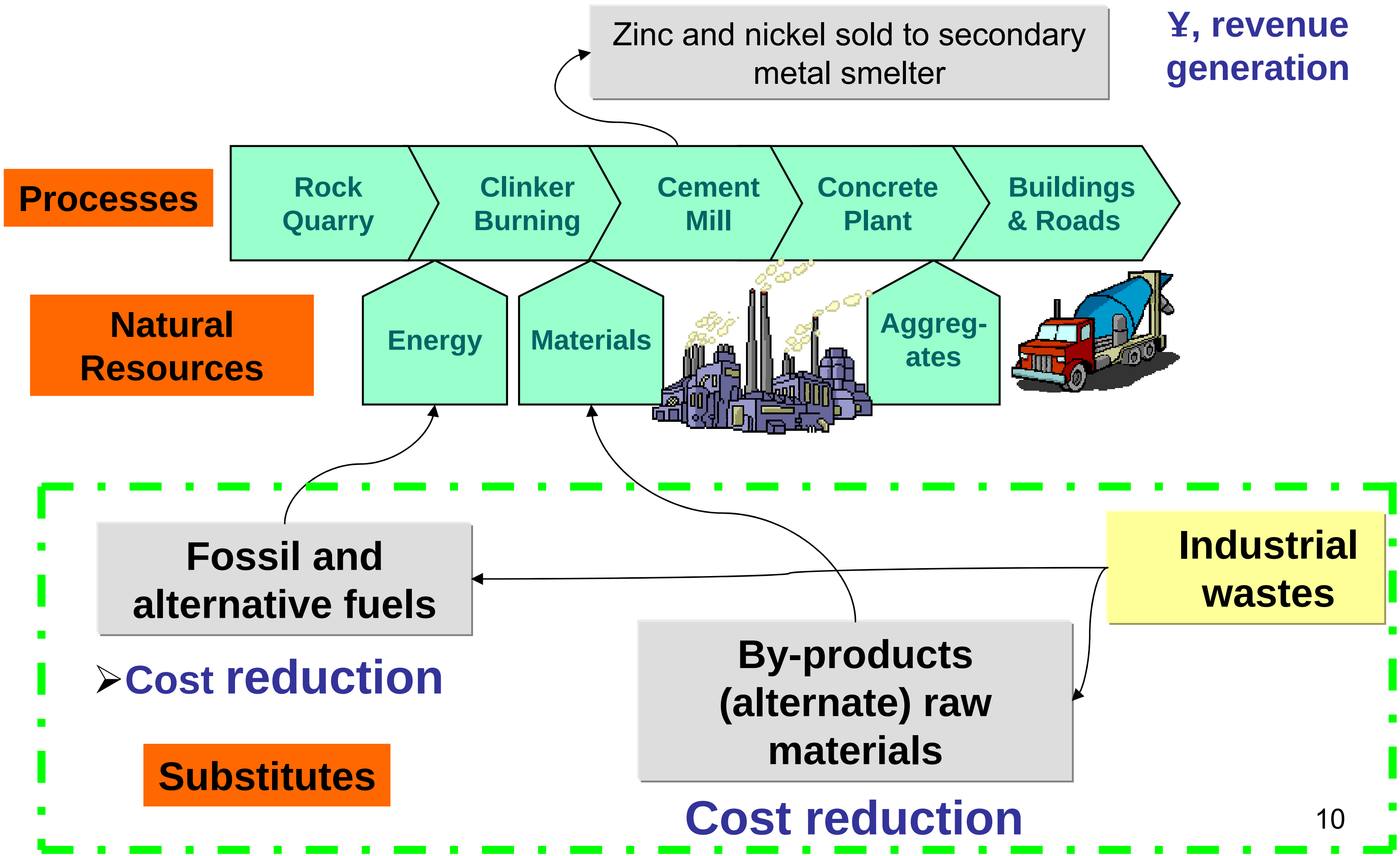
Key Performance Indicators for the C.I.

