

# 1 Introduction

Energy is a key issue that is present in all the sectors of modern economies. The availability of cheap, abundant and safe energy sources is indeed a requisite for sustained economic development in emerging economies. The ways in which it is consumed and used to produce welfare is the matter of several disciplinary fields. Energy technologies are important because energy is crucial in the overall economic system, not only because of the scarcity of the resources (the world energy mix is based on non renewable energy carriers), but also because of the environmental concerns. Indeed, environmental degradation is due, to a large extent, to the effects of energy production, transformation and use.

The environmental aspects of energy consumption are becoming very important, but the vulnerability of the energy system to price shocks should not be forgotten: two out of the three large global economic recessions in the last fifty years were associated with a supply shock in the energy sector.

The rediscovery of the risks of global climate change by climatologists in the middle of the seventies was reflected in the eighties by the appearance of the above question on international political agendas: statement of the Heads of State in the Hague (1989), then the Rio Conference (1992), the ratification of the United Nations Framework Convention on Climate Change (1994) and the launching of the international negotiation process within the framework of the "Conferences of the Parties". Considerable stimulus has thus been given to research on the possible consequences of climate change and the control strategies. In the case of the IPCC in particular, research has focused on three major issues: scientific aspects, effects and abatement measures, and the socio-economic aspects of climate change (IPCC, 1995). In the latter case, which involves the economic analysis of strategies to combat climate change, the two key issues in environmental economics must be addressed, namely evaluation of damage and evaluation of the cost of reducing emissions.

In general, research into the evaluation of environmental damage has attracted increasing attention in recent years, which has resulted in the development of a

methodology and numerous applied studies, in particular in the energy sector (for the electricity sector, see the results of the external study, ExternE, Commission-DG XII, 1996). However, evaluation of the damage associated with climate change is hampered by intrinsic difficulties, due on the one hand to the diversity of long term local impacts and their low level of predictability, and, on the other hand, to ethical questions related to the comparability of damage in societies with extremely unequal levels of wealth (Hourcade, 1996). In the absence of a consensus on the evaluation of damage, it is therefore difficult to apply the principles of "cost benefit" analysis, advocated by the economic theory of the environment. This seeks a "pollution optimum" through equalisation of marginal pollution costs and pollution control. "Cost effectiveness" analyses have thus been favoured, aimed at minimising the cost of pollution control measures to meet a specific emission level target.

## 1.1 Objectives

There three main objectives in this volume: Firstly, it aims at presenting a "business as usual" (BAU or baseline) energy and emissions outlook for the European Union and for the world by major region. Such an outlook is an essential framework for a) evaluating the likely extent of the greenhouse gas problem, at least to the extent that it depends on energy, b) examining the sectors, fuels and regions that are especially important for any increase in emissions, and c) the analysis of the potential of existing and other likely policy measures.

Having arrived at this BAU energy and emissions outlook, the second objective of the volume is to examine alternative policy packages, mainly within the EU, that may be adopted in order to tackle the problem. Many individual measures and packages have been discussed in recent years within the EU and especially in the lead up to the Kyoto conference. These include regulation type measures as well as market instruments such as taxes and emission trading.

Equally important to the effectiveness of measures are their likely cost and their impact on other policy objectives such as security of energy supply, financial robustness of the public sector. While this issue has been examined from macroeconomic perspective elsewhere in more detail, some of the costs of these measures are also examined in Part II of this report.

Finally, the third objective of the volume is to examine to long term potential of technology in assisting in solving the GHG problem. To this end, the project aimed at assessing the role of technology progress breakthroughs, which are partly the result of R&D policy. Using the power generation sector as a case study,