# Energy Efficiency Through Insulation: The Impact on Global Climate Change

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## Introduction

In recent years, the international community has joined together in recognition of the growing threat from global climate change. Under the 1992 international treaty, developed countries are required to scale back their greenhouse gas emissions to 1990 levels by the year 2000. Under the auspices of the United Nations Framework Convention on Climate Change (FCCC)[1], the parties are charged with designing a plan for significantly reducing carbon dioxide emissions in the post-2000 time period. In fact, as stated in Article 2, the ultimate objective of the FCCC is "...stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."

"Greenhouse gases" such as carbon dioxide, methane and nitrous oxide exist naturally in the atmosphere, but also are released in great quantities as a result of human activities. Scientists predict that, given current trends of increasing emissions of most greenhouse gases, atmospheric concentrations are expected to increase through the next century and beyond. According to a summary report by the Intergovernmental Panel on Climate Change (IPCC) Second Assessment Synthesis of Scientific-Technical Information Relevant to Interpreting Article 2 of the U.N. FCCC (1995)[2], "Most emission scenarios indicate that, in the absence of mitigation policies, greenhouse gas emissions will continue to rise during the next century and lead to greenhouse gas concentrations that by the year 2100 are projected to change climate more than projected for twice the pre-industrial concentrations of carbon dioxide."

The debate over global climate change has focused on both naturally occurring greenhouse gas emissions as well as the emissions generated as the result of human activities, including the burning of fossil fuels, land-use change and agriculture. The IPCC summary report states that "the anthropogenic emissions of these gases have contributed about 80% of the additional climate forcing due to greenhouse gases since pre-industrial times (i.e. since about 1750 A.D.)"

While some might debate the extent of the impact of human behavior on global climate change, that some impact does occur is certain. Given that fact, it seems only prudent to pursue appropriate means to encourage changes in human behavior which will lead to reductions in the level of greenhouse gas emissions and, ultimately, to a reduction in the threat from global climate change. There are many ways to effect changes in human behavior. One involves education and training on the need for greater understanding of the potential threat from global climate change. Another is through adoption and implementation of technologies designed to enhance humankind's ability to reduce the consumption of energy. This paper will address the second area; specifically, how improving energy efficiency through existing insulation technologies in the residential and commercial building sectors can significantly reduce the level of emission of greenhouse gases and, in turn, global climate change.

# The Role of Energy Efficiency and Insulation in Global Climate Change

Energy efficiency is defined largely as cost-effective ways to reduce energy consumption through existing and improved technologies as well as through sound energy use practices. The idea behind energy efficiency is quite simple - if people consume less energy, there will be less emission of greenhouse gases as the result of the burning of fossil fuels. That, in turn, means a greater supply of fossil fuels which can then be used for other purposes in both developed and developing nations. Energy efficiency technologies and practices can therefore play a significant role in reducing the threat of global climate change.

One of the easiest and most effective energy efficient technologies available today is insulation. Overall benefits from insulation are numerous, including thermal performance, personal comfort, sound control, condensation control, fire protection and personnel protection. The thermal insulating properties of insulation materials provide important energy and environmental benefits. Made from a variety of substances including fiber glass, mineral wool, foam and other materials, insulation products are primarily designed to reduce the transfer of heat through building structures in residential, commercial and industrial applications. By their very nature, insulation products enable consumers to reduce more energy use and more emission of pollutants annually than it takes to manufacture them. This results in a very positive overall energy and environmental balance for thermal insulation. While there are significant savings realized from industrial process insulation and mechanical insulation as well, this paper will focus on studies that analyze the energy and environmental savings of fiber glass, rock wool and slag wool thermal insulation in buildings.

# Insulation Savings in the United States

In a 1996 study[3] of the energy and environmental benefits of fiber glass, rock wool and slag wool insulation materials prepared for the North American Insulation Manufacturers Association (NAIMA), researchers compared the energy used to make insulation with the energy currently being saved by insulation products installed in the building envelope of residential and commercial structures. According to the report, prepared jointly by Energy Conservation Management, Inc. (ECM), the Alliance to Save Energy, and Barakat & Chamberlin, Inc., the benefits from insulation far outweigh the cost, with the ratio of energy investment to energy savings having a range of (12 to 1) per year. This ratio means that for every Btu invested in the manufacture of thermal insulation, 12 Btu in energy savings are realized in the first year of service.