	Objectives	Indicators
Society	• Assure worker health & safety • Respect needs of local communities	• Lost time events per 200K hr. • No. of citizen meetings per yr.
Ecology	• Reduce global warming emissions • Find beneficial uses for wastes • Minimize cement process waste • Improve energy efficiency	• Net CO_2 per ton of cement • % substitution rate • Non-product output per ton • Tons of cement per MJ
Economy	• Support developing economies	• % of staff with local origin

Approaches to sustainable waste management

- **The *waste reduction* Approach**
- **The Reuse and Recycling Approach**
- **Always in mind today that, wastes of one industry are the starting materials for another industry**

Application of Industrial Ecology principles to the Cement Industry



Substitution in 2000

Production stage	Input material	Proportion	Trend
Clinker production	**Raw material**		
	Natural raw material	95 %	→
	Secondary raw material / ash	5 %	→
	Fuels		
	Fossil fuels	77 %	↘
	Alternative fuels	23 %	↗
Cement grinding	**Main constituents**		
	Cement clinker	79 %	↘
	Σ other	17 %	↗
	Calcium sulphates		
	Gypsum / anhydrite	75 %	→
	Industrial calcium sulphates	25 %	→

Cement Industry Implications

Like other extractive, energy-intensive industries, the cement industry is not on a sustainable path.

Major industry aspects are arguably unsustainable:

- **Quarrying impacts**
- **Depletion of minerals**
- **Energy use (in quarrying and production)**
- **Carbon dioxide emissions**

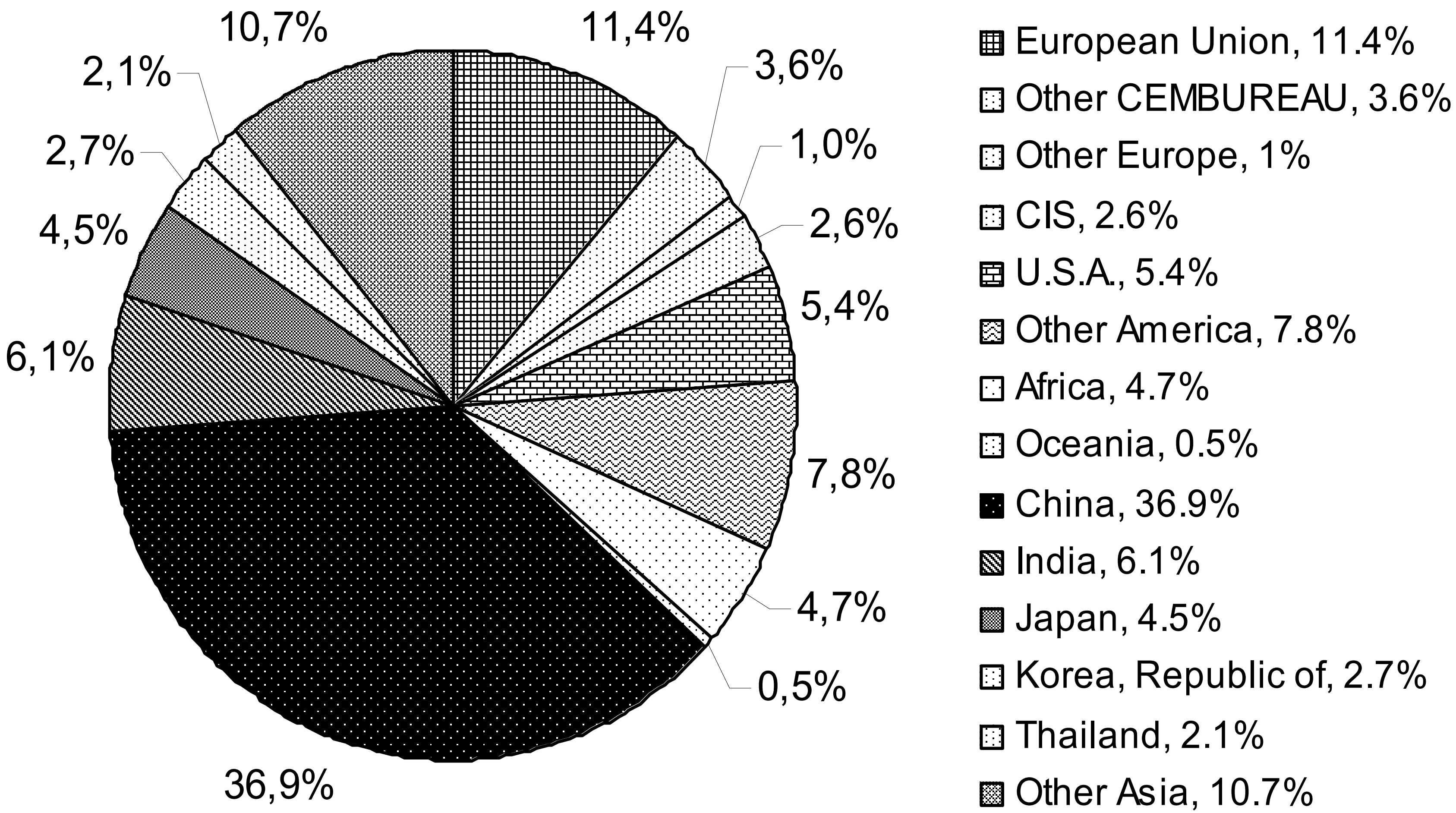
➢ The market for cement could be influenced by emergence of “preferred” alternative construction methods and materials.

