CHAPTER I

Setting the Scene

Introduction

In addition to the purely scientific and technological energy-related issues (such as the influence of energy consumption on global warming phenomenon or the development of energy technology), policy-makers must address the economic and social consequences of their choices. They can support their decisions with projections of socio-economic factors and evaluations of impacts as determined by quantitative tools, mainly economic and energy models.

Speaking about the applications of macro-econometric modelling in France, Paul Zagamé already underlined twenty years ago the important role of models in providing economic information: "Prévisions, variantes analytiques, scénarios complexes et études macro-sectorielles: de cette masse importante de travaux peut se dégager (…) le rôle important que les modèles ont joué dans le dispositif d'information économique"[1].

Recently and more directly concerning energy-related policies, Jean-Charles Hourcade, Mark Jaccard, Chris Bataille and Frédéric Ghersi highlighted that:

> Policy-makers are interested in a better understanding of the effectiveness and cost of policies (…). What technologies would serve this purpose, and how could or would the economy adapt in response to policy to achieve this end? Two contrasting modelling types have developed to answer these questions: conventional Bottom-up models and conventional Top-down models[2].

The focus of this book on economics and energy is justified for two reasons. Firstly because there is a relation between energy consumption and economic growth, as underlined by Jean-Marie Chevalier, "Il existe un lien fort mais complexe entre la consommation d'énergie et le déve-

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1 P. ZAGAME, *L'expérience française de modélisation macro-économétrique: bilan et perspectives*, Revue d'économie politique, No. 5, Paris, 1987.

2 J.C. HOURCADE, M. JACCARD, C. BATAILLE, F. GHERSI, *Hybrid modelling: New answers to old challenges*, The Energy Journal, Special issue, IAEE, Cleveland, 2006.

loppement économique"[3]. Secondly, because most of the models that will be analysed in this book are either Top-down, i.e. economic-oriented, either Bottom-up, i.e. energy technology-oriented.

At the national-level (cf. *Commissariat Général du Plan* – now *Centre d'Analyse Stratégique* – in France or the Department of Energy in the US), European-level (European Commission) and international-level (International Energy Agency), modelling activities provide systematic and quantified information to decision-makers on the expected future according to various scenarios. Scenarios include a "reference case", together with variants appropriate to the issue under study, e.g. impacts of a climate policy on medium to long-term CO_2 emissions, consequences of a gradual nuclear phasing out on the energy mix, effects from an intensive renewable energy scenario on employment, impacts from a depletion of fossil fuel on the energy system, etc.

Without entering in the modelling formalisation (conception, variables, equations, time series, language), the objective of this book mainly consists in analysing the influence of results coming from scientists – in particular economists (Top-down modellers) and engineers (Bottom-up modellers) – on the European decision-making process.

This book does not enter in the debate where economic analysis leads to stronger or weaker regulation[4]. Confronted by various risks and challenges – especially when the future (10 to 50 years ahead) and the potential impacts (costs and benefits) are concerned – are (economic) researchers playing a role in European Union (EU) policy-making? This book aims to demonstrate the answer to this question by providing facts, figures and precise references based on five case studies of EU energy-related policies covering ten years (1995-2005).

Economic and energy modelling must cope with uncertainties that exist in any exercise that "looks ahead" (future) or that evaluates the potential impacts of a specific policy or measure. As Dominique Finon notes

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3 J.M. CHEVALIER, *Les grandes batailles de l'énergie*, Gallimard, Paris, 2004. This complexity is well reflected in the conclusions of a study led by Jan Horst Keppler. Studying the relation between energy consumption and economic growth in ten developing countries, he concluded that China and India show a solid relationship while the other eight did not show a link between various indicators of *per capita* energy consumption and *per capita* income at the five per cent level of significance. J.H. KEPPLER, *Causality and cointegration between energy consumption and economic growth in developing countries*, in J.H. KEPPLER, R. BOURBONNAIS, J. GIROD (eds.), *The econometrics of energy systems*, Palgrave Macmillan, New York, 2007.

4 R. MORGENSTERN, *Economic analysis at EPA: Assessing regulatory impacts, Resources for the Future*, Washington, DC, 1997.

La combinaison d'hypothèses dynamiques sur les technologies, les comportements, la perception des raretés et la croissance conduit à un multi équilibre, c'est-à-dire à un éventail très vaste de futurs. Mais il ne reflète pas la réalité de l'incertitude globale sur la trajectoire d'ensemble, car les paramètres des systèmes technologique, économique et social interagissent entre eux pour opérer la sélection des futurs[5].

