

# Introduction

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This volume combines the methodology and results on private and full costs estimation with the assessment and the evaluation of different instruments of energy policy, and the projection of electricity scenarios.

The book provides the results of the research performed by the CASES project, which is a Coordination Action on ‘Cost Assessment of Sustainable Energy Systems’ funded by the European Commission under the Sixth Framework Programme, Sustainable Energy Systems.

## DESCRIPTION AND OBJECTIVES OF THE CASES PROJECT

The CASES Coordination Action (CA for short) carried out its activities from April 2006 to September 2008. In this period it evaluated policy options for improving the efficiency of energy use, underpinning this evaluation with a consistent and comprehensive picture of the social cost of energy, and made this crucial knowledge available to all stakeholders.

In particular CASES compiled a complete and coherent assessment of the social cost (external plus private cost) of different electricity generation technologies, in EU countries and in selected non-EU countries, under well-defined energy scenarios to 2030.

The cost database provides a unique quantitative support to the assessment of alternative policy options in the perspective of improving the efficiency of energy use. CASES, in providing a set of recommendations on the use of different policy instruments for the internalisation of the external costs of energy production, contributes directly to policy and provides an information base on the effectiveness and on the consequences of the use of different instruments. In addition, the assessment of the full costs estimates of electricity generation allows policy-makers to become more aware of the consequences that different fuels and technologies have on human health, the environment and society. Finally the project disseminates research findings to energy sector producers and users, and to the policy-making community.

In detail, the objectives of the CASES CA were the following:

- To compile coherent and detailed estimates of both external and internal costs of electricity generation for different energy sources at the national level for the EU27 countries and for some non-EU countries under energy scenarios to 2030;
- To evaluate policy options for improving the efficiency of energy use, taking into account the Full Cost data;
- To disseminate research findings to energy sector producers and users, and to the policy-making community.

A complete and consistent assessment of the full cost of energy sources, which includes the external cost plus the private cost, is of paramount importance for energy and environmental policy making. Energy policy making is concerned with both the supply side and the demand side of energy provision. On the supply side, deciding on alternative investment options requires knowledge of the full cost of each energy option under scrutiny. On the demand side, social welfare maximisation should lead to the formulation of energy policies which steer consumers' behaviour towards the minimisation of costs imposed on society as a whole. Demand side policies can benefit significantly from the integration of full energy costs in the corresponding policy formulation process.

These issues are of particular relevance when framed within the current European context of progressive enlargement and integration. In particular two recent developments are of relevance here: the liberalisation of the European markets for gas and electricity, and the recent addition of new Member States. These processes are intrinsically dynamic. New policy instruments are being developed and applied in order to cope with the changes in the policy arena, including emissions trading, and the comprehension of different options is continually enriching the policy framework.

In this perspective, the first objective of this Coordinated Action was to compile a consistent and detailed set of estimates of the external and internal costs of electricity generation for different technologies, at the national level for the EU27 countries, and for Turkey, Brazil, India and China, under energy scenarios to 2030. The project builds on state-of-the-art methodologies reaching a dynamic assessment of full costs, by updating all the information from previous projects, such as ExternE, according to the evolution of technologies and to the expansion of knowledge on external costs. The integration of private and external costs is built within one dynamic framework, to arrive at agreed ranges of estimates, for different countries, of the full cost of each energy source. Following this objective, CASES provides state-of-the-art projections of the evolution of energy prices

and of the private and external costs of major technologies, likely to be employed to generate energy from different sources over the next 25 years.

The second objective of the CA was to apply the comparative cost data of different types of electricity generation technologies, to the assessment of alternative policy options for improving the efficiency of energy use and reducing its impact on the environment over the next few decades. Not only are the cost estimates important in this context, but so is the range of their uncertainty; a better understanding of the social and private costs also strengthens the credibility of policy-making decisions by reducing the uncertainty ranges. In this part of the project, the social and fiscal implications of a given policy measure were analysed, with an eye for the distributional consequences for poor and vulnerable groups. This assessment was dynamic and underlined the implications of different levels of internalisation on the investment decisions and on key social indicators. In addition, the analysis covered the impact of the use of different methods of decision-making (the project focused in particular on cost-benefit and multi-criteria decision analysis), on the selection of projects and the implications of different policies to reduce energy insecurity, now and over time. Different instruments to promote renewable energy sources were then compared in terms of the degree in which they internalised the positive externalities associated with renewable energy use.

The third objective of the project was the dissemination of the knowledge on electricity generation costs. Once evaluated and brought into a coherent framework, the results of the different components of the project are of great interest for the energy sector producers and users, as well as for the policy-making community. Dissemination consists of a set of activities to validate and disseminate the project outputs. These activities range from the publication of articles in the peer-reviewed literature, to presentations and lectures at project workshops and conferences involving key stakeholders and policy makers, at external seminars, workshops and conferences, to open discussion with energy producers and end-user organisations and, of course, this book.

## INSTITUTIONS AND RESEARCH CENTRES INVOLVED

The Consortium of the CASES's Co-ordination Action consists of 26 partners established in 20 states; it covers the entire European area and also involves three institutions in two developing continents (Asia and South America).

Most of the institutions are established for their research activities (11) and for higher education (9). The other participants are not specialised in one

particular activity but they provide scientific expertise and carry out complementary activities necessary to achieve the objectives of this Co-ordination Action.