The ECM study looked specifically at the energy-saving benefits of the insulation currently in place in the United States in residential and commercial buildings as well as in industrial applications. The findings of the ECM study are startling. The authors reported that "because of home insulation, drastically less energy is needed to heat and cool homes in the United States today when compared to the same homes without insulation. This difference results in energy savings of 51 percent or 10.4 quadrillion Btu nationwide." That 10.4 quadrillion Btu is equivalent to a 255-day supply of gasoline for the entire United States or to 51% of the total annual industrial energy consumption in the United States. In the commercial building sector, the study found that insulation currently in place saves 1.51 quadrillion Btu annually, or a 37-day supply of gasoline for the entire United States

Table 1 below summarizes the energy savings realized from insulation currently in place in these sectors:

**Table 1 - Energy Use (Quadrillion Btu)**

| | No insulation | Baseline (existing) | Savings | % Savings |
|---|---|---|---|---|
| Residential | 20.41 | 10.00 | 10.41 | 51% |
| Commercial | 8.21 | 6.70 | 1.51 | 18% |
| Residential & Commercial | 28.62 | 16.70 | 11.91 | 42% |

(Source: "Green and Competitive: Energy, Environmental, and Economic Benefits of Fiberglass and Mineral Wool Insulation Products," by Energy Conservation Management, Inc., et al, June 1996.)

While these numbers may be impressive, future energy savings may be even greater. The study also considered the potential for additional energy-savings and environmental impact if insulation levels were increased to meet standard energy codes. For example, if all residential buildings were insulated according to the Council of American Building Officials' Model Energy Code (MEC) 1992, a minimum energy efficiency standard for houses, an additional 2 quadrillion Btu in energy savings would be achievable. Add in energy savings potential from the commercial and industrial sectors, and the study estimates that it would be possible to save 2.2 quadrillion Btu of energy annually. That additional savings is equivalent to a 54-day supply of gasoline for the entire United States.

Yet the benefits of insulation go far beyond the increased comfort levels and money saved in utility bills for home and business owners. The environmental implications of the energy savings from insulation go right to the heart of global climate change, simply because less energy consumption means less emission of greenhouse gases.

Consider again the 10.41 quadrillion Btu saved as the result of insulation currently in place in residential homes. According to the ECM study, if current levels of residential insulation did not exist, U.S. carbon dioxide emissions would increase by 15%, with 1.35 trillion pounds of carbon dioxide being emitted into the atmosphere each year. In order to eliminate that much additional carbon dioxide from the atmosphere, nearly 300 million acres of trees would need to be planted.

Even more significant is the unrealized potential savings from improved thermal insulation in the residential sector. If levels of insulation in all U.S. residential buildings were improved to meet the Model Energy Code, an additional 249.2 billion pounds or 125 million tons per year of carbon dioxide emissions could be avoided. This would, in turn, reduce total carbon dioxide emissions in the U.S. by nearly 30%. Additionally, improved insulation in the commercial building sector would reduce carbon dioxide emissions - 36.12 billion pounds less or 18 million tons or another 4% reduction in total annual U.S. carbon dioxide emissions.

As illustrated in Table 2 below, the potential for reducing carbon dioxide emissions ($CO_2$) through improved insulation is considerable.

**Table 2 - Carbon Dioxide Emissions Reduction (Billion Pounds)**

| | Existing | Additional Potential |
|---|---|---|
| Residential | 1,347 | 249.2 |
| Commercial | 211 | 36.1 |
| Industrial | Not Calculated | 8.2 |
| Total | 1,558 | 293.5 |

(Source: "Green and Competitive: Energy, Environmental, and Economic Benefits of Fiberglass and Mineral Wool Insulation Products," by Energy Conservation Management, Inc., et al, June 1996.)