Even if the efficiency of the mathematical tools has been demonstrated in some sciences (like in physics) and the efficiency of informatics has been largely improved these last thirty years, this efficiency has not the same characteristics in economy. For example, in the energy field, it is still very difficult to anticipate the price of fuels, the energy demand or the behaviours of the agents in liberalised energy markets.

J.M. Chevalier highlights the weaknesses of the model results in the energy field.

Malgré la sophistication des outils utilisés, la prévision énergétique pure demeure un exercice impossible. On s'est tellement trompé dans le passé que l'on a aujourd'hui la certitude de ne pas savoir prévoir. On s'est trompé sur l'évolution des prix, le volume des ressources, le niveau attendu de la demande, les coûts estimés de telle ou telle forme d'énergie[6].

That is also why several authors prefer to represent uncertain factors through scenarios. As Peter Schwartz wrote:

Tout modèle économétrique repose sur une série d'hypothèses traitant de la manière dont fonctionne le monde. Le processus d'élaboration d'un scénario est particulièrement utile lorsqu'il s'agit de réfléchir aux conséquences des changements fondamentaux et des discontinuités qui mettent en cause ces hypothèses[7].

Nevertheless, this difficult nature of the economic and energy modelling does not reduce the important value – according to our initial postulate – of these studies for supporting EU energy-related policy-making. Their value lies in the systematic approach that can provide quantitative assessments of the impacts of policy measures and the factors that can affect or modify those impacts. Moreover, as Albert Strub underlined at the end of the 1970s: "The critical use of energy modelling can help, better than any intuitive effort, to narrow down the

5 D. FINON, *Prospective énergétique et modélisation – Identification de pistes de progression méthodologique*, Note au Conseil Scientifique de l'Institut français de l'Énergie, Paris, juin 2003. A shorter version of this paper can be found in D. FINON, *Prospective énergétique et modélisation de long terme: les voies de progression méthodologique*, Revue de l'Énergie, No. 553, janvier 2004.

6 J.M. CHEVALIER, *Les grandes batailles de l'énergie*, *op. cit.*

7 P. SCHWARTZ, *La planification stratégique par scénarios*, Futuribles, Paris, mai 1993.

multitude of possible future choices to those most promising economically and in particular to those most attractive to our society"[8].

At the EU-level, in the field of energy, some examples of recent issues justify the interest of this book: What is the impact of a EU-wide energy taxation? What medium to long-term target (for renewable energy sources, for energy efficiency, or for combined heat and power) has to be fixed? What is the most cost-effective or cost-benefit climate change policy? What monetary value has to be attributed to energy socio-environmental damages (external costs)?

Even within the chosen areas (taxation, energy and environment targets, etc.), the analysis reported here is selective: it covers mainly the quantitative tools, the EU policies in the energy-related field and the specific period since the middle of the 1990s to 2005. Many economic studies are broad in their scope and contribute to several of the aspects with which this work is concerned. Their outputs may be omitted in certain contexts simply in order to focus on the scope of the book, i.e. economic and energy modelling with EU decision-making process.

This book has the objective to detect the influence, if any, of the European energy economic research on EU policy-making. More specifically, the aim is to make an analysis of EU-decisions in energy-related fields and to underline the reasons of such choices, i.e. putting in evidence – and that is the main assumption – the role of economic research results in final EU policy decisions[9].

As Alan Manne, Richard Richels and John Weyant pointed out thirty years ago

> Energy policy is an interdisciplinary field. It involves economics, law, politics, engineering, resource geology, biomedical impacts, and environmental risk assessment – along with the methodologies that are already familiar to the operations researcher: optimization algorithms, simulations, decision analysis and econometric estimation. Unlike business applications in the private sector, it is exceedingly difficult to determine the impacts of these studies[10].

By answering to the question of modelling influence on the European policy-making in the energy-elated field, the following issues will be covered:

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8 A. STRUB, *Energy systems analysis*, International Conference of Dublin, 9-11/10/1979, D. Reidel-Kluwer, ECSC-EEC-EAEC, Brussels and Luxemburg, 1980.

9 D. ROSSETTI di VALDALBERO, *Energy market regulation: Impacts of EU research*, in Ch. BÖHRINGER, A. LANGE, *Applied research in environmental economics*, ZEW-Physica-Verlag, Heidelberg, 2005.