*Table 0.1 List of Institutions and Research Centres Involved in the CASES Project*

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| Institutions involved into the CASES project  |
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| Fondazione Eni Enrico Mattei – FEEM (IT)  |
| University of Bath – UBATH (UK)   |
| National Technical University of Athens – NTUA (GR)   |
| University of Stuttgart – Institute of Energy Economics and the Rational Use of Energy – USTUTT/IER (DE)  |
| Flemish Institute for Technological Research – VITO (BE)  |
| Danish Technical University, Risoe National Laboratory – RISOE/DTU (DK)                                   |
| Observatoire Méditerranéen de l’Energie – OME (FR)  |
| University of Flensburg – UFLENS (DE)   |
| Energy Research Centre of the Netherlands – ECN (NL)  |
| Vrije Universiteit Amsterdam – Institute for Environmental Studies – VU/IVM (NL)                          |
| POYRY/ECON Analysis AS – ECON (NO)  |
| Fundação COPPETEC – COPPETEC (BR)   |
| SWECO Grøner as – SWECO (NO)  |
| Lithuanian Energy Institute – LEI (LT)  |
| Indian Institute of Management Ahmedabad – IIMA (IN)  |
| Energy Research Institute – ERI (CHN)   |
| Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas – CIEMAT (ES)                      |
| Univerzita Karlova v Praze – Charles University Environment Center – CUEC (CZ)                            |
| Stockholm Environment Institute – SEI (SE)  |
| Centre for European Policy Studies – CEPS (BE)  |
| University of Warsaw – Warsaw Ecological Economics Center – UWARS (PL)                                    |
| Energy Agency of Plovdiv – EAP (BG)   |
| Türkiye Bilimsel ve Teknik Arastırma Kurumu – Marmara Research Center, Institute of Energy – TUBITAK (TR) |
| Wageningen Universiteit – WU (NL)   |
| Istituto di Studi per l’Integrazione dei Sistemi – ISIS (IT)  |
| Paul Scherrer Institut – PSI (CH)   |

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## STRUCTURE OF THE BOOK

This volume combines methodology and data on social costs with the evaluation of different instruments of energy policy, and the projection of electricity scenarios. In the book the contributions from the partners of the project are collected and harmonised. The research activities reported range from databases and technical reports on emissions, to private, external and social costs of electricity generation in Europe and in selected non-EU countries, to studies on electricity insecurity and on uncertainties in external costs estimation, to studies on policy assessment and on policy instruments to internalise external costs in the electricity sector and, finally, on electricity scenarios by country and primary fuel for 2010, 2020 and 2030.

This volume is divided into three parts: the first part concerns cost assessment, the second part concerns policy evaluation and the third part provides electricity scenarios up to 2030.

The first part reports on the methodologies and the results regarding private and external costs of electricity generation. The analysis of external costs includes the damage estimation on human health, environment, crops, materials and climate change (Chapter 1). Moreover, the uncertainty on external costs estimation is assessed. In the analysis performed, external costs (Chapter 1) and private costs (Chapter 3) are assessed for the whole life cycle of the power plant, from construction to dismantling, including the cost of extraction and transportation of fuel and waste disposal. Chapter 2 is focused on the assessment of the insecurity of supply externalities and the policy instruments to reduce electricity supply insecurity.

Costs are calculated and assessed for a wide set of technologies, which include nuclear and fossil-fired power plants, renewables and combined heat and power plants. Social costs of electricity are then calculated by summing up the private and external costs, and are assessed as average values of all EU27 countries (Chapter 4). In addition, a country-specific analysis is presented for selected technologies for selected non-EU countries: Brazil, India, China and Turkey (Chapter 5). The time horizon considered includes the present, 2020 and 2030.

The second part of the book focuses on policy evaluation. Chapter 6 reports on a comparative analysis of instruments to internalise externalities in the electricity sector in Europe. A detailed evaluation of alternative policy options for improving the efficiency of energy use and reducing its impact on the environment over the next few decades is developed. This assessment is dynamic and underlines the implications of different levels of internalisation of externalities on the investment decisions and on key social indicators in Europe and in some non-European countries. Policy instruments to promote renewable energy sources in Brazil, China, India and Turkey are analysed.

Chapter 7 illustrates an analysis of the methodologies used for policy evaluation, in particular cost–benefit analysis, cost-effectiveness analysis and multi-criteria decision analysis.

The third part of the book presents innovative electricity scenarios, which take into account social costs, by country and primary fuel, for 2010, 2020 and 2030. This part shows the evolution of energy prices and of the private and external costs of major technologies, likely to be employed to generate energy from different sources over the next 25 years. In addition, it analyses how the technological mix in electricity production will change from the present to the future if external costs are internalised. Chapter 8 describes such scenarios for the EU.

All databases on emissions, external, private and social costs and the tools used for policy evaluation are available to the reader on a dedicated webpage; the detailed instructions to download are provided at the end of the book in the List of Annexes.

The homogeneous data templates are designed for Europe and show the values of emissions and costs for each technology at present, in 2020 and in 2030. The database of external costs includes damage estimation on human health, environment, crops, materials and climate change. External, private and social costs are assessed for the whole life cycle of the power plant, from construction to dismantling, including the cost of extraction and the transportation of fuel and waste disposal.

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