➢ The large energy requirements of cement production will become untenable in the face of rising costs and global warming concerns.

➢ Vast emerging markets in Asia may not follow the same consumption patterns as the developed nations.

2001 World Cement Production by Region (Total Production 1.69 billion tons)

Source: CEMBUREAU, Annual Report 2001

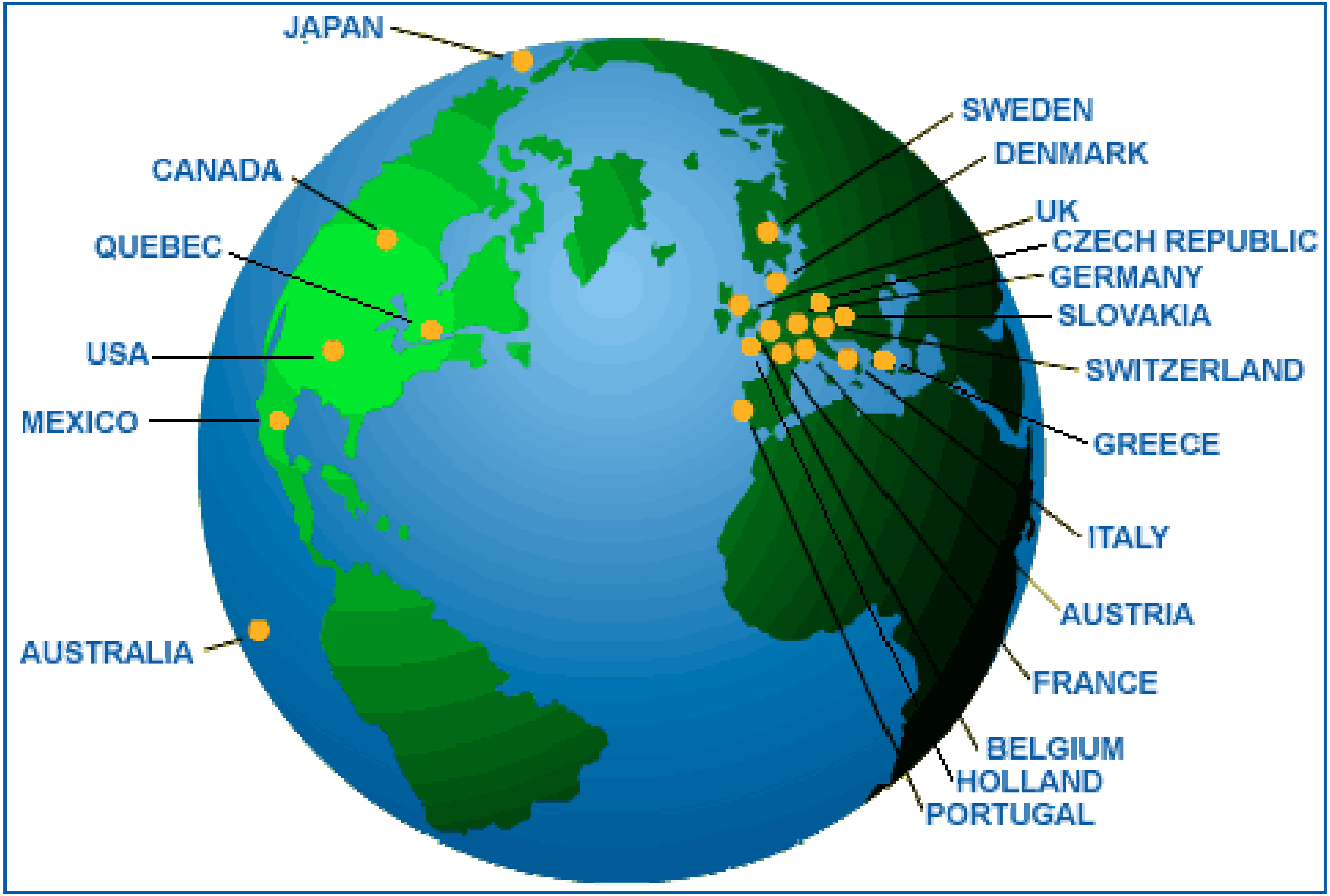


Application of the sustainable development principles to the Greek Cement Industry

Case study "Use of scrap tires as alternative fuel"

Evaluation of:

- **Economic benefit**
- **Environmental benefits**


JAPAN
CANADA
QUEBEC
USA
MEXICO
AUSTRALIA
SWEDEN
DENMARK
UK
CZECH REPUBLIC
GERMANY
SLOVAKIA
SWITZERLAND
GREECE
ITALY
AUSTRIA
FRANCE
BELGIUM
HOLLAND
PORTUGAL

Economic Benefit in the Greek C.I. 1st slide

- Greek Cement Production: **15.5×10^6 tons/yr**
- CO_2 emissions/yr : 15.5×10^6 tons cement x 0.83 tonnes CO_2/ton cement =

  12.87×10^6 tons
- Actually 9% lower: **11.71×10^6 tons** (due to the use of fly ash and slags in cement)
- Total CO_2 emissions/yr from fossil fuels burning in Greece: **26.21×10^6 tonnes C x 3.67 =** **96.19×10^6** tons
- Percentage of total CO_2 emissions in Greece assigned to the cement industry: **(11.71/96.19)x100=**

  = 12.2%.
- Coal mass used in the Greek cement production : **15.5×10^6 tons cement x 0.13 tons coal / ton cement = 2.015×10^6 tons coal.**

Economic Benefit in the Greek C.I. 2nd slide
from using scrap tires as alternative fuel

- Scrap tires rejected annually in Greece (Assumption **3.0** million passenger cars-whole tire replacement every three years): 4.0 million tires/year weighing **$40x10^3$ tons/year**
- The heat content (mean) / ton scrap tires **29 GJ/ton** and heat content /ton coal (6000 kcal/kg) **25.3 GJ/ton**
- *Ratio* (**29 / 25.3 = 1.15)** tons coal can be replaced by 1 ton of scrap tires
- From the above results: **$2.015x10^6$** tons coal /yr, needed for the cement production , **$46x10^3$ = ($40x10^3$x1.15)** tons coal (2.3% of total) can be replaced by scrap tires.