10 A. MANNE, R. RICHELS, J. WEYANT, *Energy policy modelling: a survey*, Operations Research, Vol. 27, No. 1, 1979.

- EU energy research dealing with nuclear (fission and fusion) and non nuclear research, essentially fossil fuels, energy efficiency, renewables, fuels cells and hydrogen highlighting the economic research in energy also called "energy system" research or "energy strategic" research undertaken since the 1970s in Europe[11].
- Qualitative *versus* quantitative instruments, i.e. the scientific controversies on energy foresight taking into consideration the various tools for looking at the future(s) and for evaluating policies such as Scenario method, Delphi surveys, economic and energy models, or longer-term exercises like the ones developed by Shell or by the Intergovernmental Panel on Climate Change (IPCC)[12].
- Top-down and Bottom-up models with their economic or technological explicitness, with some critical issues (database, paradigms, assumptions, exogenous parameters, driving forces, invariants, "reference", policy scenarios, sociological aspects and technical and geographical representations), with long-term challenges and "backcasting" approach, and with the treatment of technological progress and climate change policies[13].

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[11] D. ROSSETTI di VALDALBERO, B. SCHMITZ, W. RALDOW, M. POIREAU, *European Union energy research*, Revue de l'Énergie, No. 576, Paris, March-April 2007.

[12] G. BERGER, *L'attitude prospective*, Revue prospective, No. 1, 1958; J. DURAND, *Prospective*, *discontinuité et instabilité*, Futuribles, Paris, Automne 1975; D.H. MEADOWS, D. MEADOWS, J. RANDERS, W. BEHRENS, *Limits to Growth*, Universe Books, New York, 1972; P. WACK, *La planification par scénarios*, Futuribles No. 99, Paris, mai 1986; J. LESOURNE, Ch. STOFFAES, *La prospective stratégique d'entreprise – Concepts et études de cas*, Intersections, Paris, 1996; M. GODET, *The art of scenarios and strategic planning: Tools and pitfalls*, Technological Forecasting and Social Change, New York, 2000; K. VAN DER HEIJDEN, P. SCHUTTE, *Key questions for designing scenario applications*, Scenario and Strategy Planning, Vol. 1, No. 6, 2002; Shell, *Energy needs, choice and possibilities: scenarios to 2050*, London, 2001; IPCC, *Climate change, fourth assessment report*, Summary for policymakers, WMO/UNEP/IPCC, 2007.

[13] C. BOEHRINGER, *The synthesis of Bottom-up and Top-down in energy policy modelling*, Energy Economics, No. 20, 1998; P. CAPROS, L. MANTZOS, P. CRIQUI, N. KOUVARITAKIS, A. SORIA RAMIREZ, L. SCHRATTENHOLZER, E.L. VOUYOUKAS, *Climate technology strategies*, Physica-Verlag, Germany, 1999; N. NAKICENOVIC, W.D. NORDHAUS, R. RICHELS, F.L. TOTH, *Integrative assessment of mitigation, impacts, and adaptation to climate change*, IIASA, Laxenburg-Austria, 1994; M. GRUBB, J. EDMONDS, *The cost of limiting fossil fuel CO_2 emissions – a survey and analysis*, Annual Review of Energy and Environment, Vol. 18, 1997; P. CRIQUI, L. VIGUIER, *The costs of CO_2 reduction and the impact of flexibility mechanisms in meeting the Kyoto targets*, Int. J. Global Energy Issues, 2000; D. FINON, *Prospective énergétique et modélisation de long terme: les voies de progression méthodologique*, *op. cit.*; J. GIROD, *Dynamic demand analysis and the process of adjustment*, in J.H. KEPPLER, R. BOURBONNAIS, J. GIROD (eds.),

- Reliability of model results analysing past projections (1985) with current statistical data and putting in evidence where and why some forecasts were extremely close or far to what really happened. This evaluation is based on the European "Energy 2000 study" that used the EFOM optimisation model and the MEDEE energy demand foresight model[14].
- Comparison of EU, international and US Bottom-up modelling-based studies of energy (WETO, WEO and IEO) allowing to "benchmark" the studies and to show the extent of agreement or difference among assumptions and results of the "Reference case" of the three studies covering the world with the 2030 timeframe[15].
- Science and society, research and policy interactions by underlying the EU *sui generis* decision-making process, the initiative power of the Commission, the specific EU Governance including the "comitology", the "scientific support to policies" highlighted in the European Research Area Communications, the use of expertise and the "Impact assessment"[16].

The econometrics of energy systems, *op. cit.*; L.R. KLEIN, *The Making of National Economic Forecasts*, Edward Elger, London, 2009.

14 J.F. GUILMOT, D. McGLUE, P. VALETTE, C. WAETERLOOS, *Energy 2000*, European Commission, Luxembourg, 1986; LAPILLONNE B., CHATEAU B., *The MEDEE model for long term energy demand forecasting*, Socio-Economic Planning Sciences, Vol. 15, issue 2, 1981; D. FINON, *Scope and limitations of formalized optimization of a national energy system*, in A. STRUB (ed.), *Energy models for the European Community*, IPC Science and Technology Press Limited, 1979; P.A. PILAVACHI, Th. DALAMAGA, D. ROSSETTI di VALDALBERO, J.-F. GUILMOT, *Ex-post evaluation of European energy models*, *Energy Policy*, Vol. 36, 2008.