# International Savings from Insulation

While we have focused on energy and environmental savings from insulation in the United States, the benefits of insulation are well documented in other countries as well. For example, the European Insulation Manufacturers Association (EURIMA), representing over 30 mineral fiber manufacturers in 16 European countries, has conducted a study of the European insulation industry's contribution to the solution of global warming. The report, entitled "Thermal Insulation Means Environmental Protection,"[4] found that:

- The EURIMA member countries account for approximately 3 billion of the 20 billion tons of $CO_2$ emitted into the world's atmosphere per year.
- Households and small businesses alone accounted for a quarter (737 million tons) of the 1987 $CO_2$ emissions in the countries under review.
- Depending on the climatic conditions in the individual countries, heating accounted for 60 to 80% of these emissions.
- As a result, there is an annual reduction potential of approximately 600 million tons of heating-related $CO_2$ emissions which could be cut dramatically by the application of improved thermal insulation in the EURIMA countries.

**Table 3 -Possible reduction of $CO_2$ emissions caused by heating by means of better building insulation**

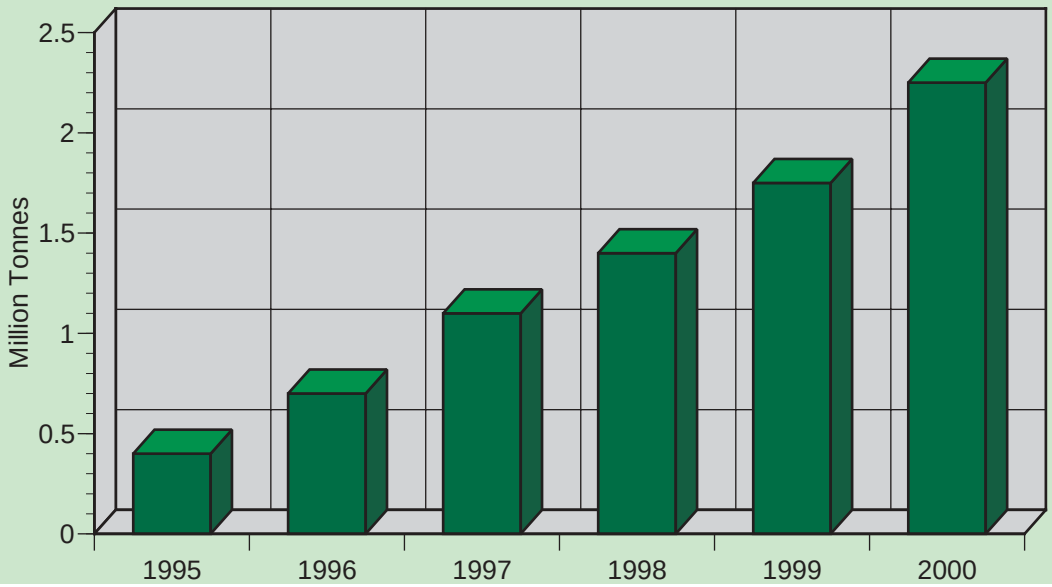
| EURIMA Countries | Actual emissions (million t) | | Possible reduction | | |
|---|---|---|---|---|---|
| | Total | Heating | million t | % Total | % Heating |
| Austria | - | 21 | 10 | - | 48 |
| Belgium | 112 | 33 | 22 | 20 | 67 |
| Denmark | 64 | 12 | 3 | 5 | 25 |
| Finland | 65 | 12 | 1 | 2 | 8 |
| France | 280 | 55 | 36 | 13 | 65 |
| Germany | 743 | 150 | 100 | 13 | 67 |
| Ireland | 27 | 7 | 5 | 18 | 71 |
| Italy | 360 | 36 | 18 | 5 | 50 |
| Netherlands | 167 | 40 | 27 | 16 | 68 |
| Norway | 35 | 3 | 1 | 3 | 33 |
| Spain | 186 | 27 | 13 | 7 | 50 |
| Sweden | 93 | 20 | 2 | 2 | 10 |
| Switzerland | 42 | 17 | 11 | 26 | 65 |
| Turkey | 186 | 69 | 17 | 9 | 25 |
| U.K. | 542 | 75 | 37 | 7 | 49 |
| TOTAL | (~3,000) | (~600) | (~310) | (~10) | (~50) |

(Source: "Thermal Insulation Means Environmental Protection," Study by the European Insulation Manufacturers Association (EURIMA), 1990.)

