Abstract. Scientists are now being asked to recommend measures to reduce the risks of climatic change due to anthropogenic greenhouse gases. Considerably less effort, however, has been allotted to understanding the efficacy of controlling these gases than to their effects. This paper briefly describes and applies an energy-economic model to assess the effectiveness of carbon dioxide control policies that theoretically could be enacted in China, a large, developing nation with an energy inefficient and 'carbon-intensive' economy. The paper also assesses the effectiveness of similar international efforts, as well as the effect of each initiative on Chinese income levels. Carbon dioxide control measures are contained in scenarios drawn to the year 2075 and include family planning, fossil fuel taxes, mandatory or technical energy efficiency improvements, and a combination of these.

The results suggest, not surprisingly, that no nation alone, not even China, can decisively affect the global CO₂ problem. More importantly, however, the potential for energy efficiency improvements in China is found to be both very large and economically attractive. Scenario analysis suggests that energy efficiency measures could both reduce carbon emissions significantly and increase Chinese per capita incomes. Similar conclusions are drawn regarding worldwide energy-efficiency measures. Thus, appropriate public policy measures to capture the existing energy-efficiency potential might both reduce the risk of climatic change and improve economic standards of living.

1. Introduction

Can and should policy-makers act to reduce the risk of climatic change due to anthropogenic greenhouse gases? As scientists have grappled with this question, a schism has appeared between what has been called the 'activists' and the 'muddlers-through' (Kellogg, 1987). The former call for early action, arguing that trace gases could cause deleterious and irreversible atmospheric changes long before science fully understands them. The latter urge against action, arguing that without thoroughly understanding the problem it would try to solve, society might take costly, unnecessary, or ineffective measures. Judgment of whether action would be worthwhile, however, is beyond the competence of science.

The decision to act or not to slow the release of greenhouse gases belongs to the realm of what Alvin Weinberg called 'Transcience' (Weinberg, 1967). It demands complex and personal judgments regarding acceptable levels of risk, the value of present versus future benefits, intergenerational equity, as well as
the technical and economic potential for controlling greenhouse gases. The decision thus can be properly made only by society through its political institutions.

Scientists, nevertheless, are increasingly asked to inform the climate-change debate about the potential benefits and costs of action and inaction (NCR, 1983; Firor, 1987; Schneider, 1987). In this respect, science can usefully assess technical and economic measures for their efficacy. Unfortunately, considerably less effort has been allotted to understanding means of controlling human sources of greenhouse gases than to their effects (Edmonds and Reilly, 1983; Edmonds and Reilly, 1985). Nowhere is this more obvious than when climate modellers merely extrapolate trends of carbon dioxide emissions — especially if the resulting scenarios are used to conclude that a greenhouse warming is inevitable and political action against it futile. This practice is reminiscent of the errors of energy supply planners of the late sixties and early seventies, who assumed that energy use (the main source of anthropogenic carbon emissions) and economic output moved in lock-step, and that energy-use was highly price-inelastic. This somewhat deterministic outlook has of course been discredited by the price-induced energy-efficiency response of recent years. Since 1970, the United States and Japan, for example, have reduced the energy intensity of their economies by 30% (U.S. Department of Energy, 1987).

Surprisingly, the potential role of energy-efficiency in ameliorating climatic change due to increasing atmospheric carbon has been minimized in the literature. This is particularly true concerning the developing nations, which may hold legitimate claims to increase absolute levels of energy use. For example, one influential book concluded ‘...energy conservation has little meaning for [developing] countries when per capita energy consumption is, say, only 5% of that in the United States’ (Kellogg and Schwarze, 1981). Energy efficiency, however, is not defined by per capita rates of consumption but by the level of amenity supplied per energy unit. Energy is a means, not an end, and as it turns out, developing nations are often exceedingly inefficient in energy use. Thus, it is possible that economic growth could occur with considerably less generation of carbon emissions than the trend-extrapolation scenarios suggest. Indeed, economic growth will likely be retarded by energy-use inefficiency. But it remains true that economic growth could be sufficient to cause a major atmospheric warming. To assess the overall potential for policies that affect energy use to reduce the growth of carbon emissions and their impact on incomes, one needs a consistent, transparent, theoretically sound, and reproducible framework, or model. Any model — and an extrapolation or hunch in one’s head is a model — which does not meet these criteria not only lacks rigor but is invalid.

This paper asks whether it is technically and economically feasible for a major developing country, China, to reduce significantly its current and projected energy-intensity and its expected carbon emissions. China is a logical choice for such a study: It represents 20% of the human population; it possesses