15 European Commission, *World Energy Technology Outlook-2050 (WETO-H2)*, Luxembourg, 2006; International Energy Agency, *World Energy Outlook (WEO)*, Paris, 2006; US Department of Energy (EIA), *International Energy Outlook (IEO)*, Washington, 2006.

16 H. WALLACE, W. WALLACE, M.A. POLLACK, *Policy-making in the European Union*, Oxford University Press, 2005; F. CHALTIEL, *Le processus de décision dans l'Union européenne*, La Documentation française, Paris, 2006; J. RICHARDSON, *European Union – power and policy-making*, Routledge, 2006; Y. MENY, P. MULLER, J.-L. QUERMONNE, *Politiques publiques en Europe*, L'Harmattan, Paris, 1995; B. STEUNENBERG; C. KOBOLDT, D. SCHMIDTCHEN, *Comitology and the balance of power in the European Union*, International review of Law and Economics, 1996; W. WESSELS, *Comitology: fusion in action – Politico-administrative trends in the European Union system*, Journal of European Public Policy, Vol. 5, No. 2, 1998; European Commission, *European Governance – a White Paper*, COM(2001)428; European Commission, *Towards a European Research Area*, COM(2000)6; European Commission, *Making a reality of the ERA: guidelines for EU research activities (2002-2006)*, COM(2000)612; European Commission, *Communication on the collection and use of expertise by the Commission: Principles*

This book is multidisciplinary, treating different topics (energy, research, environment), but is most related to economics (models) and political science (decision-making). Although it also addresses EU legal and institutional issues – like the "new EU legislative culture" – and some engineering (Bottom-up) modelling results, this book focuses essentially on economic research and its role on the EU policy-making in the energy-related fields.

Up to now, this question has only been marginally explored on the theoretical side. This publication – also getting insights from experience – is therefore necessary to conceptualise the issues of scientific support to EU policies and eventually to improve the decision-making in Europe.

Methodology

The methodology starts from an experience-based established fact (*constat*); in the European Union, a policy initiative succeeds in its implementation if it receives a three-level support:

- If it responds to immediate economic and social needs, i.e. if the initiative is economically feasible and socially acceptable at a certain moment under specific conditions. It has often been mentioned in the literature that the conjunctural factor (*facteur conjoncturel*) plays a key role in the European construction. The role of "stakeholders" – of the representation of economic and social interests – is particularly relevant here[17].
- If there is adequate consensus among the major EU political actors, i.e. if the initiative can be subject to a broad agreement from Member States (Council), the European Parliament and the European Commission. The role of Ministers, Deputies and Commissioners as well as political parties and national and EU administrations are determinants[18].

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and guidelines – Improving the knowledge base for better policies, COM(2002)713; European Commission, *Communication on Impact Assessment*, COM(2002)276.

17 M. ARTIS, F. NIXSON, *The economics of the European Union*, Oxford University Press, 2007; J.-C. DEFRAIGNE, *Economie européenne et politique*, L'Harmattan, Paris, 2004; A. LAMFALUSSY, L. BERNARD, A. CABRAL, *The Euro-zone: A new economic entity?*, Bruylant, Bruxelles, 1999; S. DESSELAS, *Un lobbying professionnel à visage découvert*, éd. du Palio, 2007; J.-D. GIULIANI, *Marchands d'influence*, Seuil, Paris, 1991; H. MICHEL, *Lobbyistes et lobbying de l'Union européenne*, Presses universitaires de Strasbourg, 2006; J. GREENWOOD, *Interest representation in the European Union*, Palgrave, 2007.

18 H. WALLACE *et al.*, Policy-making in the European Union, *op. cit.*; F. CHALTIEL, *Le processus de décision dans l'Union européenne*, *op. cit.*; J. RICHARDSON, Eu-

- If – in the energy and environment fields – the scientific community is in accord, i.e. if the initiative gets a large and shared scientific consensus. The role of scientists, mostly academics – but also from research centers, consultant companies, think tanks or sometimes from private firms – is crucial in the up-stream EU decision-making process.