Economic Benefit in the Greek C.I.
3rd slide

- Taking also into account that, the coal price for the cement industry is: ≈ 40 US$/ton (≈40 €/ton) then, the total economic benefit for the Greek cement industry will be about 1.84×10^6 Euros annually
- The total cost for the modifications of the **8** Greek cement plants accounts for:

  ≈ 8 million **Euros (about 1 mio Euros/plant)**

- **From those, it comes out that, the depreciation period of this investment is 4.5 years**

This period may be significantly shortened (for example to half) by:

- a possible increase in the availability of other alternative fuels (solvents, sewage sludges etc.) or by
- applying a disposal fee 1 € / tire replaced (2% increase of the selling price), which accounts for **4.0 million Euros / year revenues, used as an economic assistance to the cement industry to fund the waste tire program**

Other example

CEMEX Mexico invested US $1.6m to burn 100% alternative fuels in its calcination process, saving the company $2.3 million annually.

CEMEX decided to burn 100% petcoke (a by-product of the refining process with a lower sale price than fuel oil) at α kiln.

Economic Benefits

- ✓ **Increased clinker production** by **15.7% - from 2,550 to 2,950 t/d** - without expanding plant capacity
- ✓ **Reduction** of specific thermal consumption at the kiln by **11.3%** - from 885 to 785 kcal/Kg clinker- representing **96,9 Gcal/year**
- ✓ **Reduction** of specific power consumption at the kiln by **13.7%** - from 46 to 39 Kwh/Kg clinker, representing **$6.1x10^6$ Mwh/year**

- ➢ **Operational stability** and **50% reduction in time** to reach the maximum production
- ➢ Savings of **$ 2.3 million per year**

Environmental Benefits

- ➢ **Reduction of emissions**: **CO2 6%;** CO, 96%; NOx, 35.7%; HCl, 70%; SO2, 87.5%; Hydrocarbons (HC), 61.1%
- ➢ **Reduction of 15,000 metric tons** of CO_2 per year to the atmosphere

Environmental benefits

- **Reduces the use of non-renewable fossil fuels (e.g. coal, as well as diminishing the environmental impacts associated with coal mining).**
- **Reduces GHG's emissions by replacing the use of fossil fuels with materials that would otherwise have to be disposed or incinerated with additional emissions and final residues.**
- **Maximizes the recovery of energy from waste due to the higher energy efficiency of cement kilns compared to that of incinerators (50% vs 25%). All the energy is used directly in the kiln for clinker production.**
- **Maximizes the recovery of non-combustible inorganic part of the waste and eliminates the need for disposal of slag or ash, as this inorganic part substitutes raw material and is embodied in the cement. The organic part constituents are completely destroyed due to the extremely high temperatures, long residence time and oxidizing conditions in the cement kiln.**
- **Heavy metals in the cement product are bound in the concrete and in most cases, are below the health-based levels.**

We must always have in mind that, the most obvious hazard, associated with the uncontrolled disposal and accumulation of large amounts of scrap tires outdoors, is always the potential for large fires that are detrimental to the environment due to the fact that, the soil and air pollution is even worse in extinguishing the fire with foam and water. The visual pollution from the uncontrolled disposal of the 4 million tires is very serious also, since the total disposal area amounts to about 30 hectares annually (pile of 1 meter height). The disposed material assumed to have an apparent density 0.15 tons/m^3.

CONCLUSIONS

With adequate specifications and quality control, the use of waste fuel (scrap tires, solvents etc.) in cement kilns can have significant positive impacts not only in product quality, operations and the environment, but in the economic annual revenues of the Greek C.I. as well. In contrast, the disposal or incinerators have greater negative impacts on the environment because they represent a new source of emissions, that may not exist if cement kilns can burn the waste. Existing cement kilns burning waste fuels have consistently shown compliance with air quality standards.