Executive Summary

The basic issue to be analyzed in this volume concerns the trends that may be identified within the energy technology field. Our scope here is first to determine up to what extend can technology contribute to a possible structural change within energy markets leading to a less carbon-intensive exploitation system, and second to determine what are the possible mechanisms through which these changes may take place, and what are the conditions that may facilitate this transition. Ultimately, the key question to answer is what will be the energy technologies that are likely to become crucial if energy planners consider with growing attention the necessity of limiting (with different degrees of intensity) the carbon emissions to the atmosphere. The identification of these technologies is, however, not the only task to do. Indeed, these technologies may be out of the market today, and could well be faced to enormous difficulties to become operative within a competitive energy market unless some measures aiming at facilitating its implementation are taken. These measures may be viewed as a necessary effort to conduct the status of the world energy system from a non-sustainable situation, in which the free-riding behavior of some agents, the opacity of the market signals and the induced barriers to technology renewal towards a more efficient and reliable system, where costs and benefits are granted to the pertinent agents and the inefficiencies are charged with equity, so as to produce a combination of positive incentives. The passage from the present scheme to this improved situation is not automatic, and a sort of potential barrier has to be overcome. The task is to provide to policy makers an appropriate strategy so as this obstacle is overcome, ensuring a smooth and reliable transition to a environmental (climatic) safe energy exploitation schemes.

An outline of the remaining of the volume follows.

Section 1.1 recalls the basic analytical approaches and possible policy frameworks that have been used to assess the energy-environmental-economy problems, and, in particular, the global warming issue. Rather than focusing on a similar basis at all of them, it has been perceived that there are sectors (and, associated to them, the corresponding technologies) that are actually acting as catalyzers of the technology innovation process.

The power generation sector seems to be the big player within the overall picture. Arguments to support this hypothesis are given in section 1.2.

A general view onto the evolution of the energy system at a global scale is included in Chapter 2. Trends on carbon emissions, both in absolute and per capita terms are included to serve as a framing discussion for the baseline world energy projection obtained with POLES. The peculiarities of the EU and other OECD countries are also discussed, with particular emphasis on the changing structure of the power sector (liberalisation and unbundling), underlying the role that technological diversity within the electricity market can play to foster the transition towards new exploitation schemes.

Chapter 3 presents a screening on the portfolio of mitigation measures from a sectoral end-use standpoint. These include fuel mix shift, energy appliances improved efficiency as well as carbon removal and sequestration. These technologies are summarized there by sake of completeness, since, as it has been mentioned, focus will be given to power generation technologies.

The emerging clusters of electricity generation technologies are described in Chapter 4, including not only the present techno-economic status of the technologies, but also the prospects for each of them to the medium-long term (2000-2030).

The possible technological scenarios foreseen, even if concerning the whole system, have been conceived and constructed around different power generation paradigms: they are described in Chapter 5.

Based on the above-described energy technology scenarios, Chapter 6 shows the results obtained concerning the forecasts on market penetration on a technology-by-technology basis, as well as the analysis of the environmental costs and benefits associated, as predicted by the technology diffusion model SAFIRE.

The expected effects induced onto the global energy system by the technological hypothesis underlying behind these technologically-driven scenarios are described in detail in Chapter 7. The analysis presented have been conducted using the POLES model, which allow to capture with accuracy the regional specificities, as well as the integrated dynamics of the world markets of primary energy carriers.

Finally, Chapter 8 summarizes the main conclusions and gives the guidelines for setting a cost-efficient energy technology R&D strategy.