The two first "supports" are largely studied from an economic, legal, political science, sociological or historical perspective. They are directly or indirectly part of the main master or doctoral courses delivered by the "EU institutes" existing nowadays in most European universities or by specialised academic institutions like the College of Europe in Bruges, the European Institutes from the Catholic University of Louvain or the Brussels University or the European University Institute in Florence. Several European research networks, Brussels-based Think-tanks, or Foundations also largely deal with these two supports like the Centre for Economic Policy Research (CEPR), the Centre for European Policy Studies (CEPS), the European Policy Centre (EPC), the European Centre for International Political Economy (ECIPE), the Brussels European and Global Economic Laboratory (BRUEGEL), the Friends of Europe, the Madariaga or the Robert Schuman Foundations.

De facto, these two "internal" supports (economic and social from one side, and political from the other side) have largely been studied by several academics in the whole range of social sciences[19].

The last policy support, the role of scientists in EU policy-making has essentially been tackled from a "Risk governance" perspective and mainly in relation to the influence of experts in natural sciences or medicine in human health, agro-food sectors or environment. Several publications concerned for example the role of scientists in EU policy issues like genetically modified organisms or mad cow disease (BSE crisis)[20].

ropean Union – power and policy-making, *op. cit.*; L. CARTOU, J.-L. CLERGEVIE, A. GRUBER, P. RAMBAUD, *L'Union européenne*, Dalloz, Paris, 2006.

19 The term "internal EU support" is used as another important support to EU initiatives comes from "external" forces, e.g. USA and the Soviet Union during the Cold War. Several academic papers and seminars focused on the international relations and geopolitical aspects influencing the EU integration like those from the "Institut Français des Relations Internationales" (IFRI), the UK Royal Institute of International Affairs – Chatham House – or the "Italian Istituto Affari Internazionali" with their respective publications (*RAMSES*, *International Affairs Journal*, *IAI Quaderni*). P. BONIFACE, *Les relations internationales de 1945 à nos jours*, Dalloz, Paris, 2005.

20 H. TORGERSEN, *The real and perceived risks of genetically modified organisms*, EMBO, 2004; C. JAEGER, O. RENN, E. ROSA, T. WEBLER, *Risk, uncertainty and rational action*, Earthscan, London, 2001; N. NEUREITER, *Challenges of providing scientific advices to governments*, JRC, Ispra, 26/10/2008.

Regarding genetically modified (GM) products, the Commissioner in charge of Agriculture said in 2008:

> I am certainly not arguing that we should authorise imports of GM products which science has told us to reject. But where science has given a product a clean bill of health, that fact must be paramount as we follow the authorisation procedure[21].

Food safety has been a subject particularly addressed these last few years in the EU. There is evidence that "Scientific advisory committees in Brussels tend to reflect approaches of national governments", as pointed out by Christoph Srünck. To manage this distortion, a European Food Safety Authority has been established[22]. Its primary responsibility is to provide independent scientific advice on all matters with a direct or indirect impact on food safety.

Environment is a subject where the need for and legitimacy of scientific support has been recognised since the Single European Act in 1986 and the establishment of one of the first European specialised Agency, the European Environment Agency in 1990. The Commission Climate Change "Adaptation" Green Paper clearly stated that "Sound scientific results are paramount in the development of climate policy"[23].

Concerning social scientists influence on EU decision-making, the academic literature is mostly limited to their role as "experts" in the so-called "Comitology", in different "working expert groups" and in the evaluation of European programmes and projects[24]. Frédéric Allemand

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21 M. FISCHER BOEL, *Food, feed or fuel: a measured policy on agricultural markets*, Meeting with Bundesvereinigung der Deutschen Ernährugsindustrie, Berlin, 18 January 2008.

22 Ch. SRUENCK, *Why is there no mad cow disease in the United States? Comparing the politics of food safety in Europe and the U.S.*, Working Paper, Institute of European Studies, University of California, Berkeley, December 2001; H. VOS, F. WENDLER, *Food safety regulation in Europe*, Intersentia, Antwerpen-Oxford, 2006; J. BOURINET, F. SNYDER, *La sécurité alimentaire dans l'Union européenne*, Bruylant, Bruxelles, 2003.