The EURIMA report concluded that "310 million tons of heating-related emissions can be avoided every year by applying state of the art thermal insulation measures to new and existing buildings - some 50% of the total heating-related emissions and well over 10% of the total $CO_2$ emissions.

Similarly, a report from Australia[5] analyzed the potential impact on greenhouse gases from the use of more effective insulation of new and existing residential buildings. According to the Fibreglass and Rockwool Insulation Manufacturers Association of Australia (FARIMA), which represents all Australian mineral fiber manufacturers, the findings are significant. FARIMA found that a home insulated to Australian Standard AS2627, the home insulation thermal performance standard, would reduce energy lost through the walls by 20-30% and through the ceiling by 30-40%. In terms of pollution reduction potential, FARIMA states that "it has been estimated that if all new homes built in Australia each year were insulated to the recommended insulation levels for AS2627.1, the carbon dioxide emission savings from these homes would total 3.2 million tonnes a year every year within five years ..." It is important to keep in mind that this study looked only at residential homes in Australia.

**Table 4 - $CO_2$ Savings (Annual Cumulative) Million Tones per Year**




(Source: "Insulation Incentives: A submission to the Federal Ministers for the Environment: Resources and Energy on Energy Conservation and Environmental Protection" by Fibreglass and Rockwool Insulation Manufacturers Association of Australia (FARIMA). 1996.)

# Conclusion

Clearly, insulation represents a practical energy-efficiency technology that can have a real and immediate impact on global climate change. Fiber glass, rock wool and slag wool thermal insulation, applied to current minimum energy efficiency standards in both new and existing homes, can lead to considerable energy, economic and environmental benefits. The energy invested in the manufacture of these insulation materials is returned many times over in just the first year of use. In turn, the energy efficiency benefits to be realized from improved use of mineral wool insulations can reduce greenhouse gas emissions throughout the world and reduce the threat of global climate change. Similarly, the effective use of mineral wool insulation in industrial and mechanical applications can contribute to additional energy savings and pollution prevention.

As demonstrated by the studies referenced in this paper, the unrealized potential for energy and environmental savings from improved building insulation demands the attention of international forums such as this. The enormous reduction in greenhouse gas emissions as the result of insulation in existing structures should not go unrecognized. To do so would be to overlook a readily available and cost-effective energy efficient technology that offers immediate environmental benefits throughout its product lifetime.

To ensure that the benefits of thermal insulation can be attained throughout the world, it is critical that countries cooperate on education, training, development and guidance for improved energy efficiency. As such, it is important that the leaders of the Conference of the Parties to the Climate Convention provide guidance on energy efficient building practices as well as the effective use of insulation technology. By including in the international protocol on global climate change a recommendation for improved energy-efficiency for buildings with a focus on thermal performance for residential and commercial buildings, along with guidance on thermal improvements for industrial and mechanical insulation, this conference will take a major step toward its ultimate goal to stabilize the emission of greenhouse gases.

# References:

[1] United Nations Framework Convention on Climate Change (FCCC) 1992
[2] Summary Report; Intergovernmental Panel on Climate Change (IPCC), Second Assessment Synthesis of Scientific-Technical Information Relevant to Interpreting Article 2 of the U.N. FCCC, 1995
[3] "Green and Competitive: Energy, Environmental and Economic Benefits of Fiber Glass and Mineral Wool Insulation Products," by Energy Conservation Management, Inc.; The Alliance to Save Energy; and Barakat & Chamberlin, Inc., June 1996
[4] "Thermal Insulation Means Environmental Protection," study by the European Insulation Manufacturers Association (EURIMA), 1990
[5] "Insulation Incentives: A submission to the Federal Ministers for The Environment; Resources and Energy on Energy Conservation and Environmental Protection," by the Fibreglass and Rockwool Insulation Manufacturers Association of Australia (FARIMA), 1996

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