23 European Commission, *Green Paper, Adapting to climate change in Europe – options for EU action*, COM(2007)354.

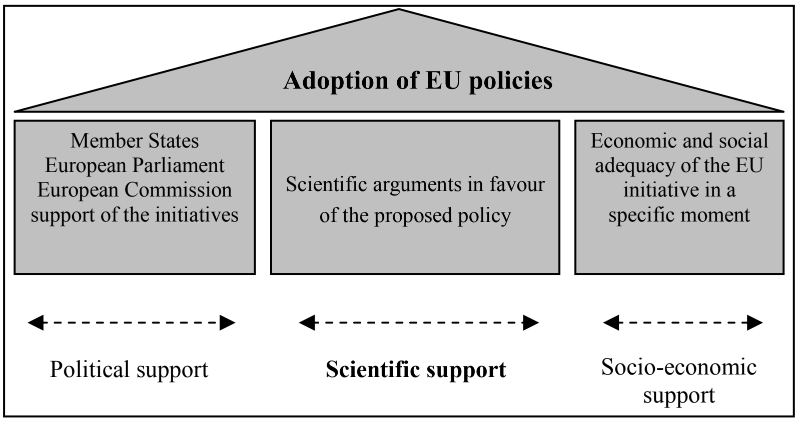
24 B. STEUNENBERG; C. KOBOLDT, D. SCHMIDTCHEN, *Comitology and the balance of power in the European Union*, International review of Law and Economics, 1996; W. WESSELS, *Comitology: fusion in action – Politico-administrative trends in the European Union system*, *op. cit.*; T. CHRISTIANSEN, T. LARSSON, *The role of committees in the European-Union policy-process*, Edward Elgar, 2007; U. PUETTER, *Providing venues for contestation: The role of expert committees and informal dialogue among ministers in European economic policy coordination*, Comparative European Politics, Vol. 5, Palgrave Macmillan, 2007.
The role of scientists is also large in the evaluation of EU programmes. For example, in the EU Framework Programme (€ 54 billion for the seventh RTD FP covering the 2007-2013 period), the funding decisions are based on peer review of research pro-

highlights that with the increasing technicity of the subjects, the experts committees become stronger and stronger and the role of ministers is more and more limited:

> La technicité des sujets reporte les discussions au sein des comités d'experts, réduisant les formations ministérielles à une simple fonction de chambre d'enregistrement. Les Ministres lisent les propositions préparées en amont[25].

The interaction among social sciences, especially economics, energy and policy-making in Europe has never been analysed in an in-depth way. The methodology developed here focuses on a specific field – energy –, on a specific policy system – European Union, and on a specific period – 1995-2005.

Figure I.1: Economic and social support, political support, and scientific support needed for the adoption of EU policies



Based on a theoretical background and on five case studies, the methodology specifically tackles the issue of economic and energy modelling with EU decision-making from different approaches:

- Description of EU energy research by statistics and history (Chapter II);

posals. External experts (mainly scientists called "evaluators") are at the core of the system. Over 50,000 evaluators – including thousands of social scientists – were registered in the database by the end of the sixth Framework Programme (2006). About 4,000 independent experts are engaged every year by the European Commission to evaluate about 16,000 proposals per year.

25 F. ALLEMAND, *L'Union pour la Méditerranée: Pourquoi? Comment?*, Fondation pour l'innovation politique, Paris, Juin 2008.

- Analysis of scientific controversies on quantitative and qualitative tools for energy foresight by literature review and examples of international studies (Chapter III);
- Assessment of potential methodological improvements on Top-down and Bottom-up models by studies and experience on EU energy economic research activities (Chapter IV);
- Description of EU modelling tools by illustrative representation of the economic and energy systems (Chapter V);
- Demonstration of the role of economists (modellers) in EU energy-related policies through five case studies (Chapter VI);
- Validation of modelling results by *ex-post* evaluation and by comparison of EU, international and USA energy outlook reports (Chapter VII);
- Identification of the role of experts in EU policy-making by legal analysis, *de facto* implementation means and deduction from previous chapters (Chapter VIII).

The last part of the work contains a final discussion and concluding messages (Chapter IX) as well as a meta-conclusion on the future of modelling in the EU decision-making process.

In drafting this book, the author considers that his professional life at the European Commission and his consequent experience of EU decision-making process have been an asset. It has facilitated access to relevant documents (cf. Commission staff working documents or preparatory studies made for the "Impact Assessment" of a specific initiative), but also has engendered a personal experience of the influence of scientists in EU energy-related policies.

The author considers that his situation allowed him to help to theorise some important aspects – but often neglected – of EU decision-making, i.e. the role of scientists and in particular of economic and energy modellers in up-stream EU policy-making. In addition, this publication is a further step for increasing the transparency of the EU decision-making process, in particular in its crucial initial political phase.

Although involved in the development of EU energy economic research and in EU-energy-related policies, the author has taken care of being impartial in the assessment of the information analysed in this book. In addition, in order to respect his "devoir de réserve" as European civil servant, the author has explicitly addressed EU policy cases up to 2005 (and not later) while this book is published in 2010.

Structure of the work

The first step aims to highlight the EU "Economic research in energy" also called "Strategic energy research". What topics and what budgets were dedicated to scientists, mainly energy economists, from the first to the sixth EU RTD Framework Programme. In this chapter, a complete state of the art of the purely EU energy RTD (i.e. not the Member States but only the Community Framework Programmes priorities and expenditures) is made. A distribution among the energy RTD topics and linked budgets (nuclear fission, nuclear fusion, and non nuclear energy) is provided. This work has never been done and up to now, no statistics existed per energy sub-topics at the EU-level. During these last two decades, it should be remembered that the budget of the Framework Programmes represented about 4% of the European Community's budget and approximately 6% of the EU's public civilian research investment.

The RTD expenditures dedicated to economic research in energy are highlighted in the six Community RTD Framework Programmes (1984-1987, 1987-1991, 1990-1994, 1994-1998, 1998-2002 and 2002-2006). This part of the work requires an in-depth analysis of the EU funding in the energy field. As the RTD Framework Programmes have only budgetary divisions in terms of "macro topic" such as energy, biotechnology, information and communication technologies, etc. a "project by project" evaluation is performed. This is the only way to get a real picture of the EU priorities and funding sub-division in the energy field. The breakdown is made between nuclear (fusion and fission) and non nuclear RTD and among non nuclear fields, i.e. essentially economic research on energy, fossil fuels, energy efficiency, CO_2 capture and storage, fuel cells, hydrogen and storage, and renewables – with a distinction among wind, photovoltaic, biomass, geothermal, solar, ocean, hybrid renewables and distributed generation.

The economic research on energy launched in the 1970s assumes today the role of "scientific support to policies". Since 2000, this has been formalised in two Commission Communications concerning the *European Research Area*: "Developing the research needed for political decisions…" and "Support for policy-making and European scientific reference system…"[26]. In addition, these research activities supporting EU policies were a precursor of the formal *Impact Assessment* "which identifies the likely positive and negative impacts of proposed policy

[26] European Commission, *Towards a European Research Area*, *op. cit.*; European Commission, *Making a reality of the ERA: guidelines for EU research activities (2002-2006)*, *op. cit.*

actions, enabling informed political judgements"[27]. Since 2003, an Impact Assessment is obligatory for all Commission major initiatives; the intention is to improve the quality and coherence of the policy development process ("better regulation" as indicated in the 2001 Commission White Paper on European Governance)[28].

In this first part of the book, EU energy research priorities and budgets are detailed. The share of socio-economic research in energy (or, more recently called research dedicated to policy support) is about 3-4% on non nuclear energy research. The main topics addressed concern the:

- Development of tools for energy strategy (modelling, forecasting and new paradigms for a lower carbon energy sector);
- Methods for the economic and environmental assessment of energy production and consumption including the monetary valuation of externalities;
- Elaboration of scenarios for energy supply and demand technologies and their interaction, and the analysis of cost effectiveness (based on full life cycle costs) and efficiency of all energy sources;
- Social acceptability, behavioural changes and international dimension related to sustainable energy RTD.

The majority of the EU energy economic research projects makes the links between energy and environment and addresses the issues of natural resources, economic growth and social needs, including both market competition and environmental constraints, Top-down and Bottom-up approaches. Among the main topics covered by the EU energy economic research, it is worthwhile mentioning the Economics, Energy and Environment (E3) models and the energy external cost-related activities. The budget allocated to EU energy economic research is estimated at around € 3-4 Million per year.

This first part of the book is original, but mainly descriptive; it provides the statistics and the historical evolution of EU energy RTD essentially based on European Commission sources.

Chapters III and IV ("Scientific controversies on energy foresight" and "Economic and energy modelling") are analytical and theoretical. Based on the academic literature on foresight and economic/energy modelling, these chapters:

- Aim to highlight the scientific debate on quantitative and qualitative tools dealing with energy futures and with the evaluation of impacts of potential policies and measures (scenarios);

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27 European Commission, *Communication on Impact Assessment*, *op. cit.*

28 European Commission, Communication, European Governance – a White Paper, *op. cit.*

- Synthesize the main strengths and weaknesses of these foresight and modelling tools also largely taking on board EU research in this field;
- Suggest some potential methodological improvements like a better dialogue between economists and technologists, between micro-economic realism and macro-economic completeness and between energy supply and demand sides

Starting from illustrative energy futures studies, such as those performed by the European Commission, the International Energy Agency, or the US Department of Energy, these chapters provide a new conceptual framework and theoretical classification in terms of:

- Quantitative (model-oriented) or qualitative (Delphi-oriented) approaches;
- Stakeholder (participatory) or expert-based works;
- Socio-political wide or techno-economic problem-solving scopes.

Most of the methods and tools dealing with the energy futures are addressed and discussed and the main critical points are highlighted. Two specific concerns are particularly underlined: making forecasts of the long-term (about 100 years) and technological progress (learning curves) especially in relation to policies for the mitigation/adaptation to climate change.

Several results from EU research projects quoted in Chapter II are given in these Chapters III and IV.

Chapter V is dedicated to the description of the main quantitative tools, essentially Economics, Energy and Environment (E3) models and methodologies developed by European researchers in the framework of the EU economic research in energy (cf. Chapters II, III and IV). These tools and methodologies are covering the world and/or the EU, are oriented towards the macro-economic issues or detailing the energy sector – sometimes focusing on specific issues like renewable energy sources and rational use of energy – or are quantifying the social and environmental damages, i.e. the energy external costs. The basic schemes of the EU macro-economic model (GEM-E3), the World and EU energy models (POLES and PRIMES), the EU energy softwares for renewables (SAFIRE) and for rational use of energy (MURE) and the EU external costs accounting framework (EXTERNE) are presented in this chapter.

Chapter VI is the empirical part of the book. Based on five case studies in the energy-related field, an assessment of EU policies (Commission "Communications", Commission proposals for directives, European Parliament and Council directives) is accomplished. The analysis addresses in particular the "origin of the figures" such as the impact of EU energy taxation, the cost of Kyoto and the economics of the EU emission trading system, the target for renewable electricity, the potential for energy efficiency, or the value of the electricity external costs. A particular attention is dedicated to the analysis of the Official Journal of the European Communities, the Commission staff working documents and the EU studies. Concretely, the following five EU case studies (political initiatives and decisions) in the energy-related field under the period 1995-2005 are analysed:

- The Community framework for energy taxation and in particular the proposal for a directive restructuring the Community framework for the taxation of energy products;
- The European Union Climate Change policy and in particular the Green Paper and the proposal for a Directive on greenhouse gas emission trading within the EU;
- The promotion of from renewable energy sources in Europe and in particular the Directive on the promotion of electricity from renewable energy sources;
- The Energy efficiency in the European Community;
- The measurement and the internalisation of external costs in Europe and in particular the Community guidelines on State aid for environmental protection.

This chapter makes the link between theory and practice. It reveals how EU energy economic research (Chapter II) and in particular its quantitative tools (Chapter V) are directly used in the preparation of EU policy-making in the energy field. It demonstrates by facts, figures and references the weight of scientists, mainly economists, in the up-stream EU decision-making.

After the case study demonstration of the impact (*ex ante*) of economic research work (quantitative tools) on EU decision-making (use of model results in EU policies), Chapter VII deals with an *ex-post* evaluation of an energy futures exercise (cf. Chapters III and IV) led in the middle of 1980s for the EU at the end of the century. In fact, to date there have been few careful comparisons between the realized and the forecast effects in the energy system although it is useful to make some evaluation of the accuracy of prospective estimates. Comparing the results of the (1985) European Commission study "Energy 2000" – performed with the so-called MEDEE and EFOM models – with current Eurostat data aims to highlight the similarities and the differences between the projection results and the real data in terms of overall energy consumption and in terms of individual energy source and technology.

The model "benchmarking" is also completed through a comparison of three Bottom-up modelling-based studies published by the European

Commission (EC-WETO), the International Energy Agency (IEA-WEO) and the US Department of Energy (US-IEO). Comparison of the assumptions and results by 2030 demonstrate where high concordances or relatively large differences exist among world energy models (POLES, WEM and SAGE).

Looking at the "origin of the figures" provided in the EU policies (case studies), Chapter VIII concerns the interaction of science and society, more particularly of research results and policy-making at the EU-level.

The specificities of the decision-making process at the EU-level is underlined, especially the "techno-political" role of the Commission. The increasing role of the "soft law" including the Communication, Green and White papers is recognised. In these official, but not legally binding documents, the role of the scientists – in particular economic modellers for energy-related policies – is obvious and important although too often neglected in the literature.

The role of experts in up-stream decision-making is not only captured in several EU legal acts (from the European Treaty to the guidelines on the use of expertise) but also in practice through the so-called "Comitology" and Impact Assessment.

Several messages are underlined in the last concluding chapter. They are related to EU energy and research policies; to qualitative and quantitative tools for energy policy analysis; to economics, energy and environment modelling and its links (interactions) with EU decision-making; to the "power of scientists" in up-stream EU policy-making. Finally, the author highlights some future modelling challenges with respect to EU policy-making.

Although the author recognises the importance of "policy drivers" in the development of new modelling tools, e.g. the fact that the oil crises in the 1970s, the sustainable development concept in the 1980s and the liberalisation of the energy markets in the 1990s have given a great impetus in the generation of new models, this subject is not covered in this book.